ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Semester I (First year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P	C	CIE	SEE	Total
1	Basic Science course	20ABS9901	Algebra and Calculus	3	-	-	3	30	70	100
2	Basic Science courses	20ABS9903	Engineering Physics	3	-	-	3	30	70	100
3	Engineering Science Courses	20AES0202	Basics of Electrical & Electronics Engineering	3	-	-	3	30	70	100
4	Engineering Science Courses	20AES0301	Engineering Graphics	1	-	4	3	30	70	100
5	Engineering Science Courses	20AES0501	Problem Solving and Programming	3	-	-	3	30	70	100
6	Engineering Science Courses (LAB)	20ABS9908	Engineering Physics Lab	-	-	3	1.5	30	70	100
7	Basic Science course (LAB)	20AES0204	Basics of Electrical & Electronics Engineering Lab	-	-	3	1.5	30	70	100
8	Engineering Science Courses (LAB)	20AES0503	Problem Solving and Programming Lab	-	-	3	1.5	30	70	100
			Total credits				**19.5**	**240**	**560**	**800**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: I **Semester**: I **Branch of Study: Common to All**

Subject Code	Subject Name	L	T	P	Credits
20ABS9901	**Algebra and Calculus**	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Apply the matrix algebra techniques for solving various linear equations.
CO2. Analyze the linear transformations of quadratic forms and importance of mean value theorems.
CO3. Apply the fundamental concepts of partial derivatives for multi variable functions.
CO4. Evaluate the multiple integrals in Cartesian, polar, cylindrical, and spherical co-ordinate systems.
CO5. Evaluate the improper integrals using special functions like Beta and Gamma.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	Matrix algebra techniques	solving various linear equations		**L3**
2	Analyze	Linear transformations	Quadratic forms and Mean value theorems.		**L4**
3	Apply	Fundamental concepts of partial derivatives	for multi variable functions		**L3**
4	Evaluate	Multiple integrals	in cartesian, polar, cylindrical, and spherical co-ordinate systems		**L5**
5	Evaluate	Improper integrals	using special functions like Beta and Gamma		**L5**

Syllabus:

Unit I: Matrix Operations and Solving Systems of Linear Equations
Rank of a matrix by echelon form, solving system of homogeneous and non-homogeneous equations linear equations. Eigen values and Eigen vectors and their properties, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem.

Unit II: Quadratic Forms and Mean Value Theorems
Diagonalisation of a matrix, quadratic forms and nature of the quadratic forms, reduction of quadratic form to canonical forms by orthogonal transformation.
Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders (without proof).

Unit III: Multivariable calculus
Partial derivatives, total derivatives, chain rule, change of variables, Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

Unit IV: Multiple Integrals
Double integrals, change of order of integration, double integration in polar coordinates, change of Variables in double integration (Cartesian to polar), areas enclosed by plane curves. Evaluation of triple integrals.

Unit V: Special Functions
Beta and Gamma functions and their properties, relation between beta and gamma functions, Bessel functions, Bessel's equation, Recurrence formulae or $J_n(x)$, Generating function- Orthoganality of Bessels functions.

Textbooks:
1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

References:

1. Dr.T.K.VIyengar, B.Krishna Gandhi, S. Ranganathamamd M.V.S.S.N Prasad, Mathematics – 1, S.Chand publications.
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
3. B.V.Ramana, Higher Engineering Mathematics, McGraw Hill Education.
4. N.Bali, M.Goyal, C.Watkins, Advanced Engineering Mathematics, Infinity Science Press.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Algebra and Calculus	CO1		2												
	CO2	3													
	CO3	3													
	CO4		3												
	CO5		3												

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	14	21.21	3	Apply	L3	PO2	Apply (L3)	3
2	10	15.15	2	Analyze	L4	PO2	Analyze (L4)	3
3	14	21.21	3	Apply	L3	PO1	Apply (L3)	3
4	14	21.21	3	Evaluate	L5	PO1	Apply (L3)	3
5	14	21.21	3	Evaluate	L5	PO1	Apply (L3)	3
	66	100						

Justification Statements:

CO1: Apply the matrix algebra techniques for solving various linear equations**.**
Action Verb: Analyze **(L4)**
PO2 Verbs: Analyze (L4)
CO1 Action Verb is equal to PO2 verb; Therefore correlation is high (3).
CO2: Analyze the linear transformations of quadratic forms and importance of mean value theorems**.**
Action Verb: Analyze **(L4)**
PO2 Verbs: Analyze (L4)
CO2 Action Verb is equal to PO2 verb; Therefore correlation is high (3).
CO3: Apply the fundamental concepts of partial derivatives for multi variable functions**.**
Action Verb: Apply **(L3)**
PO2 Verbs: Analyze (L4)
CO3 Action Verb is equal to PO2 verb; Therefore correlation is high (3).
CO4: Evaluate the multiple integrals in cartesian, polar, cylindrical, and spherical co-ordinate systems.
Action Verb: Evaluate (L5)
PO1 Verb: **Apply** (L3)
CO4 Action Verb is high level to PO1 verb; Therefore correlation is high (3).
CO5: Evaluate the improper integrals using special functions like Beta and Gamma**.**
Action Verb: Evaluate (L5)
PO1 Verb: **Apply** (L3)
CO4 Action Verb is high level to PO1 verb; Therefore correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: I **Semester**: I **Branch of Study: CE&ME**

Subject Code	Subject Name	L	T	P	Credits
20ABS9903	**Engineering Physics**	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Analyze the fundamental concepts of mechanics and gravitation.

CO2. Apply the basic principles of acoustics and ultrasonics for engineering problems.

CO3. Analyze the properties and applications of dielectric and magnetic materials.

CO4. Analyze the fundamentals of Lasers and optical fibers.

CO5. Analyze the working principles of sensors for engineering problems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Analyze	the fundamental concepts of mechanics and gravitation			**L4**
2	Apply	the basic principles of acoustics and ultrasonics		for engineering problems	**L3**
3	Analyze	the properties of dielectric and magnetic materials.			**L4**
4	Analyze	the fundamentals of lasers and optical fibers.			**L4**
5	Analyze	the working principles of sensors		for engineering problems.	**L4**

Syllabus:

Unit I: Mechanics

Basic laws of vectors and scalars –Conservative and non-conservative forces- Vector differentiation and Gradient, F = - gradV - Angular momentum and Torque-Conservation of Energy, Momentum and Angular Momentum - motion of variable mass system, motion of a rocket -Moment of Inertia-radius of Gyration-Gravitational Force, Field and Potential- Kepler`s Laws-Proof of Kepler`s laws.

Unit II: Acoustics and Ultrasonics

Introduction to Acoustics – Reverberation – Reverberation time– Sabine's formula- Derivation using growth and decay method – Absorption coefficient and its determination –factors affecting acoustics of buildings and their remedies.

Introduction to Ultrasonics – Production of Ultasonic wave by magnetostriction & piezoelectric methods – Properties-acoustic grating -Non Destructive Testing – pulse echo system through transmission and reflection modes - A, B and C – scan displays, applications.

Unit III: Dielectric and Magnetic Materials

Dielectric polarizability, Susceptibility and Dielectric constant-Types of polarizations: Electronic , Ionic, Orientation Polarizations (Qualitative)-Frequency dependence of polarization-Lorentz (internal) field-Claussius-Mossotti equation-Applications of Dielectrics.

Introduction-Magnetic dipole moment – Magnetization – Magnetic susceptibility and permeability – Origin of permanent magnetic moment – Classification of Magnetic materials-Domain Concepts of ferromagnetism – Hysteresis – soft and hard magnetic materials-Magnetic device applications.

Unit IV: Lasers and Fiber Optics

Introduction-Characteristics of Laser – Spontaneous and Stimulated emission of radiation-Einstein's coefficients-Population inversion-Pumping Mechanisms -He- Ne laser, Nd-YAG laser-Semiconductor laser-Applications of lasers.

Introduction to Optical Fibers – Total Internal Reflection-Construction of optical fibers, Critical angle of propagation – Acceptance angle – Numerical Aperture-Classification of fibers based on Refractive index, profile & modes –

Propagation of electromagnetic wave through optical fiber-importance of V number-Block Diagram of Fiber optic Communication system-Industrial Applications.

Unit V: Sensors

Sensors (qualitative description only): Different types of sensors and applications; Strain and Pressure sensors- Piezoelectric, magnetostrictive sensors, Fibre optic methods of pressure sensing; Temperature sensors - bimetallic strip, pyroelectric detectors, Hall-effect sensor, smoke and fire detectors

Textbooks:

1. M. N. Avadhanulu, P.G. Kshirsagar &TVS Arun Murthy". A Text book of Engineering Physics"- S.Chand Publications, 11th Edition2019
2. Shatendra Sharma, Jyotsna Sharma, "Engineering Physics", Pearson Education, 2018.

References:

1. K.Thyagarajan "Engineering Physics", - Mc Graw Hill Publishing Company Ltd, 2016.
2. MKVarma "Introduction to Mechanics"-Universities Press-2015.
3. D.K. Bhattacharya and A.Bhaskaran, "Engineering Physics"-Oxford Publications-2015.
4. IanRSinclair, Sensor andTransducers, 3rd eds, 2001,Elsevier(Newnes).

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Engineering Physics	CO1	3													
	CO2	3													
	CO3	3			3										
	CO4	3													
	CO5	3				3									

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	17	25	3	Analyze	L4	PO1	Apply (L3)	3
2	10	14.7	2	Apply	L3	PO1	Apply (L3)	3
3	10	14.7	2	Analyze	L4	PO1, PO4	Apply (L3) Analyze (L4)	3 3
4	14	20.5	3	Analyze	L4	PO1	Apply (L3)	3
5	17	25	3	Analyze	L4	PO1, PO5	Apply (L3) Apply (L3)	3 3
	68	100						

Justification Statements:

CO1: Analyze the fundamental concepts of mechanics and gravitation.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO1 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

CO2: Apply the basic principles of acoustics and ultrasonics for engineering problems.

Action Verb: Apply (L3)

PO1 Verbs: Apply (L3)

CO2 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

CO3: Analyze the properties and applications of dielectric and magnetic materials.

Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO3 Action Verb level is equal to PO1 and PO4 verb; Therefore correlation is high (3).
PO4 Verbs: Analyze (L4)
CO3 Action Verb level is equal to PO4 verb; Therefore correlation is high (3).

CO4: Analyze the fundamentals of Lasers and optical fibers.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO4 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).
CO5: Analyze the working principles of sensors for engineering problems.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO5 Action verb is equal to PO1 verb; therefore, the correlation is high (3).
PO5 Verb: Apply (L3)
CO5 Action Verb level is greater than PO5 verb by one level; Therefore correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : **I** Semester **: I** Branch of Study : ME

Subject Code	Subject Name	L	T	P	Credits
20AES0202	**Basics of Electrical & Electronics Engineering**	**3**	**0**	**0**	**3**

COURSE OUTCOMES: After studying the course, student will be able to:

CO1. **Apply** the concepts of Kirchhoff Laws and the basic theorems for Electrical Circuits.
CO2. **Analyze** the operational characteristics of D.C motor, generator, induction motor and transformer.
CO3. **Understand** the basic operation of Electrical Power generation and transmission systems.
CO4. **Understand** the fundamental concepts of diodes, transistors and op-amps.
CO5. **Analyze** the concepts of Number Systems, Logic Gates and Digital Circuits.
CO6. **Understand** the basic concepts and examples of Communication Systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
1	Apply	the Concepts of Kirchhoff Laws and basic theorems for Electrical circuits			L3
2	Analyze	the operational characteristics of D.C motor, generator, induction motor and transformer.			L4
3	Understand	basic operation of electrical power generation and transmission systems			L2
4	Understand	the fundamental concepts of diodes, transistors and its applications			L2
5	Analyze	the concepts of Number Systems, Logic Gates and Digital Circuits			L4
6	Understand	the basic concepts and examples of Communication Systems			L2

Syllabus:

PART-A

UNIT-I: DC & AC Circuits

Electrical circuit elements (R - L and C) - Kirchhoff laws - Series and parallel connection of resistances with DC excitation. Superposition Theorem - Representation of sinusoidal waveforms - peak and rms values - phasor representation - real power - reactive power - apparent power - power factor - Analysis of single-phase ac circuits consisting of RL - RC - RLC series circuits.

UNIT-II: DC & AC Machines

Principle and operation of DC Generator - EMF equations - OCC characteristics of DC generator – principle and operation of DC Motor – Performance Characteristics of DC Motor - Speed control of DC Motor – Principle and operation of Single Phase Transformer - OC and SC test on transformer - principle and operation of Induction Motor [Elementary treatment only]

UNIT-III: Basics of Power Systems

Layout & operation of Hydro, Thermal, Nuclear Stations - Solar & wind generating stations – Typical AC Power Supply scheme – Elements of Transmission line – Types of Distribution systems: Primary & Secondary distribution systems.

PART-B

UNIT-IV: Analog Electronics

Overview of Semiconductors, PN junction diode, Zener diode, Applications of diode as switch and rectifier, Zener diode as regulator, special purpose diodes: schottky diode, tunnel diode, varactor diode, photodiode, phototransistor and LED. BJT construction, operation, configuration and characteristics, JFET and MOSFET construction, operation, characteristics (CS configuration), applications Operational Amplifiers: Introduction, block diagram, basic op-amp circuits: Inverting, Non Inverting, summer, subtractor, voltage follower.

UNIT-V: Digital Electronics

Introduction, Switching and Logic Levels, Digital Waveform, characteristics of digital ICs, logic gates, number systems, combinational circuits - adders, multiplexers, decoders; introduction to sequential circuits, flip flops, shift register, binary counter.

UNIT-VI: Communication Systems

Introduction, Elements of Communication Systems, EM spectrum, basics of electronic communication, Amplitude and Frequency modulation, Pulse modulation, Communication receivers, Examples of communication systems: Microwave & Satellite, Fibre optic, Television, mobile communication (block diagram approach).

TEXT BOOKS:

1. D. P. Kothari and I. J. Nagrath - "Basic Electrical Engineering" - Tata McGraw Hill - 2010.
2. V.K. Mehta & Rohit Mehta, "Principles of Power System" – S.Chand – 2018.

REFERENCE BOOKS:

1. L. S. Bobrow - "Fundamentals of Electrical Engineering" - Oxford University Press - 2011.
2. E. Hughes - "Electrical and Electronics Technology" - Pearson - 2010.
3. C.L. Wadhwa – "Generation Distribution and Utilization of Electrical Energy", 3rd Edition, New Age International Publications.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Basics of Electrical & Electronics Engineering	CO1	3	2				1								
	CO2	3	3				1								
	CO3	2	1				1								
	CO4	2	3												
	CO5	3	3		3										
	CO6	2	3												

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	**15**	33.33	3	Apply	L3	PO1 PO2 PO6	Apply(L3) Analyze(L4) Thumb Rule	3 2 1
2	**17**	37.77	3	Analyze	L4	PO1 PO2 PO6	Apply(L3) Analyze(L4) Thumb Rule	3 3 1
3	**13**	**28.88**	**3**	Understand	L2	PO1 PO2 PO6	Apply(L3) Analyze(L4) Thumb Rule	2 1 1
	45	**100**						

Justification Statements:

CO1: Apply the concepts of Kirchhoff Laws and the basic theorems for Electrical Circuits.

Action Verb: Apply (L3)

PO1: Apply (L3)

CO1 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

PO2: Analyze (L4)

CO1 Action Verb is less than PO2 verb by one level; Therefore correlation is moderate (2).

PO6: Using thumb rule, CO1 correlates PO6 as low (1).

CO2: Analyze the operational characteristics of D.C motor, generator, induction motor and transformer.

Action Verb: Analyze (L4)
PO1: Apply (L3)
CO2 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO2: Analyze (L4)
CO2 Action Verb is equal to PO2 verb; Therefore correlation is high (3).
PO6: Using thumb rule, CO2 correlates PO6 as low (1).

CO3: Understand the basic operation of Electrical Power generation and transmission systems.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO3 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).
PO2: Analyze (L4)
CO3 Action Verb is less than PO2 verb by two level; Therefore correlation is low (1).
PO6: Using thumb rule, CO3 correlates PO6 as low (1).

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
4	**16**	42	3	Understand	**L2**	PO1, PO2	Apply (L3) Review(L2)	2 3
5	**12**	32	3	Analyze	**L4**	PO1, PO2, PO4	Apply (L3) Review(L2) Analyze(L4)	3 3 3
6	**10**	26	3	Understand	**L2**	PO1, PO2	Apply(L3) Review (L2)	2 3
	38	100						

Justification Statements:

CO 4: Understand the fundamental concepts of diodes, transistors and op-amps.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO4 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).
PO2 Verbs: Review (L2)
CO4 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO 5: Analyze the concepts of Number Systems, Logic Gates and Digital Circuits.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO5 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO5 Action Verb is greater than PO2 verb by two level; Therefore correlation is high (3).
PO4 Verbs: Analyze (L4**)**
CO5 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO 6: Understand the basic concepts and examples of Communication Systems.
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO6 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (2).
PO2 Verbs: Review (L2)
CO6 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **I/II** Branch of Study: Common to all branches

Subject Code	Subject Name	L	T	P	Credits
20AES0301	Engineering Graphics	1	0	4	3

Course Outcomes: After studying the course, student will be able to:

CO1. Apply the concepts of engineering curves for technical drawing
CO2. Understand the quadrant system to locate the position of points and projection of lines
CO3. Analyze the projection of planes as well as solids located in quadrant system
CO4. Analyze the sectional views and development of surfaces of regular solids
CO5. Apply orthographic and isometric projections concepts to construct the given object.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Apply	the concepts of engineering curves		for technical drawing	L3
CO2	Understand	the quadrant system to locate the position of points and projection of lines			L2
CO3	Analyze	draw the projection of planes as well as solids		located in quadrant system	L4
CO4	Analyze	the sectional views and development of surfaces		of regular solids	L4
CO5	Apply	orthographic and isometric projections concepts to construct the given object			L3

Syllabus

Unit I: Introduction to Engineering graphics: Principles of Engineering Graphics and their significance Conventions in drawing - lettering - BIS conventions.

a) **Conic sections** including the rectangular hyperbola- general method only,

b) **Cycloids -** Cycloid, epicycloids and hypocycloid

Unit II: Projection of points, lines: Projection of points in any quadrant, lines inclined to one or both planes, finding true lengths, angle made by line, traces.

Unit III: Projections of Planes: Projection of points in any quadrant, lines inclined to one or both planes, finding true lengths, angle made by line. Projections of regular plane surfaces.

Projections of Solids: Projections of regular solids inclined to one or both planes by rotational or auxiliary views method.

Unit IV: Sections of solids: Section planes and sectional view of right regular solids- prism, cylinder, pyramid and cone. True shapes of the sections.

Development of surfaces: Development of surfaces of right regular solids-prism, cylinder, pyramid, cone and their sectional parts.

Unit V: Orthographic Projections: Systems of projections, conventions and application to orthographic projections.

Isometric Projections: Principles of isometric projection- Isometric scale; Isometric views: lines, planes, figures, simple and compound solids.

Text Books:

1. K.L.Narayana & P.Kannaiah, Engineering Drawing, 3/e, Scitech Publishers
2. N.D.Bhatt, Engineering Drawing, 53/e, Charotar Publishers
3. Dhanajay A Jolhe, Engineering Drawing, Tata McGraw-Hill

4. Shah and Rana, Engineering Drawing, 2/e, Pearson Education
5. Basant Agarwal & C.M.Agarwal, Engineering Drawing, Tata McGraw-Hill

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Engineering Graphics	CO1	3		3							3			2	2
	CO2	2		2							3			2	2
	CO3	2		2							3			2	2
	CO4	3		3							3			2	2
	CO5	3		3							3			2	2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	18	24	3	Apply	L3	PO1 PO3 PO10	Apply (L3) Develop (L3) Thumb Rule	3 3 1
2	15	20	2	Understand	L2	PO1 PO3 PO10	Apply (L3) Develop (L3) Thumb Rule	2 2 1
3	15	20	2	Analyze	L4	PO1 PO3 PO10	Apply (L3) Develop (L3) Thumb Rule	3 3 1
4	15	20	2	Analyze	L4	PO1 PO3 PO10	Apply (L3) Develop (L3) Thumb Rule	3 3 1
5	12	16	2	Apply	L3	PO1 PO3 PO10	Apply (L3) Develop (L3) Thumb Rule	3 3 1
	75	100						

Justification Statements:

CO1: Apply the concepts of engineering curves for technical drawing

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO10 Verb: Thumb Rule (TR)

CO1: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO2: Understand the quadrant system to locate the position of points and projection of lines.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO2: Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: **Develop (L3)**

CO2: Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

PO10 Verb: Thumb Rule (TR)

CO2: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO3: Analyze the projection of planes as well as solids located in quadrant system**.**

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**
CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Develop (L3)**
CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO10 Verb: Thumb Rule (TR)
CO3: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO4: Analyze the sectional views and development of surfaces of regular solids
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Develop (L3)**
CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO10 Verb: Thumb Rule (TR)
CO4: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO5: Apply orthographic and isometric projections concepts to construct the given object**.**
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO5: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Develop (L3)**
CO5: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO10 Verb: Thumb Rule (TR)
CO5: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **I** Branch of Study: Common to all branches

Subject Code	Subject Name	L	T	P	Credits
20AES0501	Problem Solving and Programming	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the Programming and Algorithms concepts to Perform Basic operations.
CO2. Apply the problem solving approaches to generate different algorithms.
CO3. Understand the various operators to perform mathematical operations.
CO4. Apply the Pointers and Array Techniques to manipulate the data.
CO5. Analyze the Sorting and Searching Techniques to arrange the data in sorted order

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the Programming and Algorithms concepts		to Perform Basic operations.	L2
CO2	Apply	the problem solving approaches		to generate different algorithms	L3
CO3	Understand	the various operators		to perform mathematical operations	L2
CO4	Apply	the Pointers and Array Techniques		to manipulate the data	L3
CO5	Analyze	the Sorting and Searching Techniques		to arrange the data in sorted order.	L4

Syllabus

Unit I: Computer Fundamentals: What is a Computer, Evolution of Computers, Generations of Computers, Classification of Computers, Anatomy of a Computer, Memory revisited, Introduction to Operating systems, Operational overview of a CPU.

Introduction to Programming, Algorithms and Flowcharts: Programs and Programming, Programming languages, Compiler, Interpreter, Loader, Linker, Program execution, Fourth generation languages, Fifth generation languages, Classification of Programming languages, Structured programming concept, Algorithms, Pseudo-code, Flowcharts, Strategy for designing algorithms, Tracing an algorithm to depict logic, Specification for converting algorithms into programs.

Unit II: Introduction to computer problem solving: Introduction, the problem-solving aspect, top-down design, implementation of algorithms, the efficiency of algorithms, and the analysis of algorithms.

Fundamental algorithms: Exchanging the values of two variables, counting, summation of a set of numbers, factorial computation, sine function computation, generation of the Fibonacci sequence, reversing the digits of an integer.

Unit III: Types, Operators, and Expressions: Variable names, data types and sizes, constants, declarations, arithmetic operators, relational and logical operators, type conversions, increment and decrement operators, bitwise operators, assignment operators and expressions, conditional expressions precedence and order of evaluation.

Input and output: standard input and output, formatted output-Printf, formatted input-Scanf.

Control Flow: Statements and blocks, if-else, else-if, switch, Loops-while and for, Loops-Do- while, break and continue, Goto and labels.

Functions and Program Structure: Basics of functions, functions returning non-integers, external variables, scope variables, header variables, register variables, block structure, initialization, recursion, the C processor

Unit IV: Factoring methods: Finding the square root of a number, the smallest divisor of a number, the greatest common divisor of two integers, generating prime numbers.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Pointers and arrays: Pointers and addresses, pointers and function arguments, pointers and arrays, address arithmetic, character pointers and functions, pointer array; pointers to pointers, Multi-dimensional arrays, initialization of arrays, pointer vs. multi-dimensional arrays, command line arguments, pointers to functions, complicated declarations.

Array Techniques: Array order reversal, finding the maximum number in a set, removal of duplicates from an order array, finding the kth smallest element.

Unit V: Sorting and Searching: Sorting by selection, sorting by exchange, sorting by insertion, sorting by partitioning, binary search.

Structures: Basics of structures, structures and functions, arrays of structures, pointers to structures, self referential structures, table lookup, typedef, unions, bit-fields.

Some other Features: Variable-length argument lists, formatted input-Scanf, file access, Error handling-stderr and exit, Line Input and Output, Miscellaneous Functions.

Text Books:

1. Pradip Dey, and Manas Ghosh, "Programming in C", 2018, Oxford University Press.
2. R.G. Dromey, "How to Solve it by Computer". 2014, Pearson.
3. Brian W. Kernighan, and Dennis M. Ritchie, "The C Programming Language", 2nd Edition, Pearson

Reference Books:

1. RS Bichkar "Programming with C", 2012, Universities Press.
2. Pelin Aksoy, and Laura Denardis, "Information Technology in Theory", 2017, Cengage Learning.
3. Byron Gottfried and Jitender Kumar Chhabra, "Programming with C", 4th Edition, 2019, McGraw Hill Education.

Online Learning Resources: www.nptel.ac.in

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Problem Solving And Programming	CO1	**2**	**3**												
	CO2	**3**	**2**	**3**									**2**		
	CO3	**2**	**3**										**2**		
	CO4	**3**	**3**	**3**									**2**		
	CO5	**3**	**3**	**3**									**2**		

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	19	25%	3	Understand	L2	PO1 PO2	Apply(L3) Review(L2)	2 3
2	10	14%	2	Apply	L3	PO1 PO2 PO3 PO12	Apply(L3) Analyze (L4) Develop (L3) Thumb rule	3 2 3 2
3	19	25%	3	Understand	L2	PO1 PO2 PO12	Apply(L3) Review (L2) Thumb rule	2 3 2
4	15	20%	2	Apply	L3	PO1 PO2 PO3 PO12	Apply(L3) Review (L2) Develop (L3) Thumb rule	3 3 3 2
5	12	16%	2	Analyze	L4	PO1 PO2 PO3 PO12	Apply(L3) Review (L2) Develop(L3) Thumb rule	3 3 3 2
	75	100						

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Apply the concepts of engineering curves for technical drawing

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO10 Verb: Thumb Rule (TR)

CO1: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO2: Understand the quadrant system to locate the position of points and projection of lines.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO2: Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: **Develop (L3)**

CO2: Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

PO10 Verb: Thumb Rule (TR)

CO2: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO3: Analyze the projection of planes as well as solids located in quadrant system**.**

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO10 Verb: Thumb Rule (TR)

CO3: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO4: Analyze the sectional views and development of surfaces of regular solids

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO10 Verb: Thumb Rule (TR)

CO4: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO5: Apply orthographic and isometric projections concepts to construct the given object**.**

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO5: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO5: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO10 Verb: Thumb Rule (TR)

CO5: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **I** Branch of Study: Branch of Study: CE & ME

Subject Code	Subject Name	L	T	P	Credits
20ABS9908	**Engineering Physics Lab**	0	0	3	1.5

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze the properties of LASER and optical fibers.
CO2. Analyze the mechanical behavior of a given material using dynamic methods.
CO3. Evaluate the basic parameters of a given semiconductor material.
CO4. Analyze the basic properties of dielectric and magnetic behavior of the given material.
CO5. Apply the concepts of sensors to solve engineering problems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Analyze	the properties of LASER and optical fibers.			L4
2	Analyze	the mechanical behavior of a given material	using dynamic methods		L4
3	Evaluate	the basic parameters of a given semiconductor material.			L5
4	Analyze	the basic properties of dielectric and magnetic behavior of the given material			L4
5	Apply	the concepts of sensors		to solve engineering problems.	L3

List of Experiments:

1. Determination of wavelength of LASER light using diffraction grating **(CO1).**
2. Determination of particle size using LASER **(CO1).**
3. Hall effect-Determination of Hall voltage and Hall coefficient of a given semiconductor **(CO3).**
4. Determination of Magnetic field along the axis of a circular coil carrying current **(CO4).**
5. Determination of Rigidity modulus of a wire-Torsional pendulum (**CO2**).
6. Study the variation of B versus H by magnetizing the magnetic material (B-H curve) (**CO4**).
7. Determination of numerical aperture of a given optical fiber and angle of acceptance (**CO1**).
8. Study the variation of pressure using Strain Guage sensor (**CO5**).
9. Study the variation of temperature using Strain Guage sensor (**CO5**).
10. Determination of dielectric constant of dielectric material using charging and discharging of capacitor (**CO4**).
11. Determination of spring constant using Coupled Oscillator (**CO2**).
12. Determination of ultrasonic velocity in liquid using Acoustic grating (**CO2**).
13. Measurement of magnetic susceptibility by Gouy's method (**CO4**).
14. Study the variation of pressure using optical fiber sensors (**CO5**).
15. Study the variation of temperature using optical fiber sensors (**CO5**).

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO Experiments may be conducted in virtual mode.

References:

1. S. Balasubramanian, M.N.Srinivasan, "A Text book of Practical Physics"-S Chand Publishers, 2017.
2. http://vlab.amrita.edu/index.php-VirtualLabs, Amrita University.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Problem Solving And Programming	CO1	3			3										
	CO2	3			3										
	CO3	3			3										
	CO4	3			3										
	CO5	3			2										

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix

CO	CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Verb	BTL			
1	Analyze	L4	PO1, PO4	Apply (L3), Analyze (L4)	3 3
2	Analyze	L4	PO1, PO4	Apply (L3), Analyze (L4)	3 3
3	Evaluate	L5	PO1, PO4	Apply (L3), Analyze (L4)	3 3
4	Analyze	L4	PO1, PO4	Apply (L3), Analyze (L4)	3 3
5	Apply	L3	PO1, PO4	Apply (L3), Analyze (L4)	3 2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Justification Statements:

CO1: Analyze the properties of LASER and optical fibers.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO1 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).
PO4 Verb: Analyze (L4)
CO1 Action Verb is equal to PO4 verb; Therefore, correlation is high (3).

CO2: Analyze the mechanical behavior of a given material using dynamic methods.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO2 Action Verb is greater than PO1 verb by two levels; Therefore correlation is high (3).
PO4 Verb: Analyze (L4)
CO2 Action Verb is greater than PO4 verb by one level; Therefore correlation is high (3).

CO3: Evaluate the basic parameters of a given semiconductor material.
Action Verb: Evaluate (L5)
PO1 Verbs: Apply (L3)
CO3 Action Verb level is greater than PO1 action verb by two levels; Therefore correlation is high (3).
PO4 Verb: Analyze (L4)
CO3 Action Verb is greater than PO4 verb by one level; Therefore correlation is high (3).

CO4: Analyze the basic properties of dielectric and magnetic behavior of the given material.
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO4 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO4 Verb: Analyze (L4)
CO4 Action Verb is equal to PO4 verb; Therefore correlation is high (3).

CO5: Apply the concepts of sensors to solve engineering problems.
Action Verb: Apply (L3)
PO1 Verbs: Apply (L3)
CO5 Action Verb is equal to PO1 verb; Therefore correlation is high (3).
PO4 Verb: Analyze (L4)
CO5 Action Verb is less than PO4 verb by one level; Therefore correlation is moderate (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **I** Branch of Study: ME

Subject Code	Subject Name	L	T	P	Credits
20AES0204	**Basics Electrical & Electronics Engineering Lab**	**0**	**0**	**3**	**1.5**

COURSE OUTCOMES: After studying the course, student will be able to:

CO1. **Apply** the Kirchhoff's Laws and Superposition theorem for DC circuits.
CO2. **Analyze** the performance of AC and DC Machines by various testing methods.
CO3. **Analyze** the speed of DC shunt motor using armature and field control methods.
CO4. **Analyze** the V-I Characteristics of pn-diode and zener diode.
CO5. **Evaluate** the parameters of rectifiers with and without filters
CO6. **Analyze** the input and output characteristics of BJT and FET.

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	Apply	the Kirchhoff's Laws and Superposition theorem	for DC circuits		L3
CO2	Analyze	the performance of AC and DC Machines	by various testing methods		L4
CO3	Analyze	the speed of DC shunt motor	using armature and field control methods		L4
CO4	Analyze	the V-I Characteristics		of pn-diode and zener diode	L4
CO5	Evaluate	the parameters of rectifiers	with and without filters		L5
CO6	Analyze	the input and output characteristics		of BJT and FET	L4

PART A

List of Experiments:

1. Verification of Kirchhoff laws (**CO1**).
2. Verification of Superposition Theorem (**CO1**).
3. Open circuit characteristics of a DC Shunt Generator (**CO2**).
4. Speed control of DC Shunt Motor (**CO3**).
5. OC & SC test of 1-Phase Transformer (**CO2**).
6. Brake test on 3-Phase Induction Motor (**CO2**).
7. Brake test on DC Shunt Motor (**CO2**).

PART-B

List of Experiments:

1. PN Junction Diode Characteristics. (**CO4**)
2. Zener Diode Characteristics. (**CO4**)
3. Rectifiers (With and Without Filter). (**CO5**)
4. BJT Characteristics (CB Configuration). (**CO6**)
5. BJT Characteristics (CE Configuration). (**CO6**)
6. FET Characteristics (CS Configuration). (**CO6**)

Tools Equipment Required: DC Power supplies, Multi meters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROs, all the required active devices.

Note: All the experiments shall be implemented using both Hardware and Software.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Basic Electrical & Electronics Engineering Lab	CO1	**3**			**2**					**1**					
	CO2	**3**			**3**					**1**					
	CO3	**3**			**3**					**1**					
	CO4	**3**	**3**												
	CO5	**3**	**3**		**3**										
	CO6	**3**	**3**		**3**										

Correlation Matrix

CO	Course Outcomes(CO)		Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO12)	Level of Correlation (0-3)
	Co's Action verb	BTL			
1	Apply	L3	PO1 PO4 PO9	Apply (L3) Analyze (L4) Thumb Rule	3 2 1
2	Analyze	L4	PO1 PO4 PO9	Apply (L3) Analyze (L4) Thumb Rule	3 3 1
3	Analyze	L4	PO1 PO4 PO9	Apply (L3) Analyze (L4) Thumb Rule	3 3 1
4	Analyze	L4	PO1 PO2	Apply (L3) Review (L2)	3 3
5	Evaluate	L5	PO1 PO2 P04	Apply (L3) Review (L2) Analyze (L4)	3 3 3
6	Analyze	L4	PO1 PO2 PO4	Apply (L3) Review (L2) Analyze (L4)	3 3 3

Justification Statements:
CO1: Apply the Kirchhoff's Laws and Superposition theorem for DC circuits.
Action Verb: Apply (L3)
PO1: **Apply (L3)**
CO1 Action Verb is same as PO1 verb; Therefore correlation is high (3).
PO4: Analyze (L4)
CO1 Action Verb is less than PO2 verb by one level; Therefore correlation is moderate (2).
PO9: Using Thumb Rule, CO1 correlates to PO9 as low (1).
CO2: Analyze the performance of AC and DC Machines by various testing methods.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO2 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO4: Analyze (L4)
CO2 Action Verb is same as PO4 verb; Therefore correlation is high (3).
PO9: Using Thumb Rule, CO2 correlates to PO9 as low (1).
CO3: Analyze the speed of DC shunt motor using armature and field control methods.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO3 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO4: Analyze (L4)
CO3 Action Verb is same as PO4 verb; Therefore correlation is high (3).
PO9: Using Thumb Rule, CO3 correlates to PO9 as low (1).

CO 4: Analyze the V-I Characteristics of pn-diode and zener diode**.**
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO4 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2)
PO2 Verbs: Review (L2)
CO4 Action Verb is equal to PO2 verb; Therefore correlation is high (3).
CO 5: Evaluate the parameters of rectifiers without & with filters
Action Verb: Evaluate (L5)
PO1 Verbs: Apply (L3)
CO5 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO5 Action Verb is greater than PO2 verb by one level; Therefore correlation is high (3).
PO4 Verbs: Analyze (L4)
CO5 Action Verb is equal to PO4 verb Therefore correlation is high (3).
CO 6: Analyze the input and output characteristics of BJT and FET
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO6 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO6 Action Verb is greater than PO2 verb by one level; Therefore correlation is high (3).
PO4 Verbs: Analyze (L4)
CO6 Action Verb is equal to PO4 verb Therefore correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **I** Branch of Study: Common to ME/CE

Subject Code	Subject Name	L	T	P	Credits
20AES0503	**Problem Solving and Programming Lab**	**0**	**0**	**3**	**1.5**

COURSE OUTCOMES: After studying the course, student will be able to:
CO1. Analyze the basics of computer and concepts of C for writing simple programs.
CO2. Analyze the control statements for solving the problems using C
CO3. Design the algorithm for implementing complex problems using C.
CO4. Analyze the arrays to store and retrieve the elements.
CO5. Apply the different sorting techniques for solving real world problems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Analyze**	the basics of computer and concepts of C		for writing simple programs	L4
CO2	**Analyze**	the control statements	using C	for solving the problems	L4
CO3	**Design**	the algorithm	using C	for implementing complex problems	L6
CO4	**Analyze**	the arrays		to store and retrieve the elements.	L4
CO5	**Apply**	the different sorting techniques		for solving real world problems	L3

List of Experiments

1. Assemble and disassemble parts of a Computer **(CO1)**
2. Design a C program which reverses the number **(CO1)**
3. Design a C program, which finds the second maximum number among the given list of numbers. **(CO2)**
5. Construct a program, which finds the kth smallest number among the given list of numbers. **(CO2)**
6. Design an algorithm and implement using C language the following exchanges a ← b ← c ← d ← a **(CO2)**
7. Develop a C Program, which counts the number of positive and negative numbers separately and also compute the sum of them. **(CO2)**
8. Implement the C program which computes the sum of the first n terms of the series Sum = 1 – 3 + 5 -7 + 9 **(CO2)**
9. Design a C program, which determines the numbers whose factorial values are between 5000, and 32565. **(CO2)**
10. Design an algorithm and implement using a C program, which finds the sum of the infinite series 1 – x2/2! + x4/4! – x6/6! + ... **(CO3)**
11. Design a C program to print the sequence of numbers in which each number is the sum of the three most recent predecessors. Assume first three numbers as 0, 1, and 1. **(CO3)**
12. Implement a C program which converts a hexadecimal, octal and binary number to decimal number and vice versa. **(CO3)**
13. Develop an algorithm which computes the all the factors between 1 and 100 for a given number and implement it using C. **(CO3)**
14. Construct an algorithm which computes the sum of the factorials of numbers between m and n. **(CO3)**
15. Design a C program, which reverses the elements of the array. **(CO4)**
16. Given a list of n numbers, Design an algorithm which prints the number of stars equivalent to the value of the number. The starts for each number should be printed horizontally. **(CO4)**
17. Implement the sorting algorithms a. Insertion sort b. Exchange sort c. Selection sort d. Partitioning sort. **(CO5)**
18. Illustrate the use of auto, static, register and external variables. **(CO5)**
19. Design algorithm and implement the operations creation, insertion, deletion, traversing on a singly linked list. **(CO5)**
20. Develop a C program, which takes two numbers as command line arguments and finds all the common factors of those two numbers. **(CO5)**
21. Design a C program, which sorts the strings using array of pointers. **(CO5)**

Instructors may add some experiments to the above list. Moreover, 50% of the experiments are to be changed every academic year. Instructors can choose the experiments, provided those experiments are not repetitions.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Problem Solving And Programming Lab	CO1	3	3												
	CO2	3	3	3	3	3									
	CO3	3	3	3	3	3							3		
	CO4	3	3	3	3	3							3		
	CO5	3	3	3	2	3									

Correlation Matrix

CO	Co's Action verb	BTL	Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO12)	Level of Correlation (0-3)
1	Analyze	L4	PO1 PO2	Apply(L3) Review(L2)	3 3
2	Analyze	L4	PO1 PO2 PO3 PO4 PO5	Apply(L3) Identify (L3) Develop(L3) Analyze (L4) Apply (L3)	3 3 3 3 3
3	Design	L6	PO1 PO2 PO3 PO4 PO5 PO12	Apply(L3) Formulate (L6) Design(L6) Analyze (L4) Create (L6) Thumb rule	3 3 3 3 3 3
4	Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO12	Apply(L3) Identify (L3) Develop(L3) Analyze (L4) Apply (L3) Thumb rule	3 3 3 3 3 3
5	Apply	L3	PO1 PO2 PO3 PO4 PO5	Apply(L3) Identify (L3) Develop(L3) Analyze (L4) Apply (L3)	3 3 3 2 3

Justification Statements:

CO1: Analyze the basic concepts of C for writing simple programs.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO1 Action verb is Greater than PO1 verb. Therefore, the correlation is high(3)
PO2 Verb: Review (L2)
CO1 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

CO2: Analyze the control statements for solving the problems.
Action Verb: Analyze (L4)
PO1: Apply (L3)

CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO2 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO2 Action verb is greater than as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO2 Action verb is same as PO4 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO2 Action verb is greater than as PO5 verb. Therefore, the correlation is high (3)

CO3: Design the algorithm for implementing complex problems using C.
Action Verb: Design (L6)
PO1: Apply (L3)
CO3 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: Formulate (L6)
CO3 Action verb is same as PO2 verb. Therefore, the correlation is high (3)
PO3: Design (L6)
CO3 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is greater than as PO4 verb. Therefore, the correlation is high (3)
PO5: create (L6)
CO3 Action verb is same as PO5 verb. Therefore, the correlation is high (3)
PO12: Thumb rule
Algorithms analysis is learning process to find the solution better manner the correlation is high (3)

CO4: Analyze the arrays to store and retrieve the elements.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO4 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO4 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO4 Action verb is greater than as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO4 Action verb is same as PO4 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO4 Action verb is greater than as PO5 verb. Therefore, the correlation is high (3)
PO12: Thumb rule
Data analysis is the trending approach in the current days Therefore, the correlation is high (3)

CO5: Apply the different sorting techniques for solving real world problems.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO5 Action verb is same as PO1 verb. Therefore, the correlation is high (3)
PO2: Identify (L3)
CO5 Action verb is same as PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO5 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO5 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO5: Apply (L3)
CO5 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Semester II (First year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P	C	CIE	SEE	Total
1	Basic Science courses	20ABS9906	Differential Equations and Vector Calculus	3	-	-	3	30	70	100
2	Basic Science course	20ABS9905	Engineering Chemistry	3	-	-	3	30	70	100
3	Humanities and Social science	20AHS9901	Communicative English	3	-	-	3	30	70	100
4	Engineering Science Courses	20AES0509	Basics of Python Programming	3	-	-	3	30	70	100
5	Engineering Science Courses	20AES0304	Engineering Workshop Practice	1	-	4	3	30	70	100
6	Humanities and Social science LAB	20AHS9902	Communicative English Lab	-	-	3	1.5	30	70	100
7	Basic Science course (LAB)	20ABS9910	Engineering Chemistry Lab	-	-	3	1.5	30	70	100
8	Engineering Science Courses/Prof Core (Interdisciplinary) (LAB)	20AES0510	Basics of Python Programming Lab	-	-	3	1.5	30	70	100
	Mandatory course (AICTE suggested)	20AMC9902	Constitution of India	3	-	-	0	30	-	30
			Total credits				**19.5**	**270**	**560**	**830**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: I **Semester**: **II** **Branch of Study: Common to EEE, CE, ME and ECE**

Subject Code	Subject Name	L	T	P	Credits
20ABS9906	**Differential Equations and Vector Calculus**	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Analyze the mathematical concepts of ordinary differential equations of higher order.
CO2. Apply the methods of linear differential equations related to various engineering problems.
CO3. Analyze the partial differential equations of first and higher order.
CO4. Understand the vector differential operators such as gradient, curl, divergent.
CO5. Evaluate the vector integral theorems by using line, surface, and volume integrals.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Analyze**	the mathematical concepts of ordinary differential equations of higher order			**L4**
2	**Apply**	the methods of linear differential equations	related to various engineering problems		**L3**
3	**Analyze**	the partial differential equations	of first and higher order		**L4**
4	**Understand**	the vector differential operators	such as gradient, curl, divergent		**L2**
5	**Evaluate**	the vector integral theorems by	using line, surface, and volume integrals		**L5**

Syllabus:

UNIT I: Linear Differential Equations of Higher Order

Definitions, complete solution, operator D, rules for finding complimentary function, inverse operator, rules for finding particular integral (e^{ax}, sinax (or) cosax, X^k, $e^{ax}v$, x v(x)), method of variation of parameters.

UNIT II: Equations Reducible to Linear Differential Equations and Applications

simultaneous linear equations with constant coefficients ,Cauchy's and Legendre's linear equations, Applications to oscillations of a spring, L-C-R Circuit problems and Mass spring system.

UNIT III: Partial Differential Equations of First order and Higher Order

Linear Equations of First order P.D.E: Method of Grouping, Method of Multipliers.

Non-linear Equations of First Order PDE: f (p , q) = 0, f (z, p ,q) = 0, f (x , p) = F (y , q) and z = px +qy + f (p , q) OR Clairaut's Equation.

Homogenous Linear P.D.E with constant coefficients of Higher order: Finding complementary function, Particular Integrals of e^{ax+by}, Sin (ax+by) Or Cos (ax +by), X^mY^n and for any function of F (x, y). Non-Homogenous Linear P.D.E of constant coefficient.

UNIT IV:Vector differentiation

Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions-Divergence and Curl, vector identities.

UNIT V: Vector integration

Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

Text Books :

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2011.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

References:

1. Dr.T.K.V.Iyengar, Engineering Mathematics-I,S.Chand publishers
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics,Laxmipublication,2008
4. B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Differential Equations and Vector	CO1		3												
	CO2	3													
	CO3		3												
	CO4	2													
	CO5		3												

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	14	20.8	3	Analyze	L4	PO2	Analyze	3
2	15	22.3	3	Apply	L3	PO1	Apply	3
3	14	20.8	3	Analyze	L4	PO2	Analyze	3
4	9	13.4	2	Understand	L2	PO1	Apply	2
5	15	22.3	3	Evaluate	L5	PO2	Analyze	3
	67	100						

Justification Statements:

CO1: Analyze the mathematical concepts of ordinary differential equations of higher order.
Action Verb: Analyze (L4)
PO2 Verbs: Analyze (L4)
CO1 Action Verb is equal to PO2 verb Therefore correlation is high (3).
CO2: Apply the methods of linear differential equations related to various engineering problems.
Action Verb: Apply (L3)
PO1 Verbs: Apply (L3)
CO2 Action Verb is equal to PO1 verb; Therefore correlation is high (3).
CO3: Analyze the partial differential equations of first and higher order.
Action Verb: Analyze (L4)
PO2 Verb: Analyze (L4)
CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).
CO4: Understand the vector differential operators such as gradient, curl, divergent.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO4 Action Verb is low level to PO1 to one level; Therefore correlation is moderate (2).
CO5: Evaluate the vector integral theorems by using line, surface, and volume integrals**.**
Action Verb: Evaluate (L5)
PO2 Verb: Analyze (L4)
CO5 Action verb is high level to PO2 verb; therefore the correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: I **Semester**: **I/II** **Branch of Study: Common to CE, ME**

Subject Code	Subject Name	L	T	P	Credits
20ABS9905	**ENGINEERING CHEMISTRY**	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Apply the purification technique to remove hardness of water and to check the quality of water

CO2. Apply the electrochemical principles to the energy storage devices and corrosion prevention techniques

CO3. Analyze the preparation and applications of polymers and fuels

CO4. Apply the cement and concrete techniques in manufacturing process for engineering fields

CO5. Analyze the properties and applications of colloids and nano materials

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	the purification technique to remove hardness of water		to check the quality of water	L3
2	Apply	the Electrochemical principles to the energy storage devices and corrosion prevention techniques			L3
3	Analyze	the Preparation and applications of polymers and fuels			L4
4	Apply	the Cement and concrete techniques in manufacturing process		for engineering fields	L3
5	Analyze	the Properties and applications of colloids and nanomaterials			L4

Syllabus:

Unit 1: Water Technology

Introduction –Soft Water and hardness of water, Estimation of hardness by EDTA Method - Boiler troubles - scale and sludge, Industrial water treatment – specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO) standards, zeolite and ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

Unit 2: Electrochemistry and Applications:

Electrodes – concepts, electrochemical cell, Nernst equation, cell potential calculations. Primary cells – Fuel cells, hydrogen-oxygen, methanol fuel cells – working of the cells. Secondary cells – lead acid, nickel-metal hydride and lithium ion batteries- working of the batteries including cell reactions.

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, environmental factors (pH, temperature, DO) affecting corrosion rate, protection – corrosion inhibitors with specific examples, cathodic and anodic protection, electroplating and electro less plating (Nickel and Copper).

Unit 3: Polymers and Fuel Chemistry:

Introduction to polymers, functionality of monomers, chain growth and step growth polymerization, coordination polymerization, copolymerization (stereospecific polymerization) with specific examples and mechanisms of polymer formation.

Thermoplastics and Thermo-sets, Elastomers – applications with specific examples.

Conducting polymers – polyacetylene, polyaniline, polypyrroles – mechanism of conduction and applications.

Fuels – Types of fuels, calorific value, numerical problems based on calorific value; Analysis of coal, refining of petroleum, liquid fuels, fuels for IC engines, knocking and anti-knock agents, Octane and Cetane values, cracking of oils; alternative fuels- propane, methanol and ethanol, bio fuels.

Unit 4: Cement and Concrete Chemistry:

Introduction to building materials – Portland cement, constituents, manufacturing process-raw materials for manufacturing process, reactions below 1300 oC and reactions between 1300 and 1450 oC, reactions during cooling, grinding or storage, chemical equations, phases of cement clinker (alite, belite, aluminate and ferrite),

reactivity of clinker phases, parameters to characterize the clinker formation: lime saturation factor (LSF), silica ratio (SR) and alumina ration (AR), chemistry of setting and hardening of cement (hydration, hydrolysis, equations), scheme of concrete formation, admixtures for concrete improvement – retarders, accelerators, air-entraining agents, grinding agents, super plasticizers, dispersants, etc.

Unit 5: Surface Chemistry and Applications:

Introduction to surface chemistry, colloids, nanometals and nanometal oxides, micelle formation, synthesis of colloids (any two methods with examples), chemical and electrochemical methods (not more than two methods) of preparation of nanometals and metal oxides, stabilization of colloids, characterization of surface by physicochemical methods (SEM, TEM, XRD), adsorption isotherm, BET equation (no derivation), applications of colloids and nanomaterials – catalysis, medicine, sensors, etc.

Text books:

1. Jain and Jain, Engineering Chemistry, 16/e, Dhanpat Rai, 2013.
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e, Oxford University Press, 2010.

Reference books:

1. H.F.W. Taylor, Cement Chemistry, 2/e, Thomas Telford Publications, 1997.
2. D.J. Shaw, Introduction to Colloids and Surface Chemistry, Butterworth-Heineman,1992.
3. Skoog and West, Principles of Instrumental Analysis, 6/e, Thomson, 2007.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Engineering Chemistry	CO1	3													
	CO2	3													
	CO3		3												
	CO4	3													
	CO5	3				3									

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	**12**	**18.4**	**3**	**Apply**	**L3**	PO1	Apply (L3)	3
2	**22**	**33.8**	**3**	**Apply**	**L3**	PO1	Apply (L3)	3
3	**12**	**18.4**	**3**	**Analyze**	**L4**	PO2	Analyze (L4)	3
4	**6**	**9.2**	**1**	**Apply**	**L3**	PO1	Apply (L3)	3
5	**13**	**20**	**3**	**Analyze**	**L4**	PO1 PO5	Analyze (L4)	3 3
	75	**100**						

Justification Statements:

CO1: Apply the purification technique to remove hardness of water and to check the quality of water
PO1 Verbs: Apply (L3)
CO1 Action Verb is equal to PO1 verb by one level; Therefore correlation is high (3).
CO2: Apply the electrochemical principles to the energy storage devices and corrosion prevention techniques
Action Verb: Apply (L3)
PO1 Verbs: Apply (L3)

CO2 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

CO3: Analyze the preparation and applications of polymers and fuels

Action Verb: Analyze (L4)

PO2 Verb: Analyze (L4)

CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO4: Apply the cement and concrete techniques in manufacturing process for engineering fields

Action Verb: Apply (L3)

PO2 Verb: Apply (L3)

CO4 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO5: Analyze the properties and applications of colloids and nanomaterials

Action Verb: Analyze (L4)

PO1 Verb: Analyze (L4)

CO5 Action verb is equal to PO2 verb; therefore the correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : **I** Semester **: II** Branch of Study : ME

Subject Code	Subject Name	L	T	P	Credits
20AHS9901	**COMMUNICATIVE ENGLISH**	3	0	0	3

COURSE OUTCOMES: After studying the course, student will be able to:

CO1. Understand the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English (Listening and Writing)
CO2. Apply the grammatical structures to formulate sentences and correct word forms (Grammar)
CO3. Analyze the discourse markers to speak clearly on a specific topic in informal discussions (Speaking)
CO4. Evaluate the reading/listening texts and to write summaries based on global comprehension of these texts.(Reading and Writing)
CO5. Create the coherent paragraph interpreting a figure/graph/chart/table (Writing)

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom's level
1	Understand	the context, topic, and pieces of specific information from social or transactional dialogues	spoken by native speakers of English.		L2
2	Apply	the grammatical structures to formulate sentences and correct word forms.			L3
3	Analyze	the discourse markers to speak clearly on a specific topic in informal discussions.			L4
4	Evaluate	the reading/listening texts and to write summaries		based on global comprehension of these texts.	L5
5	Create	the coherent paragraph		interpreting a figure/graph/chart /table.	L6

Syllabus

UNIT -1

Lesson: On the Conduct of Life: William Hazlitt

Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing : Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph.

Grammar and Vocabulary- I : Parts of Speech, Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form – wh questions; word order in sentences.

Vocabulary -2: Formal/academic words and phrases.

UNIT -2

Lesson: The Brook: Alfred Tennyson

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/small groups on specific topics followed by short structured talks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Writing: Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters.

Grammar & Vocabulary building-1: Cohesive devices - linkers, sign posts and transition signals; use of articles and

zero article; prepositions.
Vocabulary building -2: Idioms and Phrases, Homonyms, Homophones and Homographs.

UNIT -3
Lesson: The Death Trap: Saki
Listening: Listening for global comprehension and summarizing what is listened to.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed **Reading:** Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension.
Writing: Summarizing – identifying main idea/s and rephrasing what is read.
Grammar and Vocabulary building-II: Direct and indirect speech, reporting verbs for academic purposes.
Technical Writing-1: personal experiences, unforgettable incidents, travelogues. (Imaginative, Narrative and Descriptive)
UNIT-4
Lesson: Innovation: Muhammad Yunus
Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.
Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions
Reading: Studying the use of graphic elements in texts to convey information, reveal trends / patterns / relationships, communicate processes or display complicated data.
Writing: Letter Writing: Official Letters/Report writing***, e-mail writing***
Grammar and Vocabulary: Quantifying expressions - adjectives and adverbs; comparing and contrasting; Voice - Active & Passive Voice.
Vocabulary 2 : Jigsaw Puzzles, Vocabulary Activities through Web tools
UNIT -5
Lesson: Politics and the English Language: George Orwell
Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.
Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides.
Reading: Reading for comprehension.
Writing: Writing structured essays on specific topics using suitable claims and evidences.
Grammar and Vocabulary: Editing short texts –identifying and correcting common errors in grammar and usage.
Technical Writing-2: Narrative short story, Newspaper articles on science fiction.

Text Book:

1. Language and Life: A Skills Approach- I Edition 2019, Orient Black Swan

Reference Books:

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd Edition, 2018.
3. Raymond Murphy's English Grammar in Use Fourth Edition (2012) E-book
4. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012.
5. Oxford Learners Dictionary, 12th Edition, 2011
6. Norman Lewis Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary (2014)
7. Speed Reading with the Right Brain: Learn to Read Ideas Instead of Just Words by David Butler

Web links
www.englishclub.com
www.easyworldofenglish.com
www.languageguide.org/english/
www.bbc.co.uk/learningenglish
www.eslpod.com/index.html
www.myenglishpages.com

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
COMMUNICATIVE ENGLISH	CO1										3				
	CO2									2	3				
	CO3										3				
	CO4										3				
	CO5										3				

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	10	20	**2**	**Understand**	**L2**	PO10	Thumb Rule	2
2	10	20	**2**	**Apply**	**L3**	PO9, PO10	Thumb Rule Thumb Rule	2, 2
3	10	20	**3**	**Analyze**	**L4**	PO10	Thumb Rule	3
4	10	20	**3**	**Evaluate**	**L5**	PO10	Thumb Rule	3
5	10	20	**3**	**Create**	**L6**	PO10	Thumb Rule	3
	50	100						

Justification Statements:

CO1: Understand the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English

Action Verb: Understand (L2)

CO1 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO2: Apply the grammatical structures to formulate sentences and correct word forms.

Action Verb: Apply (L3)

CO2 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2)

CO3: Analyze the discourse markers to speak clearly on a specific topic in informal discussions

Action Verb: Analyze (L4)

CO3 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO12 as high (3).

CO4: Evaluate the reading/listening texts and to write summaries based on global comprehension of these texts.

Action Verb: Evaluate (L5)

CO4 Action Verb Evaluate is of BTL 5. Using Thumb rule, L5 correlates PO6 to PO12 as high (3).

CO5: Create the coherent paragraph interpreting a figure/graph/chart/table

Action Verb: Create (L6)

CO5 Action Verb Create is of BTL 6. Using Thumb rule, L6 correlates PO6 to PO12 as high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **II** Branch of Study: **ME**

Subject Code	Subject Name	L	T	P	Credits
20AES0509	**Basics of Python Programming**	**3**	**0**	**0**	**3**

Course Outcomes: After studying the course, student will be able to:

CO1. **Understand** the Basic concepts of python programming to build scripts in IDLE.
CO2. **Apply** the modularity techniques to invoke user-defined functions.
CO3. **Apply** the concept of Strings and Lists to perform iterative operations on data.
CO4. **Apply** the Mutable and Immutable data types to perform python Programs.
CO5. **Analyze** the oops concepts to develop applications with reusability.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Understand	the Basic concepts of python programming		to build scripts in IDLE	L2
CO2	Apply	the modularity techniques		to invoke user defined functions	L3
CO3	Apply	the concept of Strings and Lists		to perform iterative operations on data	L3
CO4	Apply	the Mutable and Immutable data types		to perform python Programs	L3
CO5	Analyze	the oops concepts		to develop applications with reusability .	L4

Syllabus

Unit I: Introduction: What is a program, Running python, Arithmetic operators, Value and Types. **Variables, Assignments and Statements**: Assignment statements, Script mode, Order of operations, string operations, comments. **Functions**: Function calls, Math functions, Composition, Adding new Functions, Definitions and Uses, Flow of Execution, Parameters and Arguments, Variables and Parameters are local, Stack diagrams, Fruitful Functions and Void Functions, Why Functions.

Unit II: Case study: The turtle module, Simple Repetition, Encapsulation, Generalization, Interface design, Refactoring, docstring. **Conditionals and Recursion**: floor division and modulus, Boolean expressions, Logical operators, Conditional execution, Alternative execution, Chained conditionals, Nested conditionals, Recursion, Infinite Recursion, Keyboard input. **Fruitful Functions**: Return values, Incremental development, Composition, Boolean functions, more recursion, Leap of Faith, Checking types

Unit III: Iteration: Reassignment, Updating variables, The while statement, Break, Square roots, Algorithms. **Strings**: A string is a sequence, len, Traversal with a for loop, String slices, Strings are immutable, Searching, Looping and Counting, String methods, The in operator, String comparison. **Case Study**: Reading word lists, Search, Looping with indices. **Lists**: List is a sequence, Lists are mutable, Traversing a list, List operations, List slices, List methods, Map filter and reduce, Deleting elements, Lists and Strings, Objects and values, Aliasing, List arguments.

Unit IV: Dictionaries: A dictionary is a mapping, Dictionary as a collection of counters, Looping and dictionaries, Reverse Lookup, Dictionaries and lists, Memos, Global Variables. **Tuples:** Tuples are immutable, Tuple Assignment, Tuple as Return values, Variable-length argument tuples, Lists and tuples, Dictionaries and tuples, Sequences of sequences. **Files:** Persistence, Reading and writing, Format operator, Filename and paths, Catching exceptions, Databases, Pickling, Pipes, Writing modules. **Classes and Objects**: Programmer-defined types, Attributes, Instances as Return values, Objects are mutable, Copying.

Unit V: Classes and Functions: Time, Pure functions, Modifiers, Prototyping versus Planning **Classes and Methods**: Object oriented features, Printing objects, The init method, The __str__method, Operator overloading, Type-based Dispatch, Polymorphism, Interface and Implementation **Inheritance**: Card objects, Class attributes, Comparing cards, decks, Printing the Deck, Add Remove shuffle and sort, Inheritance, Data encapsulation. **The**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Goodies: Conditional expressions, List comprehensions, Generator expressions, any and all, Sets, Counters, default dict, Named tuples, Gathering keyword Args

Text Books:

1. Allen B. Downey, "Think Python", 2nd edition, SPD/O'Reilly, 2016.

Reference Books:

1. Martin C.Brown, "The Complete Reference: Python", McGraw-Hill, 2018.
2. Kenneth A. Lambert, B.L. Juneja, "Fundamentals of Python", CENGAGE, 2015.
3. R. Nageswara Rao, "Core Python Programming", 2nd edition, Dreamtech Press, 2019

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Basics of Python Programming	CO1	**2**	**3**			**2**									
	CO2	**3**	**3**	**3**		**3**							**2**		
	CO3	**3**	**3**	**3**	**2**								**2**		
	CO4	**3**	**3**	**3**	**2**								**2**		
	CO5	**3**	**3**	**3**	**3**								**2**		

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	10	19	2	Understand	L3	PO1 PO2 PO5	Apply(L3) Review(L2) Apply(L3)	2 3 2
2	13	24	3	Apply	L2	PO1 PO2 PO3 PO5 PO12	Apply(L3) Review (L2) Develop (L3) Apply(L3) Thumb rule	3 3 3 3 2
3	10	19	2	Apply	L4	PO1 PO2 PO3 PO4 PO12	Apply(L3) Review (L2) Develop (L3) Analyze (L4) Thumb rule	3 3 3 2 2
4	09	17	2	Apply	L4	PO1 PO2 PO3 PO4 PO12	Apply(L3) Review(L2) Develop (L3) Analyze(L4) Thumb rule	3 3 3 2 2
5	11	20	3	Analyze	L3	PO1 PO2 PO3 PO4 PO12	Apply(L3) Review (L2) Develop (L3) Analyze (L4) Thumb rule	3 3 3 3 2
	53	100						

Justification Statements:

CO1: Understand the Basic concepts of python programming to build scripts in IDLE..

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Review (L2)

CO1 Action verb is same as PO2 verb.. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO1 Action verb is less than PO5 verb by one level. Therefore, the correlation is medium (2)
CO2: Apply the modularity techniques to invoke user defined functions.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same as PO1 verb. Therefore, the correlation is high (3)
PO2: Review (L2)
CO2 Action verb is greater than PO2 verb. Therefore, the correlation high (3)
PO3: Develop (L3)
CO2 Action verb same as PO3 verb. Therefore, the correlation high (3)
PO5: Apply(L3)
CO2 Action verb same as PO5 verb. Therefore, the correlation high (3)
PO12: Thumb rule
For some modular applications user defined functions are created to meet societal needs. Therefore, the correlation is medium (2)
CO3: Apply the concept of Strings and Lists to perform iterative operations on data.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO3 Action verb is less than PO1 verb by two level. Therefore, the correlation is medium (2)
PO2: Review (L2)
CO3 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO3 Action verb is less than one level as PO4 verb. Therefore, the correlation is medium (2)
PO12: Thumb rule
For some of python Program Concepts are used to create programs. Therefore, the correlation is medium (2)
CO4: Apply the Mutable and Immutable data types to perform python Programs.
Action Verb: Apply (L3)
PO1: Apply(L3)
CO4 Action verb is same as PO1 verb by one level. Therefore, the correlation is high (3)
PO2: Review(L2)
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO4 Action verb is same as PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze(L4)
CO4 Action verb is less than one level as PO4 verb. Therefore, the correlation is medium (2)
PO12: Thumb rule
For some of python Program Concepts are used to create programs. Therefore, the correlation is medium(2)
CO5: Analyze the oops concepts to develop applications with reusability.
Action Verb: Analyze (L4)
PO1: Apply(L3)
CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2: Review (L2)
CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3: Develop (L3)
CO5 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO4: Analyze (L4)
CO5 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO12: Thumb rule
For some of python Program Concepts are used to create programs. Therefore, the correlation is medium (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **II** Branch of Study: CE, ECE,ME,EEE

Subject Code	Subject Name	L	T	P	Credits
20AES0304	**Engineering Workshop Practice**	**1**	**0**	**4**	**3**

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the workshop tools and operational capabilities.
CO2. Apply the wood working skills to prepare different joints.
CO3. Apply the sheet metal operations to prepare different components in real world applications.
CO4. Apply the fitting operations for various applications.
CO5. Apply the basic electrical engineering knowledge for house wiring practice.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the workshop tools and operational capabilities			**L2**
2	Apply	the wood working		skills to prepare different joints	**L3**
3	Apply	the sheet metal operations		to prepare different components in real world applications.	**L3**
4	Apply	the fitting operations	in various applications		**L3**
5	Apply	the basic electrical engineering knowledge for house wiring practice			**L3**

WOOD WORKING: (CO1 and CO2)

Familiarity with different types of woods and tools used in woodworking and make following joints
a) Half – Lap joint
b) Mortise and Tenon joint
c) Corner Dovetail joint or Bridle joint

SHEET METAL WORKING: (CO1 and CO3)

Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets
a) Tapered tray
b) Conical funnel
c) Elbow pipe
d) Brazing

FITTING: (CO1 and CO4)

Study the difference types of fits and tolerances, surface finishing materials. Familiarity with different types of tools used in fitting and do the following fitting exercises
a) V-fit
b) Dovetail fit
c) Semi-circular fit
d) Bicycle tyre puncture and change of two-wheeler tyre

ELECTRICAL WIRING: (CO1 and CO5)

Study the different types of circuits and connections, Familiarities with different types of basic electrical circuits and make the following connections
a) Parallel and series
b) Two-way switch
c) Godown lighting
d) Tube light
e) Three phase motor
f) Soldering of wires

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ENGINEERING WORKSHOP PRACTICE	CO1	2												2	2
	CO2	3	3	3			2			2				2	2
	CO3	3	3	3			2			2				2	2
	CO4	3	3	3			2			2				2	2
	CO5	3	3	3			2			2				2	2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix

CO	CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Verb	BTL			
1	Understand	**L2**	PO1	Apply (L3)	2
2	Apply	**L3**	PO1 PO2 PO3 PO6 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule Thumb Rule	3 3 3 2 2
3	Apply	**L3**	PO1 PO2 PO3 PO6 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule Thumb Rule	3 3 3 2 2
4	Apply	**L3**	PO1 PO2 PO3 PO6 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule Thumb Rule	3 3 3 2 2
5	Apply	**L3**	PO1 PO2 PO3 PO6 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule Thumb Rule	3 3 3 2 2

Justification Statements:
CO1: Understand workshop tools and operational capabilities.
Action Verb: Understand **(L2)**
PO1 Verb: Apply (L3)
CO1 Action Verb is less than one to PO1 verb. Therefore, correlation is medium (2)

CO2: Apply wood working skills to prepare different joints.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO2 Action Verb is equal to PO1 verb. Therefore, correlation is high (3)
PO2 verb: Identify (L3)
CO2 Action Verb is equal to PO2 verb. Therefore, correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action Verb is equal to PO3 verb. Therefore, correlation is high (3)

CO3: Apply sheet metal operations to prepare different components in real world applications.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)

CO2 Action Verb is equal to PO1 verb. Therefore, correlation is high (3)
PO2 verb: Identify (L3)
CO2 Action Verb is equal to PO2 verb. Therefore, correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action Verb is equal to PO3 verb. Therefore, correlation is high (3)

CO4: Apply fitting operations for various applications.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO2 Action Verb is equal to PO1 verb. Therefore, correlation is high (3)
PO2 verb: Identify (L3)
CO2 Action Verb is equal to PO2 verb. Therefore, correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action Verb is equal to PO3 verb. Therefore, correlation is high (3)

CO5: Apply basic electrical engineering knowledge for house wiring practice**.**
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO2 Action Verb is equal to PO1 verb. Therefore, correlation is high (3)
PO2 verb: Identify (L3)
CO2 Action Verb is equal to PO2 verb. Therefore, correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action Verb is equal to PO3 verb. Therefore, correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **II** Branch of Study: (Common to all branches)

Subject Code	Subject Name	L	T	P	Credits
20AHS9902	Communicative English Lab	0	0	3	1.5

Course Outcomes: After studying the course, student will be able to:

CO1. Evaluate the awareness on mother tongue influence and neutralize it in order to improve fluency in spoken English.
CO2. Understand the different aspects of the language with emphasis on LSRW skills and make use of different strategies in discussions.
CO3. Apply the knowledge of vocabulary and skills in various language learning activities.
CO4. Analyze the speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension.
CO5. Evaluate the acceptable etiquette essentials in social and professional presentations.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Evaluate	the awareness on mother tongue influence and neutralize it	in order to improve fluency in spoken English		**L5**
2	Understand	the different aspects of the language with emphasis on LSRW skills and		make use of different strategies in discussions	**L2**
3	Apply	the knowledge of vocabulary and skills		in various language learning activities	**L3**
4	Analyze	the speech sounds, stress, rhythm, intonation and syllable division	for better listening and speaking comprehension		**L4**
5	Evaluate	the acceptable etiquette essentials in social and professional presentations			**L5**

Unit 1
1. Phonetics (**CO1**)
2. Non - verbal communication (CO2)
3. Vocabulary (word formation, one word substitutes, words often misused & confused, collocations idioms & phrases) (**CO3**)

Unit 2
1. Reading Comprehension (**CO2, CO4**)
2. JAM (**CO2, CO3**)
3. Distinction between Native and Indian English accent (Speeches by TED and Kalam). (**CO4**)

Unit 3
1. Situational dialogues/Giving Directions (**CO1**)
2. Describing objects/places/persons (**CO2, CO3**)

Unit 4
1. Fun – Buzz (Tongue twisters, riddles, puzzles etc) (**CO3**)
2. Formal Presentations (**CO5**)

Unit 5
1. Debate (Contemporary / Complex topics) (**CO2**)
2. Group Discussion (**CO2**)

Software Source:
K-Van Solutions Software

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Reference:
Teaching English - British Council

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Communicative English Lab	CO1										3				
	CO2									2					
	CO3										2				
	CO4										3				
	CO5										3				

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours (Approx. Hrs)			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
		%	corr	Verb	BTL			
1	9	25	3	Evaluate	L5	PO10	Thumb Rule	3
2	6	16	2	Understand	L2	PO9	Thumb Rule	2
3	6	16	2	Apply	L3	PO10	Thumb Rule	2
4	6	16	3	Analyze	L4	PO10	Thumb Rule	3
5	9	25	3	Evaluate	L5	PO10	Thumb Rule	3
	36	100						

Justification Statements:

CO1: Evaluate awareness on mother tongue influence and neutralize it in order to improve fluency in spoken English.

Action Verb: Evaluate (L5)

CO1 Action Verb **Evaluate** is of BTL 5. Using Thumb rule, L5 correlates PO6 to PO12 as high (3).

CO2: Understanding the different aspects of the language with emphasis on LSRW skills and make use of different strategies in discussions

Action Verb: Understand (L2)

CO2 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2)

CO3: Apply knowledge of vocabulary and skills in various language learning activities

Action Verb: Apply (L3)

CO3 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

CO4: Analyze speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension

Action Verb: Analyze (L4)

CO4 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO12 as high (3).

CO5: Evaluate the acceptable etiquette essentials in social and professional presentations.

Action Verb: Evaluate (L5)

CO5 Action Verb Evaluate is of BTL 5. Using Thumb rule, L5 correlates PO6 to PO12 as high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **II** Branch of Study: CE, ECE, ME, EEE

Subject Code	Subject Name	L	T	P	Credits
20ABS9910	**Engineering Chemistry Lab**	**0**	**0**	**3**	**1.5**

Course Outcomes: After studying the course, student will be able to:

CO1. **Apply** the internal and external indicators in volumetric analysis.
CO2. **Analyze** the preparation and applications of advanced polymer materials.
CO3. **Analyze** the mixture of components by chromatographic techniques.
CO4. **Apply** the analytical and electro analytical technique to measure the strength of acids.
CO5. **Evaluate** the physical properties like surface tension, adsorption and viscosity.

List of Experiments:

1. Determination of Hardness of a groundwater sample. (**CO1**)
2. Estimation of iron (II) using Diphenylamine indicator (Dichrometry – Internal indicator method) (**CO1**)
3. Determination of pH metric titration of (i) strong acid vs. strong base (**CO4**)
4. Conductometric titrations of (i) strong acid vs. strong base (ii) Weak acid Vs Strong base (**CO4**)
5. Determination of Strength of an acid in Pb-Acid battery (**CO1**)
6. Preparation of phenol-formaldehyde resin (**CO2**)
7. Preparation of TIO2/ZnO nano particles(Precipitation Method) (**CO2**)
8. Estimation of Calcium in port land Cement (**CO1**)
9. Adsorption of acetic acid by charcoal (**CO1**)
10. Thin layer chromatography (**CO3**)
11. Determination of Viscosity of lubricating oils by Red Viscometer 1 &2 (**CO5**)
12. Determination of Copper by Iodometry (**CO1**)
13.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	the internal and external indicators in		in volumetric analysis	**L3**
2	Analyze	the preparation and applications of advanced polymer materials.			**L4**
3	Analyze	the Mixture of components	by chromatographic techniques		**L4**
4	Apply	the Electro analytical technique to measure the strength of acids.			**L3**
5	Evaluate	the Physical properties like surface tension, adsorption and viscosity			**L5**

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO Experiments may be conducted in virtual mode.

Reference:

Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Engineering Chemistry Lab	CO1				3										
	CO2				3										
	CO3				3										
	CO4				3										
	CO5				3										

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix

CO	CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Verb	BTL			
1	Apply	L3	PO4	PO4: Analyze (L4)	2
2	Analyze	L4	PO4	PO4: Analyze (L4)	3
3	Analyze	L4	PO4	PO4: Analyze (L4)	3
4	Apply	L3	PO4	PO4: Analyze (L4)	2
5	Evaluate	L5	PO4	PO4: Analyze (L4)	3

Justification Statements:
CO1: Apply the internal and external indicators in volumetric analysis.

Action Verb: Apply (L3)

PO4 Verb: Analyze (L4)

CO1 Action Verb is less than PO4; Therefore correlation is low (2)

CO2: Analyze the preparation and applications of advanced polymer materials

Action Verb: Analyze **(L4)**

PO4 Verb: Analyze (L4)

CO2 Action Verb is equal to PO4 verb; Therefore, correlation is high (3)

CO3: Analyze the mixture of components by chromatographic techniques.
Action Verb: Analyze **(L4)**

PO4 Verb: Analyze (L4)

CO3 Action Verb is equal to PO4 verb; Therefore, correlation is high (3)

CO4: Apply the electro analytical technique to measure the strength of acids.
Action Verb: Apply (L3)

PO4 Verb: Analyze (L4)

CO4 Action Verb is less than PO4; Therefore correlation is low (2)

CO5: Evaluate the physical properties like surface tension, adsorption and viscosity.

Action Verb: Evaluate (L5)

PO4 Verb: Analyze (L4)

CO5 Action Verb is greater than PO4 verb; Therefore, correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **II** Branch of Study: COMMON TO ME/CIVIL

Subject Code	Subject Name	L	T	P	Credits
20AES0510	**Basics of Python Programming Lab**	**0**	**0**	**3**	**1.5**

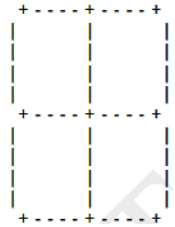
COURSE OUTCOMES: After studying the course, student will be able to:

CO1. **Analyze** the basic concepts of Python Programming
CO2. **Apply** the loops and conditional statements of python using IDLE and programs.
CO3. **Analyze** the compound data using Lists, Tuples and dictionaries using functions.
CO4. **Apply** the development applications using python datatypes to read and write data from files.
CO5. **Design** the solutions using OOPs concepts for real world problems in python.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the basic concepts of Python Programming			L4
CO2	Apply	the loops and conditional statements of python	using IDLE and programs.		L3
CO3	Analyze	the compound data using Lists, Tuples and dictionaries	using functions.		L4
CO4	Apply	the development applications	using python datatypes	to read and write data from files	L3
CO5	Design	the solutions	using OOPs concepts.	for real world problems in python	L6

List of Experiments

1. Install Python Interpreter and use it to perform different Mathematical Computations. Try to do all the operations present in a Scientific Calculator (**CO1**)
2. Write a function that draws a grid like the following:**(CO1)**



3. Write a function that draws a Pyramid with # symbols**(CO1)**

4. Using turtles concept draw a wheel of your choice **(CO1)**
5. Write a program that draws Archimedean Spiral **(CO1)**
6. The letters of the alphabet can be constructed from a moderate number of basic elements, like vertical and horizontal lines and a few curves. Design an alphabet that can be drawn with a minimal number of basic elements and then write functions that draw the letters. The alphabet can belong to any Natural language excluding English. You should consider at least Ten letters of the alphabet. **(CO1)**
7. The time module provides a function, also named time that returns the current Greenwich Mean Time in "the epoch", which is an arbitrary time used as a reference point. On UNIX systems, the epoch is 1 January 1970.
   >>> import time
   >>>time.time()
   1437746094.5735958
   Write a script that reads the current time and converts it to a time of day in hours, minutes, and seconds, plus the number of days since the epoch. **(CO1)**
8. Given n+r+1 <= 2r . n is the input and r is to be determined. Write a program which computes minimum value of

r that satisfies the above **(CO2)**

9. Write a program that evaluates Ackermann function (**CO2**)
10. The mathematician Srinivasa Ramanujan found an infinite series that can be used to generate a numerical approximation of 1/ π :
    Write a function called estimate_pi that uses this formula to compute and return an estimate of π

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801} \sum_{k=0}^{\infty} \frac{(4k)!(1103 + 26390k)}{(k!)^4 396^{4k}}$$

    It should use a while loop to compute terms of the summation until the last term is smaller than 1e-15 (which is Python notation for 10 -15). You can check the result by comparing it to math.pi.(**CO2**)
11. Choose any five built-in string functions of C language. Implement them on your own in Python. You should not use string related Python built-in functions.(**CO2**)
12. Given a text of characters, Write a program which counts number of vowels, consonants and special characters.**(CO2)**
13. Given a word which is a string of characters. Given an integer say 'n', Rotate each character by 'n' positions and print it. Note that 'n' can be positive or negative.**(CO2)**
14. Given rows of text, write it in the form of columns.**(CO2)**
15. Given a page of text. Count the number of occurrences of each latter (Assume case insensitivity and don't consider special characters). Draw a histogram to represent the same**(CO2)**
16. Write program, which performs the following operations on list's. Don't use built-in functions(**CO3**)
    a) Updating elements of a list
    b) Concatenation of list's
    c) Check for member in the list
    d) Insert into the list
    e) Sum the elements of the list
    f) Push and pop element of list
    g) Sorting of list
    h) Finding biggest and smallest elements in the list
    i) Finding common elements in the list
17. Write a program to count the number of vowels in a word.(**CO3**)
18. Write a program that reads a file, breaks each line into words, strips whitespace and punctuation from the words, and converts them to lowercase.(**CO4**)
19. Go to Project Gutenberg (http://gutenberg.org) and download your favorite out-of-copyright book in plain text format. Read the book you downloaded, skip over the header information at the beginning of the file, and process the rest of the words as before. Then modify the program to count the total number of words in the book, and the number of times each word is used. Print the number of different words used in the book. Compare different books by different authors, written in different eras.(**CO4**)
20. Go to Project Gutenberg (http://gutenberg.org) and download your favorite out-of-copyright book in plain text format. Write a program that allows you to replace words, insert words and delete words from the file.(**CO4**)
21. Consider all the files on your PC. Write a program which checks for duplicate files in your PC and displays their location. Hint: If two files have the same checksum, they probably have the same contents.(**CO4**)
22. Consider turtle object. Write functions to draw triangle, rectangle, polygon, circle and sphere. Useobject oriented approach.(CO5)
23. Write a program illustrating the object oriented features supported by Python.(**CO5**)
24. Design a Python script using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction, first class, second class, third class and failed.(**CO5**)
25. Design a Python script to determine the difference in date for given two dates in YYYY:MM:DD format(0 <= YYYY <= 9999, 1 <= MM <= 12, 1 <= DD <= 31) following the leap year rules.(**CO5**)
26. Design a Python Script to determine the time difference between two given times in HH:MM:SS format.(0 <= HH <= 23, 0 <= MM <= 59, 0 <= SS <= 59)(**CO5**)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Basics of Python Programming Lab	CO1	**2**	**3**												
	CO2	**3**	**2**	**2**											
	CO3	**3**	**3**	**2**	**2**					**1**			**1**		
	CO4	**3**	**2**												
	CO5		**1**	**3**	**3**	**3**			**2**	**1**			**2**		

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix

CO	CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Verb	BTL			
1	Analyze	L4	PO1	Apply(L3)	2
			PO2	Analyze(L4)	3
2	Apply	L3	PO1	Apply(L3)	3
			PO2	Analyze (L4)	2
			PO12	Thumb rule	2
3	Analyze	L4	PO1	Apply(L3)	3
			PO2	Analyze (L4)	3
			PO3	Design (L6)	2
			PO4	Design (L6)	2
			PO9	Thumb rule	1
			PO12	Thumb rule	1
4	Apply	L3	PO1	Apply(L3)	3
			PO2	Analyze (L4)	2
5	Design	L6	PO2	Analyze (L4)	1
			PO3	Design (L6)	3
			PO4	Design (L6)	3
			PO5	Develop (L6)	3
			PO8	Thumb rule	2
			PO9	Thumb rule	1
			PO12	Thumb rule	2

Justification Statements:

CO1: Analyze the basic concepts of Python Programming
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Analyze (L4)
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO2: Apply the loops and conditional statements of python using IDLE and programs.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Analyze (L4)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)
PO12: Thumb rule
For usage of the loops and conditional statements of python using IDLE is medium. Therefore, the correlation is medium (2)

CO3: Analyze the compound data using Lists, Tuples and dictionaries using functions.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO3 Action verb is higher level as PO2 verb. Therefore, the correlation is high (3)
PO3: Design (L6)
CO3 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)
PO4: Design (L6)
CO3 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO9: Thumb rule
Teamwork is required to analyze the compound data using. Hence, the correlation is low (1)
PO12: Thumb rule
Construct real time applications using functions can be life-long learning. Therefore, the correlation is low (1)

CO4: Apply the development applications using python datatypes to read and write data from files.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)
CO4 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

CO5: Design the solutions using OOPs concepts for real world problems in python.
Action Verb: Design (L6)
PO2: Analyze (L4)
CO5 Action verb is less than PO2 verb by two levels. Therefore, the correlation is low (1)
PO3: Design (L6)
CO5 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4: Design (L6)
CO5 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5: Develop (L6)
CO5 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)
PO8: Thumb rule
IOT Applications can be used to make society better place. Therefore, the correlation is medium (2)
PO9: Thumb rule
Teamwork is required to Create BPP applications. Hence, the correlation is low (1)
PO12: Thumb rule
In real time, oops concepts are used to solve the societal problems. Therefore, the correlation is medium (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **I** Semester: **II** Branch of Study: COMMON TO ME/CIVIL

Subject Code	Subject Name	L	T	P	Credits
20AMC9902	**Constitution of India**	**3**	**0**	**0**	**0**

COURSE OUTCOMES: After studying the course, student will be able to:

CO1. **Understand** the historical background of the Constitution making and its importance for building a democratic India.
CO2. **Remember** the basic features of Indian Constitution
CO3. **Understand** the fundamental rights and duties for becoming a good citizen of India.
CO4. **Understand** the Powers and functions of Governor, President, and Judiciary.
CO5. **Understand** the functions of local administration bodies.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the historical background of the Constitution making and its importance	for building a democratic India.		**L2**
2	**Remember**	the basic features of Indian Constitution			**L1**
3	**Understand**	the fundamental rights and duties	for becoming a good citizen of India.		**L2**
4	**Understand**	the Powers and functions	of Governor, President, and Judiciary.		**L2**
5	**Understand**	the functions of local administration bodies			**L2**

Unit:1
History of Making of the Indian Constitution - History Drafting Committee, (Composition & Working)
Unit:2
Philosophy of the Indian Constitution - Preamble Salient Features
Unit:3
Contours of Constitutional Rights & Duties - Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.
Unit:4
Organs of Governance - Parliament – Composition - Qualifications and Disqualifications - Powers and Functions - Executive, President, Governor - Council of Ministers -Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions.
Unit:5
Local Administration - District's Administration head: Role and Importance - Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation - Panchayati raj: Introduction, PRI: Zilla Panchayat - Elected officials and their roles, CEO Zilla Panchayat: Position and role - Block level: Organizational Hierarchy (Different departments) - Village level: Role of Elected and Appointed officials - Importance of grass root democracy.

Suggested books for reading:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Constitution of India	CO1						2						2		
	CO2						1	1							
	CO3								2				2		
	CO4						2						2		
	CO5						2						2		

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	4	14	2	Understand	L2	PO6, PO12	Thumb Rule Thumb Rule	2 2
2	4	14	1	Remember	L1	PO6, PO7	Thumb Rule Thumb Rule	1 1
3	8	26	2	Understand	L2	PO8, PO12	Thumb Rule Thumb Rule	2 2
4	8	26	2	Understand	L2	PO6, PO12	Thumb Rule Thumb Rule	2 2
5	6	20	2	Understand	L2	PO6, PO12	Thumb Rule Thumb Rule	2 2
	30	100						

Justification Statements:

CO1: Understand the historical background of the Constitution making and its importance for building a democratic India.

Action Verb: Understand (L2)

CO1 Action Verb is Understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO2: Remember the basic features of Indian Constitution

Action Verb: Remember (L1)

CO2 Action Verb is Remember of BTL 1. Using Thumb rule, L1 correlates PO6 to PO12 as low (1).

CO3: Understand the fundamental rights and duties for becoming a good citizen of India.

Action Verb: Understand (L2)

CO3 Action Verb is Understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO4: Understand the Powers and functions of Governor, President, and Judiciary.

Action Verb: Understand (L2)

CO4 Action Verb is Understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO5: Understand the functions of local administration bodies.

Action Verb: Understand (L2)

CO5 Action Verb is Understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Semester III (Second year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P	C	CIE	SEE	Total
1	Basic Science courses	20ABS9913	Probability and Statistics, Partial Differential Equation	3	-	-	3	30	70	100
2	Professional Core Course	20APC0308	Thermodynamics	3	-	-	3	30	70	100
3	Professional Core courses	20APC0301	Engineering Mechanics	3	-	-	3	30	70	100
4	Professional Core courses	20APC0306	Material Science and Engineering	3	-	-	3	30	70	100
5	Professional Core courses	20APC0303	Machine Drawing	3	-	-	3	30	70	100
6	Professional Core courses (LAB)	20APC0307	Material Science and Engineering Lab	-	-	3	1.5	30	70	100
7	Professional Core courses (LAB)	20APC0313	Mechanical Engineering Workshop Practice	-	-	3	1.5	30	70	100
8	Professional Core courses (LAB)	20APC0324	CAD Lab	-	-	3	1.5	30	70	100
	Skill oriented course*	20ASC0301	CATIA	1	-	2	2	100	-	100
	Mandatory course (AICTE suggested)	20AMC9903	Environmental Studies	3	-	-	0	30	-	30
			Total credits				**21.5**	**370**	**560**	**930**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: I **Semester**: **II** **Branch of Study: CE and ME**

Subject Code	Subject Name	L	T	P	Credits
20ABS9913	**Probability and Statistics, Partial Differential Equation**	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:

- **CO1.** **Understand** the discrete and continuous data through statistical methods.
- **CO2.** **Analyze** the fundamental laws of probability and its applications.
- **CO3.** **Apply** the formulation of null hypothesis to large samples.
- **CO4.** **Apply** the techniques for testing of hypothesis for small samples.
- **CO5.** **Analyze** the applications of partial differential equations in Cartesian coordinates

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the discrete and continuous data	through statistical methods.		**L2**
2	Analyze	the fundamental laws of probability and its applications.			**L4**
3	Apply	the formulation of null hypothesis	to large samples		**L3**
4	Apply	the techniques for testing of hypothesis for small samples.	for small samples		**L3**
5	Analyze	the applications of partial differential equations	in cartesian coordinates		**L4**

Syllabus:

Unit 1: Descriptive statistics:

Measures of Central tendency, Measures of Variability (spread or variance), correlation, correlation coefficient, rank correlation, regression coefficients, method of least squares, regression lines.

Unit 2: Probability

Probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous)**,** probability distribution: Binomial - Poisson approximation to the binomial distribution and normal distribution-their properties.

Unit 3: Testing of Hypothesis

Formulation of null hypothesis, critical regions, level of significance. Large sample tests: test for single proportion, difference of proportions, test for single mean and difference of means.

Unit 4: Small Sample Tests

Student t-distribution (single mean, two means and paired t-test), Testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit.

Unit 5: Applications of Partial Differential Equations

Method of separation of variables, solution of 1D-wave, 1D-heat and 2D-Laplace's equation in Cartesian coordinates.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43/e, 2010.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 2006.

References:

1) S.Chand ,Engineering Mathematics-II byDr.T.K.V.Iyengar, Dr.B.Krishna Gandhi, S.Ranganatham, Dr.M.V.S.S.N.Prasad
2) W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9/e, Wiley India, 2009.
3) E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India,1995.
4) N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 2008.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Probability and Statistics, Partial Differential Equation Calculus	CO1		2												
	CO2		3												
	CO3	3													
	CO4	3													
	CO5		3												

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	14	19.71	2	Understand	L2	PO2	Analyze	2
2	17	23.94	3	Analyze	L4	PO2	Analyze	3
3	14	21.9	2	Apply	L3	PO1	Apply	3
4	16	22.53	3	Apply	L3	PO1	Apply	3
5	10	14.08	2	Analyze	L3	PO2	Analyze	3
	71	100						

Justification Statement:

CO1: Understand the discrete and continuous data through statistical methods.
Action Verb: Understand (L2)
PO2 Verbs: Analyze (L4)
CO1 Action Verb is low levelto PO2 verb by two level; Therefore correlation is moderate (2).

CO2: Analyze the fundamental laws of probability and its applications**.**
Action Verb: Analyze (L4)
PO2 Verbs: Analyze (L4)
CO2 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO3: Apply the formulation of null hypothesis to large samples.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO3 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO4: Apply the techniques for testing of hypothesis for small samples.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO4 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO5: Analyze the applications of partial differential equations in Cartesian coordinates.
Action Verb: Analyze
PO2 Verb: Analyze (L4)
CO5 Action verb is equal to PO2 verb; therefore the correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : II **Semester** : I **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0308	Thermodynamics	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. **Apply** the thermodynamic and steam properties to derive the steam based problems
CO2. **Analyze** the laws of thermodynamics to heat-pumps, heat engines, and refrigerators
CO3. **Understand** the concepts of entropy, availability, and irreversibility of the systems
CO4. **Analyze** the concepts of ideal gas equation, gas and vapour mixture and perfect gases
CO5. **Evaluate** the TdS equations and Maxwell relations.

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	Apply	thermodynamic properties and steam properties	to derive the steam based problems		L2
CO2	Analyse	the laws of thermodynamics	to heat-pumps, heat engines, and refrigerators		L4
CO3	Understand	the concepts of entropy and availability of the systems			L4
CO4	Analyze	concepts of gas and vapour mixture			L4
CO5	Evaluate	the TdS equations and Maxwell relations			L5

UNIT I

Introduction: Basic Concepts: Macroscopic and microscopic viewpoints, definitions of thermodynamic terms, quasi – static process, point and path function, forms of energy, ideal gas and real gas, Zeroth law of thermodynamics.

Properties of Steam and use of Steam Tables: Pure Substances, P-V-T surfaces, T-s and h-s diagram, Mollier chart, dryness fraction, property tables, analysis of steam undergoing various thermodynamic processes using Mollier chart– steam calorimetry

UNIT II

First law of Thermodynamics: Joule's experiment - first law of thermodynamics, corollaries-perpetual motion machines of first kind, first law applied to non-flow and flow process- limitations of first law of thermodynamics.

Second Law of Thermodynamics: Kelvin - Planck statement and Clausius statement and their equivalence, corollaries - perpetual motion machines of second kind - reversibility and irreversibility, cause of irreversibility - Carnot cycle, heat engine, heat pump and refrigerator, Carnot theorem, Carnot efficiency

UNIT III

Entropy: Clausius inequality - Concept of Entropy- entropy equation for different processes and systems
Availability and Irreversibility: Definition of exergy and energy, expressions for availability and irreversibility. Availability in steady flow, non-flow processes and irreversibility.

UNIT IV

Thermodynamic Equations: Avogadro's law, equation of state, ideal gas equation, Vander Waal's equation, reduced properties, law of corresponding states, compressibility chart. Gibbs-Dalton law, volumetric analysis of gas mixture, apparent molecular weight and gas constant, specific heat of a gas mixture, adiabatic mixing of perfect gases, gas and vapour mixtures.

UNIT V

Thermodynamic Relations: Maxwell relations, TdS equations, difference in heat capacities, ratio of heat

capacities, Energy equation, Joule Thompson coefficient, Clausius-Clapeyron equation. Reactive mixture of gases

Text Books:

1. P. K. Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill, 2013.
2. Yunus A. Cengel, Michaela A. Boles, Thermodynamics, 7/e, Tata McGraw Hill, 2011.

Reference Books:

1. J. B. Jones and G. A. Hawkins, Introduction to Thermodynamics, 2/e, John Wiley & Sons, 2012.
2. Moran, Michael J. and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, 3/e, Wiley, 2015
3. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009
4. R. K. Rajput, S. Chand & Co., Thermal Engineering, 6/e, Laxmi publications, 2010.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Thermodynamics	CO1	**3**	**3**		**3**									**2**	**2**
	CO2	**3**	**3**		**3**									**2**	**2**
	CO3	**2**	**3**		**1**									**3**	**3**
	CO4	**3**	**3**		**3**									**3**	**3**
	CO5	**3**	**3**		**3**									**2**	**2**

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	**15/84**	**18**	**2**	Apply	L3	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **2**
2	**21/84**	**25**	**3**	Analyze	L4	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **3**
3	**12/84**	**14**	**2**	Understand	L2	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**2** **3** **1**
4	**20/84**	**24**	**3**	Analyze	L4	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **3**
5	**16/84**	**19**	**2**	Evaluate	L5	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **3**

Justification Statements:

CO1: Apply the thermodynamic properties and steam properties to derive the steam-based problems
Action Verb: **Apply** (L3)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyse (L4)**
CO1 Action verb is less than level as PO4 verb. Therefore, the correlation is high (3)

CO2: Analyse the laws of thermodynamics to heat-pumps, heat engines, and refrigerators
Action Verb: **Analyse** (L4)
PO1 Verb: **Apply (L3)**
CO2 Action verb is greater than level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO2 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyse (L4)**
CO2 Action verb is as same level as PO4 verb. Therefore, the correlation is high (3)
CO3: Understand the concepts of entropy and availability of the systems
Action Verb: **Understand** (L2)
PO1 Verb: **Apply (L3)**
CO3 Action verb is less than level as PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Review (L2)**
CO3 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyse (L4)**
CO3 Action verb is less than level as PO4 verb by two levels. Therefore, the correlation is low (1)
CO4: Analyse the concepts of idea gas equation, gas and vapour mixture and perfect gases
Action Verb: **Analyse** (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is greater than level as PO1 verb. Therefore, the correlation is High (3)
PO2 Verb: **Review (L2)**
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: **Understand (L2)**
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
CO5: Evaluate the TdS equations and Maxwell reactions
Action Verb: Evaluate (L5)
PO1 Verb: **Apply (L3)**
CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: **Understand (L2)**
CO5 Action verb is greater than PO7 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : II **Semester** : I **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0301	Engineering Mechanics	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. **Understand** the fundamentals on different forces and relative motions of mechanisms
CO2. **Analyze** the variable forces on surfaces of mechanism and strengthen the frames.
CO3. **Evaluate** the balancing of mechanisms for improving working efficiency of mechanisms.
CO4. **Analyze** the principles of least action to study of forces and movement of mechanical systems.
CO5. **Evaluate** the external and internal efficiency of mechanisms through different kinds of principles.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the fundamentals on different forces and relative motions of mechanisms			L2
CO2	Analyze	the variable forces on surfaces of mechanism and strengthen the frames.			L4
CO3	Evaluate	the balancing of mechanisms	for improving working efficiency of mechanisms.		L5
CO4	Analyze	the principles of least action	to study of forces and movement of mechanical systems.		L4
CO5	Evaluate	the external and internal efficiency of mechanisms	through different kinds of principles.		L5

UNIT I

Introduction to Engineering Mechanics: Composition and resolution of forces, parallelogram law, principle of transmissibility, types of force systems - concurrent and concurrent coplanar forces, resultant of coplanar force systems couple, moment of a force Varignon's theorem, concept of equilibrium of coplanar force systems.

UNIT II

Friction: Laws of friction, types of friction, equilibrium of force systems involving frictional forces. Free body diagrams involving frictional forces.

Analysis of Structures: Introduction to plane trusses, analysis of plane trusses by method of joints.

UNIT III

Properties of Surfaces and Volumes: Centroid and center of gravity, derivation of centroids from first moment of area, centroids of composite sections, center of gravity of common volumes - cylinder, cone, sphere, theorem of Pappus-guldinus.

Moment of Inertia: Area moment of inertia of plane and composite shapes, parallel axis theorem, perpendicular axis theorem, polar moment of inertia, mass moment of inertia of common volumes thin plates, cylinder, cone, sphere, rectangular prism, radius of gyration

UNIT IV

Virtual Work: Equilibrium of ideal systems, work done by a force, work done by a couple, principle of virtual work.

Kinematics: Equations of motion for rigid bodies, constant and variable acceleration, rectilinear and curvilinear motion and motion under gravity -projectile motion, use of rectangular coordinates, radius of curvature, rotation of a rigid body about a fixed axis.

UNIT V

Kinetics: Principles of dynamics - Newton's Laws of motion, D'Alembert's principle in rectilinear translation, principle of work and energy.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Ideal Systems: Principle of conservation of energy, concept of power, conservation of linear and angular momentum, principle of momentum and impulse, impact - types of impact.

Text Books:

1. N H Dubey, Engineering Mechanics: Statics and Dynamics, McGraw Hill, 2014.
2. S Timoshenko, DH Young, JV Rao, Sukumar Pati, Engineering Mechanics (in SI units), 5/e, McGraw Hill, 2013.
3. S S Bhavikatti, Engineering Mechanics, 4/e, New Age International, 2008

References:

1. Irving Shames, G K M Rao, Engineering Mechanics: Statics and Dynamics, 4/e, Pearson, 2009.
2. K L Kumar, Veenu Kumar, Engineering Mechanics, 4/e, Tata McGraw Hill, 2010.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Engineering Mechanics	CO1	**2**	**2**	**2**										**2**	**2**
	CO2	**3**	**3**	**3**										**3**	**3**
	CO3	**3**	**3**	**3**										**3**	**3**
	CO4	**3**	**3**	**3**										**3**	**3**
	CO5	**3**	**3**	**3**										**3**	**3**

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	16	16/82=19.51	2	Understand	L2	**PO1** **PO2** **PO4**	**Apply (L3)** **Identify(L3)** **Analysis(L4)**	2 2 1
2	14	14/82=17.07	2	Analyze	L4	**PO1** **PO2** **PO4**	**Apply (L3)** **Identify(L3)** **Analysis(L4)**	3 3 3
3	18	18/82=21.95	3	Evaluate	L5	**PO2** **PO3** **PO4** **PO5**	**Identify (L3)** **Develop(L3)** **Analysis(L4)** **Apply(L3)**	3 3 3 3
4	18	18/82=21.95	3	Analyze	L4	**PO1** **PO2** **PO5**	**Apply (L3)** **Identify(L3)** **Develop(L3)**	3 3 3
5	16	18/82=19.51	2	Evaluate	L5	**PO1** **PO4** **PO5**	**Apply (L3)** **Analysis(L4)** **Develop(L3)**	3 3 3

Justification Statements

CO1. Understand the fundamentals on different forces and relative motions of mechanisms
Action verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Identify (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)
PO4 Verb: Analysis (L4)
CO1 Action verb is less than PO4 verb by two levels. Therefore, the correlation is low (1)
CO2. Analyze the variable forces on surfaces of mechanism and strengthen the frames.

Action verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO2 Action verb is same level of PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO2 Action verb is same level of PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analysis (L4)
CO2 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
CO3. Evaluate the balancing of mechanisms for improving working efficiency of mechanisms.
Action verb: Evaluate (L5)
PO2 Verb: Identify (L3)
CO3 Action verb is same level of PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO3 Action verb is same level of PO3 verb. Therefore, the correlation is high (3)
PO4 : Analysis(L4)
CO3 Action verb is same level of PO4 verb. Therefore, the correlation is high (3)
PO5: Apply (L3)
CO3 Action verb is same level of PO5 verb. Therefore, the correlation is high (3)
CO4. Analyze the principles of least action to study of forces and movement of mechanical systems.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO4 Action verb is same level of PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO4 Action verb is same level of PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: Develop (L3)
CO4 Action verb is same level of PO5 verb. Therefore, the correlation is high (3)
CO5. Evaluate the external and internal efficiency of mechanisms through different kinds of principles.
Action Verb: Evaluate (L5)
PO1 Verb: Apply (L3)
CO5 Action verb is same level of PO1 verb. Therefore, the correlation is high (3)
PO4 Verb: Analysis (L4)
CO5 Action verb is same level of PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: Develop (L3)
CO4 Action verb is same level of PO5 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : II **Semester** : I **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0306	Material Science and Engineering	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. **Understand** the principles of crystal structure and binary phases of metals and alloys
CO2. **Apply** the heat treatment techniques to steels
CO3. **Analyze** the micro-structural characteristics of steels and cast irons for industrial applications
CO4. **Analyze** the micro-structural characteristics of nonferrous metals and alloys
CO5. **Understand** the structure, properties, and applications of polymers, ceramics and composites

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the principles of crystal structure and binary phases	of metals and alloys		L2
CO2	Apply	the heat treatment techniques	to steels		L3
CO3	Analyze	the micro-structural characteristics of steels and cast irons	for industrial applications		L4
CO4	Analyze	the micro-structural characteristics	of nonferrous metals and alloys		L4
CO5	Understand	the structure, properties, and applications	of polymers, ceramics and composites		L2

UNIT I: Structure of Metals: Crystal Structures: Unit cells, Metallic crystal structures, Imperfection in solids: Point, Line, interstitial and volume defects; dislocation strengthening mechanisms and slip systems**.**

Constitution of Alloys: Necessity of Alloying, substitutional and interstitial solid solutions-Phase diagrams: Interpretation of binary phase diagrams and microstructure development; Iron-Iron carbide diagram and microstructural aspects of ferrite, cementite, austenite, ledeburite, andcastiron.

UNIT II: Heat Treatment of Steels: Annealing, tempering, normalizing and spheroidizing, Continuous cooling curves and interpretation of final micro structures and properties austempering, mar tempering, casehardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening.

UNIT III: Steels: Plain carbon steels, used limitations of plain carbon steels. AISI & BIS classification of steels. Classification, Microstructure, properties and applications of alloy steels and tool steels.

Cast irons: Micro structure, properties and applications of white cast iron, malleable cast iron, grey cast iron, nodular cast iron and alloy cast iron.

UNIT IV: Non-ferrous Metals and Alloys: Micro structure, properties and applications of copper, bearing materials and its alloys, aluminum and its alloys. Study of Al-Cu phase diagram, precipitation hardening. Microstructure, properties and applications of titanium and its alloys

UNIT V: Ceramics, Polymers and Composites: Structure, properties and applications of ceramics, polymers and Composites. Introduction to super alloys and Nano materials.

Text Books:

1. Sydney H. Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw- Hill, 1997.
2. George E. Dieter, Mechanical Metallurgy, 3/e, McGraw-Hill, 2013.

Reference Books:

1. V. Raghavan, Material Science and Engineering, 5/e, Prentice Hall of India, 2004.
2. R. Balasubramaniam, Callister's Material Science and Engineering, 2/e, Wiley India, 2014.

3. Y. Lakhtin, Engineering Physical Metallurgy, University Press of the Pacific, 2000
4. L. H.Van Vlack, Elements of Material Science and Engineering, 6/e, Pearson Education, 2008

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Material Science and Engineering	CO1	2	2				2	3						1	1
	CO2	3	3	3		3	3	3						2	1
	CO3	3	3	3			3	3						2	2
	CO4	3	3	3			3	3						2	2
	CO5	2	2	2			2	2						1	1

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	9	9/45 = 20	L2	Understand	L2	PO1 PO2 PO6 PO7	Apply (L3) Identify (L3) Thumb Rule Thumb Rule	2 2 2 3
2	9	9/45 =20	L2	Apply	L3	PO1 PO2 PO3 PO5 PO6 PO7	Apply (L3) Identify(L3) Develop (L3) Apply (L3) Thumb Rule Thumb Rule	3 3 3 3 3 3
3	9	9/45 = 20	L2	Analyse	L4	PO1 PO2 PO3 PO6 PO7	Apply (L3) Identify(L3) Develop (L3) Thumb Rule Thumb Rule	3 3 3 3 3
4	10	10/45 = 22	L3	Analyse	L4	PO1 PO2 PO3 PO6 PO7	Apply (L3) Identify(L3) Develop (L3) Thumb Rule Thumb Rule	3 3 3 3 3
5	8	8/45 = 18	L2	Understand	L2	PO1 PO2 PO3 PO6 PO7	Apply (L3) Identify(L3) Develop (L3) Thumb Rule Thumb Rule	2 2 2 2 2

Justification Statements:

CO1: Understand the principles of crystal structure and binary phases of metals and alloys
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).
PO2 Verb: **Identify (L3)**
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2).
PO6 Verb: **Thumb Rule**
CO1: Engineering material composition and structure may influence the societal requirements. Therefore, the correlation is medium (2).

PO7 Verb: **Thumb Rule**
CO1: Compatibility of materials composition and proceeding leads to be influential on environmental sustainability. Therefore, the correlation is medium (2).

CO2: Apply the heat treatment techniques to steels
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO2: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO6 Verb: **Thumb Rule**
CO2: Engineering material composition and structure may influence the societal requirements. Therefore, the correlation is medium (2).
PO7 Verb: **Thumb Rule**
CO2: Compatibility of materials composition and proceeding leads to be influential on environmental sustainability. Therefore, the correlation is medium (2).

CO3: Analyze the micro-structural characteristics of steels and cast irons for industrial applications
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO6 Verb: **Thumb Rule**
CO3: Engineering material composition and structure may influence the societal requirements. Therefore, the correlation is medium (2).
PO7 Verb: **Thumb Rule**
CO3: Compatibility of materials composition and proceeding leads to be influential on environmental sustainability. Therefore, the correlation is medium (2).

CO4: Analyze the micro-structural characteristics of nonferrous metals and alloys
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO6 Verb: **Thumb Rule**
CO4: Engineering material composition and structure may influence the societal requirements. Therefore, the correlation is medium (2).
PO7 Verb: **Thumb Rule**
CO4: Compatibility of materials composition and proceeding leads to be influential on environmental sustainability. Therefore, the correlation is medium (2).

CO5: Understand the structure, properties, and applications of polymers, ceramics and composites.
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO5: Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).
PO2 Verb: **Identify (L3)**
CO5: Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2).
PO3 Verb: **Develop (L3)**
CO5: Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2).
PO6 Verb: **Thumb Rule**

CO5: Engineering material composition and structure may influence the societal requirements. Therefore, the correlation is medium (2).

PO7 Verb: **Thumb Rule**

CO5: Compatibility of materials composition and proceeding leads to be influential on environmental sustainability. Therefore, the correlation is medium (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : **II** Semester **: I** Branch of Study : ME

Subject Code	Subject Name	L	T	P	Credits
20APC0303	**Machine Drawing**	**3**	**0**	**0**	**3**

Course Outcomes: After studying the course, student will be able to:
CO1. Understand the concepts of conventional representation of materials and machine elements
CO2. Apply the drawing skills to design (build/develop) the machine elements and simple components
CO3. Analyze the assembly views for the part drawing of the machine and engine parts

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	**Understand**	the concepts of conventional representation	of materials and machine elements		**L2**
CO2	**Apply**	the drawing skills		to design the machine elements and simple components	**L3**
CO3	**Analyze**	the assembly views		for the part drawing of the machine and engine parts	**L4**

UNIT I
Machine Drawing Conventions: Need for drawing conventions-conventional representation of material, common machine elements and parts such as screws, nuts, bolts, keys. Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved and tapered features. Title boxes, their sizes, location and details - common abbreviations& their liberal usage.

UNIT II
Design of Machine elements and simple parts: Selection of views, additional views for the following machine elements and parts with drawing proportions**.** Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws, keys, cottered joints and knuckle joint, riveted joints for plates, flanged and protected flanged joint. Shaft coupling, spigot and socket joint, journal and foot step bearing.

UNIT III
Assembly Drawings: Drawings of assembled views for the part drawings of the following.
Engine parts- stuffing boxes, Cross heads, Eccentrics, Petrol Engine-connecting rod, piston assembly.
Other Machine parts- Screw jack, machine vice, single tool post.
Valves: Steam stop valve, feed check valve. Non- return value

Textbooks:

1. Machine Drawing- K.L. Narayana, P.Kannaiah & K.Venkata Reddy, New Age Publishers, 4th Edition, 2012.
2. Machine Drawing / N.D. Bhatt / Charotar
3. Machine Drawing – N Siddeswar, P. Kannaiah, VVS Sastry, Mc Graw Hill,2015.

References:

1. Machine Drawing- P.S. Gill, S.K. Kataria & Sons, 17th Edition, 2012
2. Machine Drawing- Dhawan, S.Chand Publications, 1st Revised Edition,1998.

Articulation matrix

Course Title	**COs**	**Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Machine Drawing	CO1	**2**												**3**	**3**
	CO2	**3**	**3**											**3**	**3**
	CO3	**3**	**3**	**3**										**3**	**3**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	12	18	L2	Understand	L2	PO1	Apply (L3)	2
2	21	31	L3	Apply	L3	PO1 PO2	Apply (L3) Review (L2)	3 3
3	33	50	L3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Review (L2) Analyze (L4)	3 3 3
	66	100						

Justification Statements:

CO1: **Understand** the concepts of conventional representation of materials & machine elements
Action Verb: **Understand (L2)**
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

CO2: **Apply** build/develop the machine elements and simple components
Action Verb: **Apply (L3)**
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO2 Action verb is same level (Greater) as PO2 verb. Therefore, the correlation is high (3)

CO3: **Analyze** the assembly views for the part drawing of the machine and engine parts
Action Verb: **Analyze (L4)**
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO3 Action verb is same level (Greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Analyze (L4)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : **II** Semester **: I** Branch of Study : ME

Subject Code	Subject Name	L	T	P	Credits
20APC0307	Material Science and Engineering Lab	0	0	3	1.5

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze the microstructure of steels and cast irons.
CO2. Analyze the microstructure of Nonferrous Alloys and heat treated steels.
CO3. Evaluate the hardenability of steels by Jominy End Quench Test.
CO4. Evaluate the hardness of treated and untreated steels.
CO5. Analyze the microstructure of ceramics and polymeric materials.

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	**Analyze**	the microstructure		of steels and cast irons.	L4
CO2	**Analyze**	the microstructure		of Nonferrous Alloys and heat treated steels.	L4
CO3	**Evaluate**	the hardenability of steels	by Jominy End Quench Test.		L5
CO4	**Evaluate**	the hardness		of treated and untreated steels.	L5
CO5	**Analyze**	the microstructure		of ceramics, polymeric materials.	L4

List of Experiments:

1. Study of microstructure of pure metals – Iron, copper and aluminum. (CO1 & CO2)
2. Study of microstructure of low carbon steel, mild steel and high carbon steel. (CO1)
3. Study of microstructure of cast irons. (CO1)
4. Study of microstructure of non-ferrous alloys – aluminum, copper, titanium, nickel and their alloys. (CO2)
5. Study hardenability of steels by Jominy End Quench Test. (CO3)
6. Study of microstructure of heat treated steels. (CO2)
7. Find hardness of various untreated and treated steels. (CO4)
8. Study of microstructure of ceramics, polymeric materials (CO5)

Articulation matrix

Course Title	**COs**	**Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Material Science and Engineering Lab	CO1	**3**	**1**	**3**						**3**				**3**	**1**
	CO2	**3**	**1**	**3**						**3**				**3**	**2**
	CO3	**3**	**2**	**3**						**3**				**3**	**1**
	CO4	**3**	**2**	**3**						**3**				**3**	**2**
	CO5	**3**	**1**	**3**						**3**				**3**	**2**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

CO	Verb	BTL	Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
1	Analyze	L4	PO1 PO2 PO3 PO9	Apply-L3 Formulate-L6 Develop-L3 Thumb Rule	3 1 3 3
2	Analyze	L4	PO1 PO2 PO3 PO9	Apply-L3 Formulate-L6 Develop-L3 Thumb Rule	3 1 3 3
3	Evaluate	L5	PO1 PO2 PO3 PO9	Apply-L3 Formulate-L6 Develop-L3 Thumb Rule	3 2 3 3
4	Evaluate	L5	PO1 PO2 PO3 PO9	Apply-L3 Formulate-L6 Develop-L3 Thumb Rule	3 2 3 3
5	Analyze	L4	PO1 PO2 PO3 PO9	Apply-L3 Formulate-L6 Develop-L3 Thumb Rule	3 1 3 3

Justification Statements:

CO1: Analyze the microstructure of steels and cast irons.

Action Verb: **Analyze (L4)**

PO1Verb: **Apply (L3)**

CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Formulate (L6)**

CO1 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9: using thumb rule CO1 correlates highly PO9. Therefore, the correlation is high (3)

CO2: **Analyze** the microstructure of Nonferrous Alloys and heat treated steels.

Action Verb: **Analyze (L4)**

PO1Verb: **Apply (L3)**

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Formulate (L6)**

CO2 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9: using thumb rule CO2 correlates highly PO9. Therefore, the correlation is high (3)

CO3: Evaluate the hardenability of steels by Jominy End Quench Test.

Action Verb: **Evaluate (L5)**

PO1Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Formulate (L6)**

CO3 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9: using thumb rule CO3 correlates highly PO9. Therefore, the correlation is high (3)

CO4: **Evaluate** the hardness of treated and untreated steels.

Action Verb: **Evaluate (L5)**

PO1Verb: **Apply (L3)**

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Formulate (L6)**

CO4 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9: using thumb rule CO4 correlates highly PO9. Therefore, the correlation is high (3)

CO5: Analyze the microstructure of ceramics, polymeric materials.

Action Verb: **Analyze (L4)**

PO1Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Formulate (L6)**

CO5 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9: using thumb rule CO5 correlates highly PO9. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : II **Semester** : I **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0313	Mechanical Engineering Workshop Practice	0	0	3	1.5

CO Statements: After studying the course, student will be able to:

CO1. Analyze the average grain size of sand and patterns for producing components through sand-casting process.

CO2. Apply the different welding techniques to join the metal components

CO3. Analyze the process of assembling and disassembling the Two wheeler

CO4. Create the simple plastic components using appropriate fabrication techniques

CO5. Apply the power tools in real time applications

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the average grain size of sand and patterns	for producing components through sand-casting process		L4
CO2	Apply	the different welding techniques		to join the metal components	L3
CO3	Analyze	the process of assembling and disassembling		the Two Wheeler	L4
CO4	Create	the simple plastic components	using appropriate fabrication techniques		L6
CO5	Apply	the power tools		in real time applications	L3

List of Experiments:

I Foundry Practice: (CO1)

1. (a) Determination of average grain size for sand sample using sieve shaker

   (b) Preparation of a green sand mould using single piece pattern

2. Preparation of a green sand mould using split piece pattern with core and demonstration of casting.

II Welding Practice: (CO2)

i) Lap joint, butt joint and T joint using arc welding.

ii) Lap joint using resistance spot welding

iii) Lap and butt joints using gas welding

III Assembling/Disassembling Practice: (CO3)

i) Bicycle

ii) Clutch and carburetor

iii) Two wheeler engine

IV Manufacture of a Plastic Component (CO4)

i) Use of injection moulding machine

ii) Joining of plastic components

V Use of Power Tools (CO5)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Mechanical Engineering Workshop	CO1	**3**	**3**	**1**		**1**				**3**				**2**	**1**
	CO2	**3**		**3**		**3**	**2**			**2**				**3**	**2**
	CO3	**3**		**3**		**3**				**3**				**2**	**2**
	CO4	**3**		**3**		**3**				**3**				**3**	**2**
	CO5	**3**				**3**	**2**			**3**				**2**	**1**

Correlation matrix

CO	Cos		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	Analyze	L4	PO1	Apply(L3)	3
			PO2	Identify(L3)	3
			PO3	Design(L6)	1
			PO5	Create (L6)	1
			PO9	Thumb Rule	3
2	Apply	L3	PO1	Apply(L3)	3
			PO3	Develop(L3)	3
			PO5	Apply(L3)	3
			PO6	Thumb Rule	2
			PO9	Thumb Rule	3
3	Analyze	L4	PO1	Apply(L3)	3
			PO3	Develop(L3)	3
			PO5	Create (L3)	3
			PO9	Thumb Rule	3
4	Create	L6	PO1	Apply(L3)	3
			PO3	Develop (L3)	3
			PO5	Create (L6)	3
			PO9	Thumb Rule	3
5	Apply	L3	PO1	Apply(L3)	3
			PO5	Develop (L3)	3
			PO6	Thumb Rule	3
			PO9	Thumb Rule	3

Justification Statements:

CO1: Analyze the average grain size of sand and patterns for producing components through sand-casting process.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3Verb: **Design (L6)**

CO1 Action verb is two levels less than PO3 verb. Therefore, the correlation is low (1)

PO5 Verb: **Create (L6)**

CO1 Action verb is two levels less than PO3 verb. Therefore, the correlation is low (1)

PO9 Verb: **Thumb Rule**

Using thumb rule CO1 correlates highly with PO9. Therefore, the correlation is high (3)

CO2: Apply the different welding techniques to join the metal components

Action Verb: Apply (L6)

PO1 Verb: **Apply (L3)**

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**
CO2 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)
PO6 Verb: **Thumb Rule**
Using thumb rule CO2 correlates moderately with PO9. Therefore, the correlation is medium (2)
PO9 Verb: **Thumb Rule**
Using thumb rule CO2 correlates highly PO9. Therefore, the correlation is high (3)
CO3: Analyze the process of assembling and disassembling the two wheeler
Action Verb: Analyze (L2)
PO1 Verb: **Apply (L3)**
CO3 Action verb is one less than PO1 verb. Therefore, the correlation is medium (2)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Create (L3)**
CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
Using thumb rule CO3 correlates highly with PO9. Therefore, the correlation is high (3)
CO4: Create the simple plastic components using appropriate fabrication techniques
Action Verb: Create (L6)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Create (L6)**
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
Using thumb rule CO4 correlates highly with PO9. Therefore, the correlation is high (3)
CO5: Apply the power tools in real time applications
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO6 verb. Therefore, the correlation is high (3)
PO5 Verb: **Create (L6)**
CO5 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)
PO6 Verb: **Apply (L3)**
Using thumb rule CO2 correlates moderately with PO9. Therefore, the correlation is medium (2)
PO9 Verb: **Thumb Rule**
Using thumb rule CO5 correlates highly with PO9. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : II **Semester** : I **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0324	CAD Lab	0	0	3	1.5

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the basic concepts of computer aided drafting software.

CO2. Analyze the fundamental drafting features for making a Part-Design using CAD software.

CO3. Apply the knowledge of draw and modify tools for designing components using CAD packages.

CO4. Apply the computer aided drafting software concepts to design the solids and intersections in three dimensions.

CO5. Analyze the perspective and orthographic views in computer aided drafting software**.**

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	Understand	the basic concepts of computer aided drafting software.			L2
CO2	Analyze	the fundamental drafting features		for making a Part-Design using CAD software.	L4
CO3	Apply	the knowledge of draw and modify tools		for designing components using CAD packages.	L3
CO4	Apply	the computer aided drafting software concepts		to design the solids and intersections in three dimensions.	L3
CO5	Analyze	the perspective and orthographic views		in computer aided drafting software.	L4

LIST OF EXPERIMENTS:

1. Introduction to Computer Aided Drafting software packages.
2. Practice on basic elements of a Computer Aided Drafting packages
3. Practice on features of a Computer Aided Drafting package
4. Drafting of Solids, Intersection of Solids
5. Drafting of Perspective views
6. Drafting of Orthographic views of simple parts

Note: Any of the standard Software Packages like – AUTO CAD, Pro-E, Uni – Graphics, Catia …. Etc may be used

Articulation Matrix

Course Title	**COs**	**Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
COMPUTER AIDED DRAFTING Lab	CO1	**2**				**2**				**1**			**1**	**3**	**3**
	CO2	**3**				**3**				**1**			**1**	**3**	**3**
	CO3	**3**				**3**				**1**			**1**	**3**	**3**
	CO4	**3**				**3**				**1**			**1**	**3**	**3**
	CO5	**3**				**3**				**1**			**1**	**3**	**3**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix

CO	CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	**Understand**	**L2**	PO1	Identify (L3)	2
			PO5	Apply (L3)	2
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1
2	**Analyze**	**L4**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1
3	**Apply**	**L3**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1
4	**Apply**	**L3**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1
5	**Analyze**	**L4**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1

Justification Statements:

CO1: **Understand** the basic concepts of computer aided drafting software.
Action Verb: **Understand (L2)**
PO1 Verb: **Identify (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO5 Verb: **Apply (L3)**
CO1 Action verb is less than PO5 verb by one level. Therefore, the correlation is medium (2)
PO9: Using the thumb rule, CO1 correlates PO9 as low (1)
PO12: Using the thumb rule, CO1 correlates PO12 as low (1)

CO2: **Analyze** the fundamental drafting features for making a Part-Design using CAD software.
Action Verb: **Analyze (L4)**
PO1 Verb: **Identify (L3)**
CO2 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO2 correlates PO9 as low (1)
PO12: Using the thumb rule, CO2 correlates PO12 as low (1)

CO3: **Apply** the knowledge of draw and modify tools for designing components using CAD packages.
Action Verb: **Apply (L3)**
PO1 Verb: **Identify (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO3 correlates PO9 as low (1)
PO12: Using the thumb rule, CO3 correlates PO12 as low (1)

CO4: **Apply** the computer aided drafting software concepts to design the solids and intersections in three dimensions.

Action Verb: **Apply (L3)**
PO1 Verb: **Identify (L3)**
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO4 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO4 correlates PO9 as low (1)
PO12: Using the thumb rule, CO4 correlates PO12 as low (1)

CO5: **Analyze** the perspective and orthographic views in computer aided drafting software.

Action Verb: **Analyze (L4)**
PO1 Verb: **Identify (L3)**
CO5 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO5 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO5 correlates PO9 as low (1)
PO12: Using the thumb rule, CO5 correlates PO12 as low (1)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: II **Semester:** I **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20ASC0301	CATIA	1	0	2	2

Course Outcomes: After studying the course, student will be able to:

CO1: Create any simple 2D models using CATIA software.

CO2: Create various 3D models using any CAD software packages.

CO3: Create simulation of any simple machine components.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Create	any simple 2D models		using CATIA	**L6**
2	Create	various 3D models		using any CAD software packages	**L6**
3	Create	simulation of any simple machine components			**L6**

List of experiments:

1. Any simple 2D drawing using CATIA.
2. 3D modelling using CATIA, Creo, Solid works, etc.,
3. Simulation of simple 3D models.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CATIA Lab	CO1	3		3		3				3				2	2
	CO2	3		3		3				3				2	2
	CO3	3		3		3				3				2	2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix

CO	CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Verb	BTL			
1	Create	L6	PO1 PO3 PO5 PO9	Apply (L3) Design (L6) Create (L6) Thumb Rule	3 3 3 3
2	Create	L6	PO1 PO3 PO5 PO9	Apply (L3) Design (L6) Create (L6) Thumb Rule	3 3 3 3
3	Create	L6	PO1 PO3 PO5 PO9	Apply (L3) Design (L6) Create (L6) Thumb Rule	3 3 3 3

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements

CO1: Create any simple 2D models using CATIA software.
Action Verb: Create (L6)
PO1 Verb: Apply (L3)
CO1 Action Verb is equal to (greater) to PO1; Therefore correlation is high (3)
PO2 Verb: Design (L6)
CO1 Action Verb is equal to PO1; Therefore correlation is high (3)
PO3 Verb: Create (L6)
CO1 Action Verb is equal to PO1; Therefore correlation is high (3)
PO9: Using thumb rule CO1 correlates highly with PO9; Therefore correlation is high (3)

CO2: Create various 3D models using any CAD software packages.
Action Verb: Create (L6)
PO1 Verb: Apply (L3)
CO2 Action Verb is equal to (greater) to PO1; Therefore correlation is high (3)
PO2 Verb: Design (L6)
CO2 Action Verb is equal to PO1; Therefore correlation is high (3)
PO3 Verb: Create (L6)
CO2 Action Verb is equal to PO1; Therefore correlation is high (3)
PO9: Using thumb rule CO2 correlates highly with PO9; Therefore correlation is high (3)

CO3: Create simulation of any simple machine components.
Action Verb: Create (L6)
PO1 Verb: Apply (L3)
CO3 Action Verb is equal to (greater) to PO1; Therefore correlation is high (3)
PO2 Verb: Design (L6)
CO3 Action Verb is equal to PO1; Therefore correlation is high (3)
PO3 Verb: Create (L6)
CO3 Action Verb is equal to PO1; Therefore correlation is high (3)
PO9: Using thumb rule CO3 correlates highly with PO9; Therefore correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: II **Semester: I** **Branch: Common to All**

Subject Code	Subject Name	L	T	P	Credits
20AMC9903	Environmental Studies	3	0	0	0

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Understand the multidisciplinary nature of environmental studies, various renewable and nonrenewable resources.
CO2. Understand the ecosystem and biodiversity to solve complex environmental problems
CO3. Apply the various types of pollution, solid waste management, and related preventive measures
CO4. Apply the rainwater harvesting, watershed management, ozone layer depletion, and wasteland reclamation.
CO5. Analyze the population explosion and impact of environmental health issues on human being.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the multidisciplinary nature of environmental studies, various renewable and nonrenewable resources.			**L2**
2	**Understand**	the ecosystem and biodiversity	to solve complex environmental problems		**L2**
3	**Apply**	the various types of pollution, solid waste management, and related preventive measures			**L3**
4	**Apply**	the rainwater harvesting, watershed management, ozone layer depletion, and wasteland reclamation			**L3**
5	**Analyze**	the population explosion and impact of environmental health issues on human being.			**L4**

SYLLABUS

UNIT – I

Multidisciplinary Nature o**f Environmental Studies:** Introduction – Multidisciplinary Nature of Environmental Studies – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources: Renewable and non-renewable energy resources – Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and over utilization of surface and sub-surface – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticides problems, water logging, salinity, case studies.

Energy resources: Renewable and non-renewable energy resources.

UNIT – II

Ecosystems: Concept of an ecosystem. – Structure and functions of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity And Its Conservation : Introduction- Definition: genetic, species and ecosystem diversity – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity:
habitat loss, poaching of wildlife, man – wildlife conflicts – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III

Environmental Pollution: Definition, Causes, effects and its control measures of: Air Pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, and Thermal pollution and Nuclear hazards.

Solid Waste Management: Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone, Tsunami and landslides.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

UNIT – IV

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting and watershed management – Resettlement and rehabilitation of people – Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies–Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Public awareness.

UNIT – V

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

TEXT BOOKS:

1. Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
2. Environmental Studies by Kaushik, New Age Publishers.
3. Environmental Studies by Sri Krishna Hitech publishing Pvt. Ltd.

REFERENCES:

1. Environmental studies by R.Rajagopalan, Oxford University Press.
2. Comprehensive Environmental studies by J.P.Sharma, Laxmi publications.
3. Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.
4. Environmental studies by A. Ravi Krishnan, G. Sujatha Sri Krishna Hitech publications.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Environmental Studies	CO1						2	2							
	CO2							2							
	CO3						2	2							
	CO4						2	2							
	CO5							2							

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix:

CO	Percentage of contact hours over the total planned contact hours				CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Register (Hrs)	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	**10**	**12**	23	3	**Understand**	**L2**	PO6, PO7	Thumb Rule Thumb Rule	2 2
2	**15**	**15**	28	3	**Understand**	**L2**	PO7	Thumb Rule	2
3	**8**	**8**	15	2	**Apply**	**L3**	PO6 PO7	Thumb Rule Thumb Rule	2 2
4	**9**	**10**	19	2	**Apply**	**L3**	PO6, PO7	Thumb Rule Thumb Rule	2 2
5	**8**	**8**	15	2	**Analyze**	**L4**	PO7	Thumb Rule	2
	50	**53**	**100**						

JUSTIFICATION STATEMENTS:

CO1: Understand the multidisciplinary nature of environmental studies, various renewable and nonrenewable resources.

Action Verb: Understand (L2)

Using Thumb rule, CO1 correlates PO6 and PO7 as a moderate (2)

CO2: Understand the ecosystem and biodiversity to solve complex environmental problems
Action Verb: Understand (L2)
Using Thumb rule, CO2 correlates PO7 as a moderate (2)
CO3: Apply the various types of pollution, solid waste management, and related preventive measures
Action Verb: APPLY (L3)
Using Thumb rule, CO3 correlates PO6 and PO7 as a moderate (2)
CO4: Apply the rainwater harvesting, watershed management, ozone layer depletion, and wasteland reclamation.
Action Verb: APPLY (L3)
Using Thumb rule, CO4 correlates PO6 and PO7 as a moderate (2)
CO5: Analyze the population explosion and impact of environmental health issues on human being
Action Verb: Analyze (L4)
Using Thumb rule, CO5 correlates PO7 as a moderate (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Semester IV (Second year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P	C	CIE	SEE	Total
1	Engineering Science Course	20AES0505	Internet of Things (IoT)	3	-	-	3	30	70	100
2	Basic Science Course / Professional core course	20AES0324	Thermal Engineering	3	-	-	3	30	70	100
3	Professional Core courses	20APC0312	Manufacturing Technology	3	-	-	3	30	70	100
4	Professional Core courses	20APC0302	Mechanics of Materials	3	-	-	3	30	70	100
5	Humanities and Social Sciences	20AHSMB01	Managerial Economics and Financial Analysis	3	-	-	3	30	70	100
6	Humanities and Social Sciences	20AHS9905	Universal Human Values	3	1	-	3	30	70	100
7	Engineering Science Courses (LAB)	20AES0506	Internet of Things (IoT) Lab	-	-	3	1.5	30	70	100
8	Professional Core courses (LAB)	20APC0326	Thermal Engineering Lab	-	-	3	1.5	30	70	100
9	Professional Core courses (LAB)	20APC0304	Mechanics of Materials Lab	-	-	3	1.5	30	70	100
10	Skill oriented course*	20ASC0302	Manufacturing Process Lab	1	-	2	2	100	-	100
			Total credits				**24.5**	**370**	**630**	**1000**

Community Service project with credits

(To visit the selected community to conduct survey (Socio-economic & domain survey) and conduct sensitization/awareness program/activities at the end of IV- semester before commencement of V-semester and complete immersion Programme also during V-Semester and submit report in V- semester. Assessment will be done at the end of V-Semester)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: II **Semester: II** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20AES0505	Internet of Things	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the vision of IoT from the Global Context.
CO2. Understand the concept of market perspective in M2M and IoT.
CO3. Understand the M2M and IoT Technology Fundamentals.
CO4. Analyze the Architectures of IoT in ETSI, IETF, ITU-T.
CO5. Apply the real world design Constraints and Industrial Automation.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the Vision of IoT from the Global Context		M2M	L2
CO2	Understand	the concept of Market Perspective in M2M & IoT		Global Value Chains	L2
CO3	Understand	the M2M and IoT Technology Fundamentals		Devices, Networks & Gateways.	L2
CO4	Analyze	the Architectures in IoT	Networks		L4
CO5	Apply	the Real World Design Constraints and Industrial Automation			L3

Syllabus:

Unit-I

M2M to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics**.**

Unit-II

M2M to IoT - A Market Perspective- Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview- Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Unit-III

M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management

Unit-IV

IoT Architecture-State of the Art - Introduction, State of the art.

Unit-V

IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints hardware is popular again, Data representation and visualization, Interaction and remote control. Industrial Automation- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things

TEXT BOOK:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014. (ISBN-13:978-0124076846)

REFERENCE BOOKS / WEBLINKS:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014. (ISBN-13: 978-8173719547)
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013. (ISBN-13: 978- 1430257400)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Internet of Things	CO1		3												
	CO2		3												
	CO3	3	3												
	CO4	2			3										
	CO5	3	2												

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	10	16	2	Understand	L2	PO2	Review (L2)	3
2	10	16	2	Understand	L2	PO1	Identify (L2)	3
3	15	23	2	Understand	L2	PO1 PO2	Apply (L3) Identify (L2)	3 3
4	14	22	3	Analyze	L4	PO1, PO4	Apply (L3) Analyze (L3)	2 3
5	14	22	3	Apply	L3	PO1 PO2	Apply (L3) Identify (L2)	3 2

Justification Statements:

CO1: Understand the vision of IoT from the Global Context**.**

Action Verb: Understand (L2)

PO2 Verbs: Review (L2)

CO1 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).

CO2: Understand the concept of Market perspective in M2M and IoT**.**

Action Verb: Understand (L2)

PO1 Verbs: Identify (L2)

CO2 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO3: Understand M2M and IoT Technology Fundamentals**.**

Action Verb: Understand (L2)

PO1 Verbs: Apply (L2)

CO3 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

PO2 Verb: Identify (L2)

CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO4: Analyze the Architecture of IoT in ETSI, IETF, ITU-T**.**

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO4 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).

PO4 Verbs: Analyze (L3)

CO4 action verb is equal to PO4 verb. Therefore correlation is high(3)

CO5: Apply Real world design Constraints and Industrial Automation**.**

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO5 Action verb is equal to PO1 verb; therefore the correlation is high (3).

PO2 Verb: Identify (L2)

CO5 Action Verb is greater than PO2 verb; Therefore correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **II** Semester: **II** Branch of Study: ME

Subject Code	Subject Name	L	T	P	Credits
20AES0324	**Thermal Engineering**	**3**	**0**	**0**	**3**

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the working of S.I and C.I engine.
CO2. Apply the fuel and cooling system for I.C engine.
CO3. Analyze the normal and abnormal combustion system as well as fuel rating system.
CO4. Analyze the testing performance of I.C engines.
CO5. Understand the working of air compressor, gas turbines, and jet propulsion system.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the working of S.I and C.I engine			L2
CO2	Apply	the fuel and cooling system	for I.C engine		L3
CO3	Analyze	the normal and abnormal combustion system as well as fuel rating system			L4
CO4	Analyze	the testing process and parameters of I.C engines			L4
CO5	Understand	working of air compressor, gas turbines, and jet propulsion system			L2

Syllabus:

UNIT I

I.C. ENGINES: Definition of Engine And Heat Engine, I.C Engine Classification – Parts of I.C. Engines, Working of I.C. Engines, Two Stroke & Four Stroke I.C. Engines SI & CI Engines, Valve and Port Timing Diagrams.

UNIT II

Fuel System: S.I. Engine: Fuel Supply Systems, carburetor types Air Filters, Mechanical and Electrical Fuel Pump – Filters– Gasoline Injection Systems.

Cooling & Lubrication Systems: Cooling Requirements, Air Cooling, Liquid Cooling, Thermo Siphon, Water And Forced Circulation System; Lubrication Systems-Flash, Pressurized and Mist Lubrication.

Ignition System: Function of An Ignition System, Battery coil Ignition System, Magneto Coil Ignition System, Electronic Ignition System using Contact Breaker, Electronic Ignition using Contact Triggers – Spark Advance and Retard Mechanism.

UNIT III

Fuels and Combustion: S I engine - Normal Combustion and Abnormal Combustion – Importance of Flame Speed and Effect of Engine Variables – Type of Abnormal Combustion, Pre-Ignition and Knocking (Explanation) – Fuel Requirements and Fuel Rating, Anti Knock Additives, Combustion Chambers. C.I. Engines: Stages Of Combustion – Delay Period And Its Importance – Effect Of Engine Variables – Diesel Knock– Combustion Chambers (DI And IDI), Fuel Requirements And Fuel Rating.

UNIT IV

Testing and Performance : Parameters of Performance - Measurement of Cylinder Pressure, Fuel Consumption, Air Intake, Exhaust Gas Composition, Brake Power – Determination of Frictional Losses And Indicated Power – Performance Test – Heat Balance Sheet and Chart.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

UNIT V

Air Compressors: Reciprocating Compressors, Effect of Clearance volume in Compressors, Volumetric Efficiency, Single Stage and Multi Stage Compressors.

GAS TURBINES: Simple Gas Turbine Plant – Ideal Cycle, Essential Components – Parameters of Performance. Jet propulsion: Principle of Operation – Classification of Jet Propulsive Engines – Working Principles with Schematic Diagrams and Representation on T-S Diagram.

Text Books:

1. Internal Combustion Engines / V. Ganesan- TMH, 4th Edition,2012
2. Thermal Engineering / Rajput / Lakshmi Publications, 9th Edition,2013

Reference Books:

1. I.C. Engines fundamentals, Heywood, McGrawHIll, 1st Edition,2011
2. IC Engines – Mathur& Sharma – DhanpathRai& Sons, ,2010
3. Engineering fundamentals of IC Engines – Pulkrabek, Pearson, PHI, 2nd Edition,2009
4. Thermal Engineering, Rudramoorthy – TMH, 10th Edition,2010
5. Thermodynamics & Heat Engines, B. Yadav, Central publishing house., Allahabad, 2002
6. Thermal Engineering – R.S. Khurmi & J.K.Gupta – S.Chand, 15th Edition,2012

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Thermal Engineering	CO1	**2**	**3**	**2**										**2**	**2**
	CO2	**3**	**3**	**3**										**3**	**3**
	CO3	**3**	**3**	**3**										**3**	**3**
	CO4	**3**	**3**	**3**										**3**	**3**
	CO5	**2**	**3**	**2**										**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	18/83	22	3	Understand	L2	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	2 3 2
2	14/83	17	2	Apply	L3	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	3 3 3
3	27/83	32	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	3 3 3
4	19/83	23	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	3 3 3
5	18/83	22	3	Understand	L2	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	2 3 2

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Understand the working of S.I and C.I engine
Action Verb: **Understand** (**L2)**
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than as PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Review (L2)**
CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is less than level as PO3 verb. Therefore, the correlation is medium (2)

CO2: Apply the fuel and cooling system for I.C engine
Action Verb: **Apply** (**L3**)
PO1 Verb: **Apply (L3)**
CO1 Action verb is as same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is as same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze the normal and abnormal combustion system as well as fuel rating system
Action Verb: **Analyse (L4)**
PO1 Verb: **Apply (L3)**
CO1 Action verb is as same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is as same level as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the testing performance of I.C engines
Action Verb: **Analyse** (L4)
PO1 Verb: **Apply (L3)**
CO1 Action verb is as same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is as same level as PO3 verb. Therefore, the correlation is high (3)

CO5: Understand the working of air compressor, gas turbines, and jet propulsion system
Action Verb: **Understand** (**L2)**
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than as PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Review (L2)**
CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is less than level as PO3 verb. Therefore, the correlation is medium (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: II **Semester**: II **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0312	Manufacturing Technology	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze the steps of casting process in fabrication of metals.
CO2. Apply the principles of rolling and extrusion techniques for fabrication of metals.
CO3. Apply the principles of forging and sheet metal forming methods for fabrication of metals.
CO4. Analyze the various welding types and joints for joining of metals.
CO5. Analyze the steps in processing and molding of plastics.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the steps of casting process in fabrication of metals			L4
CO2	Apply	the principles of rolling and extrusion techniques		for fabrication of metals	L3
CO3	Apply	the principles of forging and sheet metal forming methods		for fabrication of metals	L3
CO4	Analyze	the various welding types and joints		for joining of metals	L4
CO5	Analyze	the steps in processing and molding of plastics			L4

Syllabus:

UNIT I

Introduction: Importance and selection of manufacturing processes, classification and selection of manufacturing processes.

Casting Processes: Introduction to casting process, process steps; pattern: types, materials and allowance; Cores and design of gating system, Gating ratio and time of filling the cavity; Solidification of casting: Concept, solidification of pure metal and alloy; Special casting processes: Shell casting, investment casting, die-casting, centrifugal casting, casting defects and remedies.

UNIT II

Metal Forming: Introduction, nature of plastic deformation, hot and cold working, mechanics of metal forming; Rolling: Principle, types of rolling mill and products, roll passes, forces in rolling and power requirements; Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, wire drawing, tube drawing.

UNIT III

Forging: Principles of forging, tools and dies. Types: Smith forging, drop forging, forging hammers, rotary forging and forging defects. Sheet metal forming: blanking, piercing, bending, stamping.

UNIT IV

Material Joining Processes: Classification of welding processes, types of welds and welded joints, arc welding, submerged arc welding, gas tungsten arc welding, gas metal arc welding. applications, advantages and disadvantages of the above processes, other fabrication processes. soldering and brazing: Types and their applications, Welding defects: causes and remedies.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

UNIT V

Plastics: Types, properties and their applications, processing of plastics, extrusion of plastics, transfer molding and compression molding, injection molding, thermoforming, rotational molding and blow molding.

Text Books :

1. Rao P.N., Manufacturing Technology – Volume I, 5/e, McGraw-Hill Education, 2018.
2. Kalpakjian S and Schmid S.R., Manufacturing Engineering and Technology, 7/e, Pearson, 2018

Reference Books:

1. Millek P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, 4/e, John Wiley and Sons Inc, 2010.
2. Sharma P.C., A Textbook of Production Technology, 8/e, S Chand Publishing, 2014.
3. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies:

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Manufacturing Technology	CO1	**3**	**3**	**3**		**3**								**3**	**3**
	CO2	**3**	**3**	**3**		**3**								**3**	**3**
	CO3	**3**	**3**	**3**		**3**								**3**	**3**
	CO4	**3**	**3**	**3**		**3**								**3**	**3**
	CO5	**3**	**3**	**3**		**3**								**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	**13**	**21.3**	**3**	**Analyze**	**L4**	**PO1** **PO2** **PO3** **PO5**	**Apply (L3)** **Identify (L3)** **Develop (L3)** **Select/Apply (L3)**	**3** **3** **3** **3**
2	**13**	**21.3**	**3**	**Apply**	**L3**	**PO1** **PO2** **PO3** **PO5**	**Apply (L3)** **Identify (L3)** **Develop (L3)** **Select/Apply (L3)**	**3** **3** **3** **3**
3	**11**	**18**	**2**	**Apply**	**L3**	**PO1** **PO2** **PO3** **PO5**	**Apply (L3)** **Identify (L3)** **Develop (L3)** **Select/Apply (L3)**	**3** **3** **3** **3**
4	**13**	**21.3**	**3**	**Analyze**	**L4**	**PO1** **PO2** **PO3** **PO5**	**Apply (L3)** **Identify (L3)** **Develop (L3)** **Select/Apply (L3)**	**3** **3** **3** **3**
5	**11**	**18**	**2**	**Analyze**	**L4**	**PO1** **PO2** **PO3** **PO5**	**Apply (L3)** **Identify (L3)** **Develop (L3)** **Select/Apply (L3)**	**3** **3** **3** **3**

Justification Statements:

CO1: Analyze the steps of casting process in fabrication of metals.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**
CO1 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO1 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO1 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

CO2: Apply the principles of rolling and extrusion techniques for fabrication of metals
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO2 Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

CO3: Apply the principles of forging and sheet metal forming methods for fabrication of metals
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

CO4: Analyze the various welding types and joints for joining of metals.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO4 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO4 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO4 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

CO5: Analyze the steps in processing and molding of plastics.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO5 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO5 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO5 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **II** Semester**: II** Branch of Study: ME

Subject Code	Subject Name	L	T	P	Credits
20APC0302	Mechanics of Materials	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Apply the concepts of stresses-strains to various machine elements
CO2. Evaluate the shear forces, bending moments and bending stresses in the beams
CO3. Analyze the deflection of beams subjected to different loading conditions using various methods.
CO4. Analyze the torsional and shear stress distributions for different cross section of beams
CO5. Evaluate the buckling loads for columns and stresses in thin cylinders subjected to internal pressure.

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	Apply	the concepts of stress-strain		to various machine elements	L3
CO2	Evaluate	the shear forces, bending moments and bending stresses in the beams			L5
CO3	Analyze	the deflection of beams subjected to different loading conditions	Using various methods		L4
CO4	Analyze	the torsional and shear stress distributions for different cross section of beams			L4
CO5	Evaluate	the buckling loads for columns and stresses in thin cylinders subjected to internal pressure			L5

Syllabus:

UNIT I

Stresses and Strains: Types of stresses and strains, stress-strain relations, stress-strain diagram for ductile and other materials, axial loaded bars of uniform and varying cross section, compound bars, relation between three elastic moduli, thermal stresses. Strain energy, resilience

Principal stresses and strains: Biaxial state of stress with and without shear - Mohr's Circle and analytical methods.

UNIT II

Analysis of Beams: Types of beams and loads, shear force and bending moment diagram for cantilever, simply supported and overhanging beams for different types of loadings, point of contra flexure, relation between shearing force and bending moment.

Bending Stresses: Flexural equation, bending stress distribution and efficiency of various cross sections of beams.

UNIT III

Deflection of Beams: Differential equations of the deflection curve, Slope and deflection: using double integration method, Macaulay's method and Moment area method for simply supported, cantilever and overhanging beams. Deflection under single and several loads.

UNIT IV

Torsional and shear stresses: Theory of pure torsion, Shear Stresses: Shear stress distribution for different cross sections of beams.

UNIT V

Buckling of Columns: Analysis of columns to evaluate buckling loads with different boundary conditions, Euler's formula and its limitations, Rankine's formula.

Thin Cylinders: hoop and stresses, longitudinal, cylindrical and spherical shells subjected to internal pressure

calculation of volumetric strain.

Text Books :

1. F.P. Beer, E.R. Johnston, Jr & John. T. De Wolf, Mechanics of Materials, 7/e, Tata McGraw-Hill
2. SS Rattan, Strength of materials, 3/e, Tata McGraw-Hill

Reference Books:

1. Timoshenko, Strength of Materials Part-I& II, 3/e, CBS Publishers
2. Popov, Mechanics of Solids, 2/e, New Pearson Education

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Mechanics of Machines	CO1	**3**	**3**	**3**										**3**	**3**
	CO2	**3**	**3**	**3**										**3**	**3**
	CO3	**3**	**3**	**3**										**3**	**3**
	CO4	**3**	**3**	**3**										**3**	**3**
	CO5	**3**	**3**	**3**										**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	20	23.25	3	Apply	L3	**PO1** **PO2** **PO3**	**Apply (L3)** **Identify (L3)** **Design/develop (L3)**	3 3 3
2	20	23.25	3	Evaluate	L5	**PO1** **PO2** **PO3**	**Apply (L3)** **Identify (L3)** **Design/develop (L3)**	3 3 3
3	16	18.60	2	Analyze	L4	**PO1** **PO2** **PO3**	**Apply (L3)** **Identify (L3)** **Design/develop (L3)**	3 3 3
4	15	17.44	2	Analyze	L4	**PO1** **PO2** **PO3**	**Apply (L3)** **Identify (L3)** **Design/develop (L3)**	3 3 3
5	15	17.44	2	Evaluate	L5	**PO1** **PO2** **PO3**	**Apply (L3)** **Identify (L3)** **Design/develop (L3)**	3 3 3

Justification Statements:

CO1: Apply the concepts of stress-strain to machine members**.**

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Design (L3)**

CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO2: Evaluate the shear forces, bending moments and bending stresses in beams.
Action Verb: Evaluate (L5)
PO1Verb: **Apply (L3)**
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Design (L3)**
CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze the deflections in beam subjected to different loading conditions using double integration, macaulays's and moment area methods.
Action Verb: Analyze (L4)
PO1Verb: **Apply (L3)**
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Design (L3)**
CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the torsional and shear stress distributions for beams.
Action Verb: Analyze (L4)
PO1Verb: **Apply (L3)**
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Design (L3)**
CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Evaluate the buckling loads for columns and the stresses in thin cylinders subjected to internal pressure.
Action Verb: Evaluate (L5)
PO1Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Design (L3)**
CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **II** Semester**: II** Branch of Study: Common to All

Subject Code	Subject Name	L	T	P	Credits
20AHSMB01	MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Understand the fundamentals of managerial economics and demand concept.
CO2. Understand the production and cost concepts to optimize the output
CO3. Analyze the price output relationship in different markets.
CO4. Evaluate the capital budgeting techniques to invest in various projects.
CO5. Analyze the accounting statements to evaluate the financial performance of business entity.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	fundamentals of managerial economics			L2
CO2	Understand	production and cost concepts		To optimize the output	L2
CO3	Analyze	price output relationship in various markets			L4
CO4	Evaluate	capital budgeting techniques		To invest in various projects	L5
CO5	Analyze	accounting statements		to evaluate the financial performance of business entity	L4

Syllabus:

UNIT - I Managerial economics

Introduction – meaning, nature, significance, functions, and advantages, ME and its role in other fields. Demand - Concept, Function,Law of Demand - Demand Elasticity- Types – Measurement. Demand Forecasting- Factors governing forecasting, Methods.

UNIT – II Production and Cost Analysis

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least- cost combination– Short run and Long run Production Function- Isoquants and Isocosts, MRTS - Cobb-Douglas Production Function - Laws of Returns - Internal and External Economies of scale. Cost& Break-Even Analysis - Cost concepts and Cost behavior- Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems)-Managerial significance and limitations of Break-Even Analysis.

UNIT - III Business Organizations and Markets

Introduction – Nature, meaning, significance, functions and advantages. Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises. Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition Monopoly- Monopolistic Competition–Oligopoly-Price-Output Determination - Pricing Methods and Strategies.

UNIT – IV Capital Budgeting

Introduction to Capital, Sources of Capital. Short-term and Long-term Capital: Working capital, types, Estimating Working capital requirements. Capital Budgeting – Features, Proposals, Time value of money. Methods and Evaluation of Projects – Pay Back Method, Accounting Rate of Return (ARR), Net Present Value (NPV), and Internal Rate Return (IRR) Method (simple problems).

UNIT – V Financial Accounting and Analysis

Introduction – Nature, meaning, significance, functions and advantages. Concepts and Conventions- Double-Entry Book Keeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profitand Loss Account and Balance Sheet with simple adjustments). **Financial Analysis -** Analysis and Interpretation of Liquidity

Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

Textbooks:

1. Varshney&Maheswari: Managerial Economics, Sultan Chand, 2013.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH, 2019

Reference Books:

1. Ahuja Hl Managerial economics Schand,3/e,2013
2. S.A. Siddiqui and A.S. Siddiqui: Managerial Economics and Financial Analysis, New Age International, 2013.
3. Joseph G. Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, NewDelhi.
4. Domnick Salvatore: Managerial Economics in a Global Economy, Cengage,2013.

Online Learning Resources:

https://www.slideshare.net/123ps/managerial-economics-ppt https://www.slideshare.net/rossanz/production-and-cost-45827016 https://www.slideshare.net/darkyla/business-organizations-19917607
https://www.slideshare.net/balarajbl/market-and-classification-of-market
https://www.slideshare.net/ruchi101/capital-budgeting-ppt-59565396
https://www.slideshare.net/ashu1983/financial-accounting.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Managerial Economics and Financial	CO1	2													
	CO2		1												
	CO3	3													
	CO4		3												
	CO5		3												

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation matrix

Course Outcome (CO)	Percentage of contact hours over the total planned contact hours	CO: Action verb and BTL	Program Outcome(PO)	PO: Action verb and BTL	Level of correlation (0-3)
CO1	16%	understand	PO1	Apply	2
CO2	22%	understand	PO2	Analyse	1
CO3	22%	Analyse	PO1	Apply	3
CO4	16%	Evaluate	PO2	Analyse	3
CO5	22%	Analyse	PO2	Analyse	3

Justification Statements:

CO1: Understand the fundamentals of Managerial economics and demand concept.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

CO2: Understand the Concept of Production and cost analysis.
Action Verb: Understand (L2)
PO2: Analyze (L4)
CO2 Action verb is less than PO1 verb by two levels. Therefore, the correlation is low (1)

CO3: Analyze the price output in various markets.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO3 Action verb is more than PO1 verb by one level. Therefore, the correlation is high (3)

CO4: Evaluate the capital budgeting techniques.
Action Verb: Evaluate (L5)
PO2: Analyse
CO3 Action verb is more than PO1 verb by one level. Therefore, the correlation is high (3)

CO5: Analyse the Accounting statements and evaluate the financial performance of business entity.
Action Verb: Analyze (L4)
PO2: Analyze (L4)
CO5 Action verb is same as PO2 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **II** Semester**: II** Branch of Study: Common to all

Subject Code	Subject Name	L	T	P	Credits
20AHS9905	**Universal Human Values**	**3**	**0**	**0**	**3**

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the essentials of human values, self-exploration, happiness and prosperity for value added education.
CO2. Analyze the harmony in the human being as sentient 'I' and the material 'Body' in various aspects.
CO3. Apply the nine universal human values in relationships for harmony in the family and orderliness in the society.
CO4. Evaluate the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence.
CO5. Apply the holistic understanding of harmony on professional ethics through augmenting universal human order.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	the essentials of human values, self-exploration, happiness and prosperity for value added education			**L2**
CO2	**Analyze**	the harmony in the human being as sentient 'I' and the material 'Body' in various aspects.			**L4**
CO3	**Apply**	the nine universal human values in relationships for harmony in the family and orderliness in the society			**L3**
CO4	**Evaluate**	the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence			**L5**
CO5	**Apply**	the holistic understanding of harmony on professional ethics through augmenting universal human order.			**L3**

Syllabus:

UNIT – 1: <u>Course Introduction - Need, Basic Guidelines, Content and Process for Value Education</u>

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current. scenario
- Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT II: <u>Understanding Harmony in the Human Being - Harmony in Myself!</u>

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'

- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

UNIT III: **Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship**.

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

UNIT IV: **Understanding Harmony in the Nature and Existence - Whole existence as Coexistence**

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfillment among the four orders of nature recyclability and self-regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all- pervasive space
- Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT- V: Implications of the above Holistic Understanding of Harmony on Professional Ethics.

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
- Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions Eg. To discuss the conduct as an engineer or scientist etc.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

TEXT BOOKS

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93- 87034-47-1
2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

REFERENCE BOOKS:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
3. A. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth"
6. E. FSchumacher. "Small is Beautiful"
7. Slow is Beautiful –Cecile Andrews
8. J C Kumarappa "Economy of Permanence"
9. Pandit Sunderlal "Bharat Mein Angreji Raj"
10. Dharampal, "Rediscovering India"
11. Mohandas K. Gandhi, "Hind Swaraj or Indian Home Rule"
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland(English)
14. Gandhi - Romain Rolland (English)

Articulation matrix

Course Title	**COs**	**Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)**													
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Universal Human Values	CO1								2				2		
	CO2							3	3						
	CO3						2	2	2						
	CO4						3	3	3				3		
	CO5						2	2	2				2		

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	**7**	19.4	2	**Understand**	**2**	PO8 PO12	Thumb Rule Thumb Rule	2 2
2	**8**	22.2	3	**Analyze**	**4**	PO7 PO8	Thumb Rule Thumb Rule	3 3
3	**7**	19.4	**2**	**Apply**	**3**	PO6 PO7 PO8	Thumb Rule Thumb Rule Thumb Rule	2 2 2
4	**8**	22.2	**3**	**Evaluate**	**5**	PO6 PO7 PO8 PO12	Thumb Rule Thumb Rule Thumb Rule Thumb Rule	3 3 3 3
5	**7**	19.4	**2**	**Apply**	**3**	PO6 PO7 PO8, PO12	Thumb Rule Thumb Rule Thumb Rule Thumb Rule	2 2 2 2

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Understand the essentials of human values, self-exploration, happiness and prosperity for value added education.

Action Verb: Understand (L2)

CO1 Action Verb is Understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO2: Analyze the harmony in the human being as sentient 'I' and the material 'Body' in various aspects.

Action Verb: Analyze (L4)

CO2 Action Verb is Analyze of BTL 4. Using Thumb rule, L4 correlates PO6 to PO12 as high (3).

CO3: Apply the nine universal human values in relationships for harmony in the family and orderliness in the society.

Action Verb: Apply (L3)

CO3 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2)

CO4: Evaluate the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence.

Action Verb: Evaluate (L5)

CO4 Action Verb is Evaluate of BTL5. Using Thumb rule, L5 correlates PO6 to PO12 as high (3).

CO5: Apply the holistic understanding of harmony on professional ethics through augmenting universal human order.

Action Verb: Apply (L3)

CO5 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **II** Semester**: II** Branch of Study: EEE, ECE,CE&ME

Subject Code	Subject Name	L	T	P	Credits
20AES0506	**Internet of Things Laboratory (IoT Lab)**	**0**	**0**	**3**	**1.5**

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze the parameter of Analog and digital sensors using Development board.
CO2. Evaluate the various actuators using Bluetooth communication technology.
CO3. Analyze the sensor data-using socket Communication and Local Area Network.
CO4. Analyze the sensor and actuator data using cloud platform.
CO5. Create a prototype design to solve local area issues.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	The parameter of Analog and Digital sensors	Different Types of sensors pin configuration	Development board	L4
CO2	Evaluate	The various actuators		using Bluetooth device	L5
CO3	Analyze	The Sensor data using socket communication and local area network			L4
CO4	Analyze	the sensor and actuator data using cloud platform	Cloud Platform must compatible with development board		L4
CO5	Create	a prototype design to solve local area issue			L6

LIST OF EXPERIMENTS:

1. Select any one-development board (Eg. Arduino or Raspberry Pi) and control LED using the board **(CO1)**.
2. Using the same board as in (1), read data from a sensor. Experiment with both analog and digital sensors **(CO1)**.
3. Control any two actuators connected to the development board using Bluetooth **(CO2)**.
4. Read data from sensor and send it to a requesting client. (using socket communication) Note: The client and server should be connected to same local area network **(CO3)**.
5. Create any cloud platform account, explore IoT services and register a thing on the platform **(CO4)**.
6. Push sensor data to cloud **(CO4)**.
7. Control an actuator through cloud **(CO4)**.
8. Access the data pushed from sensor to cloud and apply any data analytics or visualization services**(CO4)**.
9. Create a mobile app to control an actuator **(CO4)**.
10. Identify a problem in your local area or college, which can be solved by integrating the things you learned so far and create a prototype to solve it (Mini Project) **(CO5)**.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Internet of Things Laboratory	CO1	**3**			**3**										
	CO2	**3**			**3**										
	CO3	**3**	**3**		**3**										
	CO4	**3**	**3**		**3**										
	CO5	**3**	**3**	**3**	**3**	**3**									

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

S.No	Course Outcomes(CO)		Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO12)	Level of Correlation (0-3)
	Co's Action verb	BTL			
1	Analyze	**L4**	PO1 PO4	Apply (L3) Analyze (L4)	3 3
2	Evaluate	**L5**	PO1 PO4	Apply (L3) Analyze(L4)	3 3
3	Analyze	**L4**	PO1 PO2 PO3	Apply (L3) Review (L2) Analyze(L4)	3 3 3
4	Analyze	**L4**	PO1 PO2 PO3	Apply (L3) Review (L2) Analyze(L4)	3 3 3
5	Create	**L6**	PO1 PO2 PO3 PO4 PO5	Apply (L3) Review (L2) Design(L6) Analyze(L4) Create(L6)	3 3 3 3 3

Justification Statements:

CO 1: **Analyze** the parameter of Analog and digital sensors using Development board. **(L4)**
PO1 Verbs: Apply (L3)
CO1 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3)
PO4 Verbs: Analyze (L4)
CO1 Action Verb is equal to PO4 verb; Therefore correlation is high (3).

CO 2: Evaluate the various actuators using Bluetooth communication technology.(L4)
PO1 Verbs: Apply (L3)
CO2 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3)
PO4 Verbs: Analyze (L4)
CO2 Action Verb is equal to PO4 verb; Therefore correlation is high (3).

CO 3: Analyze the sensor data using socket Communication and Local Area Network.(L4)
PO1 Verbs: Apply (L3)
CO3 Action Verb is greater than PO1 by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO3 Action Verb is greater than PO2 verb by two level; Therefore correlation is high (3).
PO4 Verbs: Analyze (L4)
CO2 Action Verb is equal to PO4 verb; Therefore correlation is high (3).

CO 4: Analyze the sensor and actuator data using cloud platform.(L4)

PO1 Verbs: Apply (L3)
CO4 Action Verb is greater than PO1 by one level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO4 Action Verb is greater than PO2 verb by two level; Therefore correlation is high (3).
PO4 Verbs: Analyze (L4)
CO4 Action Verb is equal to PO4 verb; Therefore correlation is high (3).

CO 5: Create a prototype design to solve local area issues.(L6)
PO1 Verbs: Apply (L3)

CO5 Action Verb is greater than PO1 by three level; Therefore correlation is high (3).
PO2 Verbs: Review (L2)
CO5 Action Verb is greater than PO2 verb by Four level; Therefore correlation is high (3).
PO3 Verbs: Design (L6)
CO5 Action Verb is equal to PO3 verb; Therefore correlation is high (3).
PO4 Verbs: Analyze (L4)
CO5 Action Verb is greater than PO2 verb by two level; Therefore correlation is high (3).
PO5 Verbs: Create (L4)
CO5 Action Verb is equal to PO5 verb; Therefore correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **II** Semester**: II** Branch of Study: ME

Subject Code	Subject Name	L	T	P	Credits
20APC0326	**Thermal Engineering Lab**	**0**	**0**	**3**	**1.5**

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze the functioning and performance of an 2-stroke and 4 -Stroke engine

CO2. Evaluate the fuel supply, cooling, lubrication, and ignition systems of an IC engine

CO3. Analyze the flame propagation and combustion of S.I and C.I engines and functioning of boilers.

CO4. Evaluate the indicated power, brake power, friction power, and their methods of measurement

CO5. Analyze the volumetric efficiency of multistage reciprocating air compressors.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Analyze**	the functioning and performance	of an 2-stroke and 4 -Stroke engine		L4
CO2	**Evaluate**	the fuel supply, cooling, lubrication, and ignition systems	of an IC engine		L5
CO3	**Analyze**	the flame propagation and combustion and functioning of boilers	of S.I and C.I engines		L4
CO4	**Evaluate**	the indicated power, brake power, friction power, and their methods of measurement			L5
CO5	**Analyze**	the volumetric efficiency	of multistage reciprocating air compressors		L4

List of Experiments:

1. Valve / Port Timing Diagrams of an I.C. Engines (**CO1**)
2. Performance Test on a 4 -Stroke Diesel Engines (**CO2**)
3. Performance Test on 2-Stroke Petrol engine (**CO2**)
4. Evaluation of Engine friction by conducting Morse test on 4-Stroke Multi cylinder Engine (**CO1**)
5. Retardation and motoring test on 4- stroke engine (**CO3**)
6. Heat Balance of an I.C. Engine. (**CO4**)
7. Air/Fuel Ratio and Volumetric Efficiency of an I.C. Engines. (**CO3**)
8. Performance Test on Variable Compression Ratio Engines for CI Engines (**CO5**)
9. Performance Test on Reciprocating Air – Compressor Unit (**CO5**)
10. Study of Boilers (**CO3**)
11. Dismantling / Assembly of Engines to identify the parts and their position in an engine. (**CO1**)
12. Engine Emission Measurement for SI & CI Engines (**CO2**)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Thermal Engineering Lab	CO1	**3**	**1**	**3**						**3**				**3**	**1**
	CO2	**3**	**2**	**3**						**3**				**3**	**1**
	CO3	**3**	**1**	**3**						**3**				**3**	**2**
	CO4	**3**	**2**	**3**						**3**				**3**	**2**
	CO5	**3**	**1**	**3**						**3**				**3**	**1**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

CO	CO Verb	CO BTL	Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
1	**Analyze**	L4	**PO1** **PO2** **PO3** **PO9**	**Apply (L3)** **Formulate (L6)** **Develop (L3)** **Thumb Rule**	**3** **1** **3** **3**
2	**Evaluate**	L5	**PO1** **PO2** **PO3** **PO9**	**Apply (L3)** **Formulate (L6)** **Develop (L3)** **Thumb Rule**	**3** **2** **3** **3**
3	**Analyze**	L4	**PO1** **PO2** **PO3** **PO9**	**Apply (L3)** **Formulate (L6)** **Develop (L3)** **Thumb Rule**	**3** **1** **3** **3**
4	**Evaluate**	L5	**PO1** **PO2** **PO3** **PO9**	**Apply (L3)** **Formulate (L6)** **Develop (L3)** **Thumb Rule**	**3** **2** **3** **3**
5	**Analyze**	L4	**PO1** **PO2** **PO3** **PO9**	**Apply (L3)** **Formulate (L6)** **Develop (L3)** **Thumb Rule**	**3** **1** **3** **3**

Justification Statements:

CO1: Analyze the working of both S.I and C.I engines with the help of indicator diagrams.

Action Verb: **Analyze (L4)**
PO1 Verb: Apply (L3)
CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Formulate (L6)
CO1 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)
PO3 Verb: Develop (L3)
CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO9: using thumb rule CO1 correlates highly PO9. Therefore, the correlation is high (3)

CO2: Evaluate the fuel supply systems, cooling, lubrication and ignition systems

Action Verb: Evaluate (L5)
PO1Verb: Apply (L3)
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Formulate (L6)
CO2 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)
PO3 Verb: Develop (L3)

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO9: using thumb rule CO2 correlates highly PO9. Therefore, the correlation is high (3)

CO3: Analyze the flame propagation inside the cylinder, stages of combustion in S.I and C.I engines**.**
Action Verb: **Analyze (L4)**
PO1Verb: **Apply (L3)**
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Formulate (L6)
CO1 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)
PO3 Verb: Develop (L3)
CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO9: using thumb rule CO3 correlates highly PO9. Therefore, the correlation is high (3)

CO4: **Evaluate** the indicated power, brake power and friction power and their methods of measurement
Action Verb: Evaluate (L5)
PO1Verb: Apply (L3)
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Formulate (L6)
CO4 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)
PO3 Verb: Develop (L3)
CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO9: using thumb rule CO4 correlates highly PO9. Therefore, the correlation is high (3)

CO5: Analyze the working of reciprocating and rotary air compressors and work done by single and multistage reciprocating air compressors.
Action Verb: **Analyze (L4)**
PO1 Verb: Apply (L3)
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Formulate (L6)
CO1 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)
PO3 Verb: Develop (L3)
CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO9: using thumb rule CO5 correlates highly PO9. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: II **Semester**: II **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0304	Mechanics of Materials Lab	0	0	3	1.5

Course Outcomes: After studying the course, student will be able to:

CO1. **Evaluate** the stress, strain, compression, and shear properties of a material by using UTM.
CO2. **Analyze** the bending strength of simply supported and cantilever beams.
CO3. **Analyze** the torsional rigidity and stiffness constant of the materials.
CO4. **Evaluate** the hardness of a specimen using hardness-testing machine.
CO5. **Evaluate** the impact strength of the materials using impact-testing machine.

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	**Evaluate**	the stress, strain, compression, and shear properties of a material	by using UTM		L5
CO2	**Analyze**	the bending strength of Simply supported and Cantilever beams			L4
CO3	**Analyze**	the torsional rigidity and stiffness constant of the materials			L4
CO4	**Evaluate**	the hardness of a specimen	using hardness-testing machine		L5
CO4	**Evaluate**	the impact strength of the materials	using impact-testing machine		L5

List of Experiments:

1. Direct tension test (CO1)
2. Bending test on (CO2)
   a. Simply supported beam
   b. Cantilever beam
3. Torsion test (CO3)
4. Hardness test (CO4)
   a. Brinells hardness test
   b. Rockwell hardness test
5. Test on springs (CO3)
6. Compression test on cube (CO1)
7. Impact test (CO5)
8. Punch shear test (CO1)

Articulation Matrix

Course Title	**COs**	**Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Mechanics of Materials Lab	CO1	**3**	**3**							**3**				**3**	**3**
	CO2	**3**	**3**							**3**				**3**	**3**
	CO3	**3**	**3**							**3**				**3**	**3**
	CO4	**3**	**3**							**3**				**3**	**3**
	CO5	**3**	**3**							**3**				**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix

CO	Verb	BTL	Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
1	**Evaluate**	L5	**PO1** **PO2** **PO9**	**Apply (L3)** **Identify (L3)** **Thumb Rule**	**3** **3** **3**
2	**Analyze**	L4	**PO1** **PO2** **PO9**	**Apply (L3)** **Identify (L3)** **Thumb Rule**	**3** **3** **3**
3	**Analyze**	L4	**PO1** **PO2** **PO9**	**Apply (L3)** **Identify (L3)** **Thumb Rule**	**3** **3** **3**
4	**Evaluate**	L5	**PO1** **PO2** **PO9**	**Apply (L3)** **Identify (L3)** **Thumb Rule**	**3** **3** **3**
5	**Evaluate**	L5	**PO1** **PO2** **PO9**	**Apply (L3)** **Identify (L3)** **Thumb Rule**	**3** **3** **3**

Justification Statements:

CO1: Evaluate the stress, strain, compression, and shear properties of a material by using UTM.
Action Verb: **Evaluate (L5)**
PO1 Verb: Apply (L3)
CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO2: Analyze the bending strength of simply supported and cantilever beams.
Action Verb: **Analyze (L4)**
PO1 Verb: Apply (L3)
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify **(L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO3: Analyze the torsional rigidity and stiffness constant of the materials.
Action Verb: **Analyze (L4)**
PO1 Verb: Apply (L3)
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO4: **Evaluate** the hardness of a specimen using hardness-testing machine.
Action Verb: **Evaluate (L5)**
PO1 Verb: Apply (L3)
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO5: Evaluate the impact strength of the materials using impact-testing machine.
Action Verb: **Evaluate (L5)**
PO1 Verb: Apply (L3)
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: II **Semester:** II **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20ASC0302	Manufacturing Process Lab	0	0	3	1.5

CO Statements: After studying the course, student will be able to:

CO1. Evaluate the strength and permeability of moulding sand
CO2. Create the patterns and gating systems in different casting techniques for production of component
CO3. Apply the different types of welding techniques to join the metal components
CO4. Apply the Blanking and Piercing operations in sheet metal processing
CO5. Apply the Hydraulic Press for bending and drawing operations in fabrication of a component

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Evaluate	the strength and permeability	of moulding sand		L5
CO2	Create	the pattern and gating system in different casting techniques		for production of component	L6
CO3	Apply	the different types of welding techniques		to join the metal components	L3
CO4	Apply	the Blanking and Piercing operations	in sheet metal processing		L3
CO5	Apply	the hydraulic press for bending and drawing operations	in fabrication of a component		L3

List of Experiments:

1. METAL CASTING

a) Gating Design and pouring time and solidification time calculations. (**CO2**)
b) Sand Properties Testing – Exercise for Strength and Permeability. (**CO1**)
c) Molding, Melting and Casting for ferrous/ nonferrous materials. **(CO2)**

2. WELDING

a) Arc Welding: Lap & Butt Joint - 2 Exercises (**CO3**)
b) Spot Welding - 1 Exercise (**CO3**)
c) TIG Welding - 1 Exercise (**CO3**)
d) Plasma welding and Brazing - 2 Exercises (Water Plasma Device). (**CO3**)

3. MECHANICAL PRESS WORKING

a) Blanking & Piercing operation and study of simple, compound and progressive press tool. (**CO4**)
b) Hydraulic Press: Deep drawing and extrusion operation. (**CO5**)
c) Bending and other operations. (**CO5**)

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Manufacturing process lab	CO1	**3**	**3**				**3**			**3**				**2**	**2**
	CO2	**3**	**3**	**3**						**3**				**3**	**2**
	CO3	**3**		**3**			**3**			**3**				**2**	**3**
	CO4	**3**	**3**				**3**			**3**				**2**	**3**
	CO5	**3**				**3**				**3**				**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation matrix

CO	Cos		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	Evaluate	L5	PO1 PO2 PO6 PO9	Apply (L3) Identify (L3) Thumb Rule Thumb Rule	3 3 3 3
2	Create	L6	PO1 PO2 PO3 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 3
3	Apply	L3	PO1 PO3 PO6 PO9	Apply (L3) Develop (L3) Thumb Rule Thumb Rule	3 3 3 3
4	Apply	L3	PO1 PO2 PO6 PO9	Apply (L3) Identify (L3) Thumb Rule Thumb Rule	3 3 3 3
5	Apply	L3	PO1 PO5 PO9	Apply (L3) Apply (L3) Thumb Rule	3 3 3

Justification Statements:

CO1: Evaluate the strength and permeability of moulding sand

Action Verb: Estimate (L5)

PO1Verb: Apply (L3)
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO6 Verb: Thumb Rule
Using thumb rule CO1 correlates highly with PO6. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
Using thumb rule CO1 correlates highly with PO9. Therefore, the correlation is high (3)

CO2: Create the pattern and gating system in different casting techniques for production of component

Action Verb: Create (L6)

PO1Verb: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
Using thumb rule CO2 correlates highly with PO9. Therefore, the correlation is high (3)

CO3: Apply the different types of welding techniques to join the metal components

Action Verb: Apply (L3)

PO1Verb: Apply (L3)
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb**:** Thumb Rule
Using thumb rule CO3 correlates highly with PO6. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
Using thumb rule CO3 correlates highly with PO9. Therefore, the correlation is high (3)

CO4: Apply the Blanking and Piercing operations in sheet metal processing
PO1Verb: Apply (L3)
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO6 Verb**:** Thumb Rule
Using thumb rule CO4 correlates highly with PO6. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
Using thumb rule CO4 correlates highly with PO9. Therefore, the correlation is high (3)

CO5: Apply the Hydraulic Press for bending and drawing operations in fabrication of a component
Action Verb: Apply (L3)
PO1Verb: Apply (L3)
CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: Apply (L3)
CO5 Action verb is same level (greater) as PO5 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
Using thumb rule CO5 correlates highly with PO9. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Semester V (Third year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P	C	CIE	SEE	Total
1	Professional Core course	20APC0327	Machine Tools	3	-	-	3	30	70	100
2	Professional Core course	20APC0309	Kinematics of Machines	3	-	-	3	30	70	100
3	Professional Core course	20APC0314	Fluid Mechanics & Hydraulic Machinery	3	-	-	3	30	70	100
4	Open Elective Course/Job oriented elective	20AHSMB02	Entrepreneurship Development	3	-	-	3	30	70	100
		20APE0521	Artificial Intelligence							
		20APE0417	Sensor Networks							
5	Professional Elective course	20APE0306	Renewable Energy Technologies	3	-	-	3	30	70	100
		20APE0302	Introduction to CAD/CAM							
		20APE0303	Nano Technology							
6	Professional Core course Lab	20APC0315	Fluid Mechanics & Hydraulic Machinery Lab	-	-	3	1.5	30	70	100
7	Professional Core course Lab	20APC0319	Machine Tools – 1 Lab	-	-	3	1.5	30	70	100
8	Skill advanced course/ soft skill course*	20ASA0502	Soft skills	1	-	2	2	100	-	100
9	Mandatory course (AICTE suggested)	20AMC9904	Professional Ethics and Human Values	2	-	-	0	30	-	30
10	CSP	20CSP0301	Community Service Project	-	-	-	1.5	100	-	100
Total credits							**21.5**	**440**	**490**	**930**

S. No	Professional Electives	Open Electives
1	Energy Conservation and Waste Heat Recovery	Wastewater Treatment and Recycling
2	Rapid Manufacturing	Solar Energy Engineering and Technology
3	Joining Technologies for Metals	Public Speaking
4	Metal Additive Manufacturing	Sustainable Energy Technology
5	Applied Thermodynamics	Renewable Energy Systems
6	Fundamentals Of Composite and Cellular Materials	Intellectual Property
7	Finite Element Method: Variational Methods to Computer Programming	Production and Operation Management
8	Joining Technologies for Metals	Disaster Management
9	Fundamentals of Conduction and Radiation	Basic Electronics
10	Powder Metallurgy	An Introduction to Artificial Intelligence

*Student shall register any number of MOOC courses from the above lists of Professional / Open electives listed by the department as approved by the BOS. But student is required to submit the pass certificate on NPTEL platform for at least one course with in the Programme duration (Before IV-II examination notification).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester**: I **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0327	Machine Tools	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the theory of metal cutting for machining the components.
CO2. Apply the principles of lathe for machining the different parts.
CO3. Analyze the working of drilling, boring, shaping and planning machines to perform various operations.
CO4. Analyze the working of milling, grinding, lapping, honing and broaching machines for surface finishing of components.
CO5. Analyze the jigs, fixtures, location and clamping to hold work and tools in various machines.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the theory of metal cutting		for machining the components	L2
CO2	Apply	the principles of lathe		for machining the different parts	L3
CO3	Analyze	the working of drilling, boring, shaping and planning machines		to perform various operations	L3
CO4	Analyze	the working of milling, grinding, lapping, honing and broaching machines		for surface finishing of components	L4
CO5	Analyze	the jigs, fixtures, location and clamping		to hold work and tools in various machines	L4

Syllabus:

UNIT I

Theory of Metal Cutting: Elementary treatment of metal cutting theory – Elements of cutting process – Geometry of single point tool and angles, chip formation and types of chips – built up edge and its effects, chip breakers. Mechanics of orthogonal cutting –Merchant's Force diagram, cutting forces – cutting speeds, feed, depth of cut, heat generation, tool life, coolants, machinability –economics of machining. cutting Tool materials and cutting fluids –types and characteristics.

UNIT II

Lathe: Engine lathe – Principle of working- specification of lathe – types of lathes – work holders and tool holders –Taper turning, thread turning and attachments for Lathes. Turret and capstan lathes – collet chucks – other work holders – tool holding devices – box and tool layout. Principal features of automatic lathes – classification – Single spindle and multi-spindle automatic lathes– tool layout and cam design

UNIT III

Drilling and Boring Machines – Principles of working, specifications, types, operations performed – tool holding devices – twist drill – Boring tools – machining time calculation.

Shaping, Slotting and planning machines –Principles of working – Principal parts – specification, classification, Operations performed. Machining time calculations.

UNIT IV

Milling machine – Principles of working – specifications – classifications of milling machines – Principal features – machining operations, Types and geometry of milling cutters– methods of indexing – Accessories to milling machines.

Grinding machine –Theory of grinding – classification– cylindrical and surface grinding machine – Tool and cutter grinding machine – special types of grinding machines – Grinding wheel: Different types of abrasives –

bonds, specification and selection of a grinding wheel. Static and dynamic balancing of a wheel Truing and Dressing of wheels. Lapping, Honing and Broaching machines – comparison of grinding, lapping and honing. machining time calculations.

UNIT V

Jigs and Fixture: Principles of design of Jigs and fixtures and uses, 3-2-1 Classification of Jigs & Fixtures – Principles of location and clamping – Types of clamping & work holding devices, typical examples of jigs and fixtures

Unit built machine tools – multi-spindle heads. Power units-principal of working types of UBMTS, characterization and applications.

Text Books:

1. Workshop Technology – Vol II, B.S.RaghuVamshi, Dhanpat Rai & Co, 10th edition, 2013
2. Production Technology by R.K. Jain and S.C. Gupta, Khanna Publishers, 17th edition, 2012

Reference Books:

1. Manufacturing Technology-Kalpakzian- Pearson
2. Metal cutting Principles by Milton C.Shaw, oxford Second Edn, 2nd edition, 2012
3. Production Technology by H.M.T. (Hindustan Machine Tools),TMH, 1st edition, 2001
4. Production Technology by K.L.Narayana, IK International Pub.
5. Machining and machine tools by AB. Chattopadyay, WileyEdn,2013
6. Unconventional Machining process by V.K.Jain, Allied Pub.
7. Manufacturing technology Vol II by P.N. Rao, Tata McGraw Hill, 4th edition, 2013

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Machine Tools	CO1	**2**	**2**	**2**		**2**								**2**	**2**
	CO2	**3**	**3**	**3**	**2**	**3**								**3**	**3**
	CO3	**3**	**3**	**3**	**3**	**3**								**3**	**3**
	CO4	**3**	**3**	**3**	**3**	**3**								**3**	**3**
	CO5	**2**	**2**	**2**		**2**								**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	12	17.9	2	Understand	L2	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Select/Apply (L3)	2 2 2 2
2	12	17.9	2	Apply	L3	PO1 PO2 PO3 PO4 PO5	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Select/Apply (L3)	3 3 3 2 3
3	14	20.9	3	Analyze	L4	PO1 PO2 PO3 PO4 PO5	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Select/Apply (L3)	3 3 3 3 3
4	16	23.8	3	Analyze	L4	PO1 PO2 PO3 PO4 PO5	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Select/Apply (L3)	3 3 3 3 3
5	13	19.4	2	Analyze	L4	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Select/Apply (L3)	3 3 3 3

Justification Statements:

CO1: Understand the theory of metal cutting for machining the components.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).
PO2 Verb: **Identify (L3)**
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2).
PO3 Verb: **Develop (L3)**
CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2).
PO5 Verb: **Select/Apply (L3)**
CO1 Action verb is less than PO5 verb by one level. Therefore, the correlation is medium (2).

CO2: Apply the principles of lathe for machining the different parts

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3).
PO4 Verb: **Analyze (L4)**
CO2 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).
PO5 Verb: **Select/Apply (L3)**
CO2 Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

CO3: Analyze the working of drilling, boring, shaping and planning machines to perform various operations.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO3 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO3 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO4 Verb: **Analyze (L4)**
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO3 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

CO4: Analyze the working of milling, grinding, lapping, honing and broaching machines for surface finishing of components.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO4 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO4 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO4 Verb: **Analyze (L4)**
CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO4 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

CO5: Analyze the jigs, fixtures, location and clamping to hold work and tools in various machines.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO5 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO5 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO5 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester**: I **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0309	Kinematics of Machines	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze different mechanisms, inversions of different kinematic chains and mobility of mechanisms.
CO2. Analyze the velocity and acceleration diagrams of simple plane mechanisms by using relative velocity method and instantaneous centre method.
CO3. Evaluate the basic parameters for Hooke's joint, straight-line motion and steering mechanisms.
CO4. Analyze the phenomenon of interference in gears and velocity ratio of gear trains.
CO5. Analyze the displacement diagrams and cam profile for different motions of the follower.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	different mechanisms, inversions of different kinematic chains and mobility of mechanisms			L4
CO2	Analyze	the velocity and acceleration diagrams of simple plane mechanisms	by using relative velocity method and instantaneous centre method		L4
CO3	Evaluate	the basic parameters for Hooke's joint, straight-line motion and steering mechanisms			L5
CO4	Analyze	the phenomenon of interference in gears and velocity ratio of gear trains			L4
CO5	Analyze	the displacement diagrams and cam profile for different motions of the follower			L4

Syllabus:

UNIT I Mechanisms, Machine and Structure:

Element or Link – Classification – Rigid Link, flexible and fluid link – Kinematic pair – Types – sliding, turning, rolling, screw and spherical pairs, Lower and Higher pairs, closed and open pairs – Constrained motion – completely, partially or successfully constrained motion, and incompletely constrained motion.

Kinematic chain – Degrees of freedom of planar mechanisms – inversion of mechanism – inversion of quadric cycle chain, single and double slider crank chain.

UNIT II Velocity and Acceleration analysis of mechanisms:

Velocity Analysis: Relative velocity method: Motion of Link – construction of velocity diagrams – determination of angular velocity of points and links – four bar chain, single slider crank chain and other simple mechanisms.

Instantaneous center method: Instantaneous center of rotation – Three centres in line theorem – Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

Acceleration Analysis: Acceleration diagram for simple mechanisms – determination of acceleration of points and angular acceleration of links – Corioli's acceleration – Klein's construction..

UNIT III Straight line motion mechanisms, Steering mechanisms, and Hooke's Joint:

Straight line motion mechanisms: Exact and approximate copiers and generated types – Peaucellier, Hart's and Scott Russell – Grosshopper, Watt, T-Chebicheff, Robert mechanisms.

Steering mechanisms: Condition for correct steering – Davis steering gear, Ackerman's steering gear.

Hooke's Joint: Single and double Hooke's joint – velocity ratio, simple problems.

UNIT IV Gears and Gear trains:

Gears: Friction wheels and toothed gears – types – law of gearing – condition for constant velocity ratio for transmission of motion – forms of teeth – Cycloidal and involute profiles – velocity of sliding, path of contact, arc

of contact and contact ratio – phenomena of interference – methods to avoid interference – condition for minimum number of teeth to avoid interference.

Gear trains: Introduction – train value – types – simple, compound, reverted and epi-cyclic gear trains – methods of finding train value or velocity ratio of epi-cyclic gear trains – sun & planetary gear systems – differential gear of an automobile.

UNIT V Cams:

Definitions – Cam and Follower – uses – types of followers and cams – radial cam terminology – types of follower motion – uniform velocity, simple harmonic, uniform acceleration and retardation motion – maximum velocity and maximum acceleration during outward and return strokes in the above cases.

Textbooks:

1. S.S.Rattan, Theory of Machines, Tata McGraw Hill Education (India) Pvt. Ltd.
2. R.S.Khurmi & J.K.Gupta, Theory of Mahines, S.Chand Publications.

References

1. Jagadish Lal, Theory of Mechanisms and Machines, Metropolitan company pvt. Ltd
2. R.K.Bansal, Theory of Machines, Lakshmi Publications.
3. Thomas Bevan, Theory of Machines, CBS.
4. P L Ballaney, Theory of Machines, Khanna Publishers.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Dynamics of Machines	CO1	**3**	**3**	**3**										**3**	**3**
	CO2	**3**	**3**	**3**										**3**	**3**
	CO3	**3**	**3**	**3**										**3**	**3**
	CO4	**3**	**3**	**3**										**3**	**3**
	CO5	**3**	**3**	**3**										**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	12	16.9	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
2	20	28.17	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	12	16.9	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
4	15	21.13	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	12	16.9	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3

Justification Statements:

CO1: Analyze different mechanisms, inversions of different kinematic chains and mobility of mechanisms.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO2: Analyze the velocity and acceleration diagrams of simple plane mechanisms by using relative velocity method and instantaneous centre method.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Evaluate the basic parameters for Hooke's joint and steering mechanisms.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the phenomenon of interference in gears and velocity ratio of gear trains.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Analyze displacement diagrams and cam profile for different motions of the follower.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester**: I **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0314	Fluid Mechanics & Hydraulic Machinery	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the behaviour of fluids under static condition and one-dimensional flow of fluids.
CO2. Understand the behaviour of fluids under dynamic condition, conduit flow and fluid flow measurement
CO3. Analyze the velocity diagrams, hydro-dynamic forces of jets and hydro-electric power station
CO4. Evaluate the characteristics and performance of hydraulic turbines
CO5. Analyze the work done and performance characteristics of rotary and reciprocating pumps

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	behaviour of fluids	under static condition	and one dimensional flow of fluids	L2
CO2	Understand	behaviour of fluids	under dynamic condition,	conduit flow and fluid flow measurement	L2
CO3	Analyze	the velocity diagrams, hydro-dynamic forces of jets and hydro-electric power station			L4
CO4	Evaluate	the characteristics and performance of hydraulic turbines			L5
CO5	Analyze	work done and performance characteristics		of rotary and reciprocating pumps	L4

Syllabus:

UNIT I

Fluid Statics: Dimensions and units: physical properties of fluids – specific gravity, porosity surface tension – vapor pressure and their influence on fluid motion – atmospheric gauge and vacuum pressure – measurement of pressure – Piezometer, U-tube differential manometers.

Fluid Kinematics: stream line, path line and streak lines and steam tube, classification of flows-steady & unsteady, uniform, non-uniform, laminar, turbulent, rotational and irrotational flows-equation of continuity for one dimensional flow.

UNIT II

Fluid Dynamics: surface and body forces – Euler's and Bernoulli's equations for flowing stream line, momentum equation and its application on force on pipe bend.

Conduit Flow: Reynold's experiment – Darcy Weisbach equation – Minor losses in pipes – pipes in series and pipes in parallel – total energy line-hydraulic gradient line. Measurement of flow: Pitot tube, venturimeter and orifice meter, Flow nozzle and Turbine current meter.

UNIT III

Turbo Machinery: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done efficiency, flow over radial vanes.

Hydroelectric Power Stations: Elements of hydro-electric power station-types-concept of pumped storage plants-storage requirements.

UNIT IV

Hydraulic Turbines: Classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design – draft tube – theory – functions and efficiency.

Performance of Hydraulic Turbines: Unit and specific quantities, characteristics, governing of turbines, selection of type of turbine, cavitation and surge tank.

UNIT V

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Pumps: Classification –Rotary & Reciprocating pumps – working – work done – manomertic head – loss efficiencies – specific speed – pumps in series and parallel – performance characteristic curves and NPSH.

TEXT BOOKS :

1. Fluid Mechanics, FRANK M. WHITE, Mc. Graw Hill Education.
2. Fluid Mechanics, Hydraulic and Hydraulic Machines by Modi & Seth, Standard book house.
3. A Text of Fluid Mechanics and Hydraulic Machines by Dr. R. K. Bansal – Laxmi Publications (P) Ltd., New Delhi.
4. Mechanics of Fluids by Potter, Wiggert, Ramadan, M. M. M. Sarcar, Cengage Publishers.
5. Subramanyam, IITM,

REFERENCE BOOKS :

1. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International.
2. Principles of Fluid Mechanics and Fluid Machines by M. Narayana Pillai, Universities Press.
3. Fluid mechanics and fluid machines by Rajput, S.Chand & Co.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Fluid Mechanics & Hydraulic Machinery	CO1	**2**	**3**											**2**	**2**
	CO2	**2**	**3**											**2**	**2**
	CO3	**3**	**3**					**3**						**3**	**3**
	CO4	**3**	**3**					**3**						**3**	**3**
	CO5	**3**	**3**					**3**						**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	**20/71**	**28**	**3**	Understand	L2	**PO1** **PO2**	**Apply (L3)** **Review (L2)**	**2** **3**
2	**15/71**	**21**	**3**	Understand	L2	**PO1** **PO2**	**Apply (L3)** **Review (L2)**	**2** **3**
3	**15/71**	**21**	**3**	Analyze	L4	**PO1** **PO2** **PO7**	**Apply (L3)** **Review (L2)** **TR- L3**	**3** **3** **3**
4	**12/71**	**17**	**2**	Evaluate	L5	**PO1** **PO2** **PO7**	**Apply (L3)** **Review (L2)** **Thumb Rule**	**3** **3** **3**
5	**9/71**	**13**	**2**	Analyze	L4	**PO1** **PO2** **PO7**	**Apply (L3)** **Review (L2)** **Thumb Rule**	**3** **3** **3**

Justification Statements:
CO1: Understand the behaviour of fluids under static condition and one-dimensional flow of fluids.

Action Verb: **Understand** (**L2**)
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO2: Understand the behaviour of fluids under dynamic condition, conduit flow and fluid flow measurement

Action Verb: **Understand** (**L2**)
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO3: Analyze the velocity diagrams, hydro-dynamic forces of jets and hydro-electric power station

Action Verb: **Analyze** (**L4**)
PO1 Verb: **Apply (L3)**
CO3 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO3 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO3 using thumb rule correlates PO7 as high (3)

CO4: Evaluate the characteristics and performance of hydraulic turbines
Action Verb: **Evaluate** (**L4**)
PO1 Verb: **Apply (L3)**
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO4 using thumb rule correlates PO7 as high (3)

CO5: Analyze the work done and performance characteristics of rotary and reciprocating pumps
Action Verb: **Analyze** (**L4**)
PO1 Verb: **Apply (L3)**
CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO5 using thumb rule correlates PO7 as high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **III** Semester**: I** Branch of Study: Common to all branches

Course Code	Subject Name	L	T	P	C
20AHSMB02	**ENTREPRENEURSHIP DEVELOPMENT**	**3**	**0**	**0**	**3**

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the concept and process of Entrepreneurship to develop entrepreneurial skills
CO2. Analyze the different feasibility studies to start a new enterprise.
CO3. Analyze the various sources of finance to entrepreneurs.
CO4. Analyze the role of central government and state government in promoting women Entrepreneurship.
CO5. Analyze the role of incubations in fostering startups.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concept and process of Entrepreneurship		to develop entrepreneurial skills	L2
CO2	Analyze	the different feasibility studies		to start a new enterprise	L4
CO3	Analyze	the various sources of finance to entrepreneurs			L4
CO4	Analyze	the role of central government and state government		in promoting women Entrepreneurship	L4
CO5	Analyze	the role of incubations		in fostering startups	L4

Syllabus:

Unit-1 Introduction to Entrepreneurship

Entrepreneurship - Concept, knowledge and skills requirement - Characteristics of successful entrepreneurs - Entrepreneurship process - Factors impacting emergence of entrepreneurship - Differences between Entrepreneur and Intrapreneur - Understanding individual entrepreneurial mindset and personality - Recent trends in Entrepreneurship.

Unit-II Formulation of Business Idea

Starting the New Venture - Generating business idea – Sources of new ideas & methods of generating ideas - Opportunity recognition - Feasibility study - Market feasibility, technical/operational feasibility - Financial feasibility - Drawing business plan - Preparing project report - Presenting business plan to investors.

Unit-III Financial Aspects of Promotion

Sources of finance - Various sources of Finance available - Long term sources - Short term sources - Institutional Finance – Commercial Banks, SFC's in India - NBFC's in India - their way of financing in India for small and medium business - Entrepreneurship development programs in India - The entrepreneurial journey- Institutions in aid of entrepreneurship development.

Unit-IV Women Entrepreneurship

Women Entrepreneurship - Entrepreneurship Development and Government - Role of Central Government and State Government in promoting women Entrepreneurship - Introduction to various incentives, subsidies and grants – Export- oriented Units - Fiscal and Tax concessions available - Women entrepreneurship - Role and importance - Growth of women entrepreneurship in India - Issues & Challenges - Entrepreneurial motivations.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Unit-V Startups and Incubation

Startups – Definition, Role of startups in India, Governmental initiatives to foster entrepreneurship across sectors. Funding opportunities for startups. Business Incubation and its benefits, Pre-Incubation and Post - Incubation process.

Textbooks:

1. D F Kuratko and T V Rao, "Entrepreneurship" - A South-Asian Perspective – Cengage Learning, 2012. (For PPT, Case Solutions Faculty may visit : login.cengage.com)
2. Nandan H, " Fundamentals of Entrepreneurship", PHI, 2013.

References:

1. Vasant Desai, "Small Scale Industries and Entrepreneurship", Himalaya Publishing 2012.
2. Rajeev Roy "Entrepreneurship", 2nd Edition, Oxford, 2012.
3. B.Janakiram and M.Rizwana‖ "Entrepreneurship Development: Text & Cases", Excel Books, 2011.
4. Stuart Read, Effectual "Entrepreneurship", Routledge, 2013.

Online Learning Resources:

1. Entrepreneurship-Through-the-Lens-of-venture Capital
2. http://www.onlinevideolecture.com/?course=mba-programs&subject=entrepreneurship
3. http://nptel.ac.in/courses/122106032/Pdf/7_4.pd
4. http://freevideolectures.com/Course/3514/Economics-/-Management-/- Entrepreneurship/50

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ENTREPRENEURSHIP DEVELOPMENT	CO1	**2**													
	CO2			**3**	**3**						**3**				
	CO3	**3**										**3**			
	CO4	**3**													
	CO5	**3**													

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

Course Outcome (CO)	Percentage of contact hours over the total planned contact hours	CO: Action verb and BTL	Program Outcome(PO)	PO: Action verb and BTL	Level of correlation (0-3)
CO1	18.86	Understand	PO1	Apply (L3)	2
CO2	18.86	Analyze	PO3 PO4 PO10	Apply (L3) Apply (L3) Thumb Rule	3 3 3
CO3	20.75	Analyze	PO1 PO11	Apply (L3) Thumb Rule	3 3
CO4	18.86	Analyze	PO1	Apply (L3)	3
CO5	22.64	Analyze	PO1	Apply (L3)	3

Justification Statements:

CO1: Understand the concept and process of Entrepreneurship to develop entrepreneurial skills
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
CO2: Analyze the different feasibility studies to start a new enterprise.
Action Verb: Analyze (L4)

PO3: Apply (L3)
CO2 Action verb is more than PO3 verb. Therefore, the correlation is High (3)
PO4: Apply (L3)
CO2 Action verb is more than PO4 verb. Therefore, the correlation is High (3)
PO10: Thumb Rule
As using thumb rule CO2 correlates with PO10. Therefore, the correlation is High (3)
CO3: Analyze the various sources of finance to entrepreneurs.
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO3 Action verb is more than PO1 verb by one level. Therefore, the correlation is High (3)
PO11: Thumb Rule
CO3 Action verb blooms level 4 correlates with PO11. Therefore, the correlation is High (3)
CO4: Analyze the role of central government and state government in promoting women Entrepreneurship**.**
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO4 Action verb is more than PO1 verb by one level. Therefore, the correlation is High (3)
CO5: Analyze the role of incubations in fostering startups**.**
Action Verb: Analyze (L4)
PO1: Apply (L3)
CO5 Action verb is more than PO1 verb. Therefore, the correlation is High (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester**: I **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0521	Artificial Intelligence	**3**	**0**	**0**	**3**

Course Outcomes: After studying the course, student will be able to:

CO1. **Understand** the basic concepts of artificial intelligence and intelligent agents
CO2. **Apply** the searching techniques for solving searching problems.
CO3. **Analyze** the concepts of Reinforcement Learning and NLP Models.
CO4. **Evaluate** Natural Language Interfaces and perception mechanisms for Machines understanding.
CO5. **Analyze** the robotic designing modules and philosophy constraints for artificial intelligence.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	The basics concepts of artificial intelligence and intelligent agents			L2
CO2	**Apply**	the searching techniques		For Solving searching problems	L3
CO3	**Analyze**	The concepts of Reinforcement Learning and NLP Models			L4
CO4	**Evaluate**	Natural Language Interfaces and perception mechanisms		For Machines understanding	L5
CO5	**Analyze**	the robotic designing modules and philosophy constraints		for artificial intelligence.	L4

UNIT - I

Introduction: What is AI, Foundations of AI, History of AI, The State of Art.

Intelligent Agents: Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents

UNIT - II

Solving Problems by searching: Problem Solving Agents, Example problems, Searching for Solutions, Uninformed Search Strategies, Informed search strategies, Heuristic Functions, Beyond Classical

Search: Local Search Algorithms and Optimization Problems, Local Search in Continues Spaces, Searching with Nondeterministic Actions, Searching with partial observations, online search agents and unknown environments.

UNIT - III

Reinforcement Learning: Introduction, Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Policy Search, applications of RL

Natural Language Processing: Language Models, Text Classification, Information Retrieval, Information Extraction.

UNIT - IV

Natural Language for Communication: Phrase structure grammars, Syntactic Analysis, Augmented Grammars and semantic Interpretation, Machine Translation, Speech Recognition

Perception: Image Formation, Early Image Processing Operations, Object Recognition by appearance, Reconstructing the 3D World, Object Recognition from Structural information, Using Vision.

UNIT - V

Robotics: Introduction, Robot Hardware, Robotic Perception, Planning to move, planning uncertain movements, Moving, Robotic software architectures, application domains

Philosophical foundations: Weak AI, Strong AI, Ethics and Risks of AI, Agent Components, Agent Architectures, Are we going in the right direction, What if AI does succeed**.**

Textbooks:

1. Stuart J. Russell, Peter Norvig, "Artificial Intelligence A Modern Approach", 3rd Edition, Pearson Education, 2019.

Reference Books:

1. Nilsson, Nils J., and Nils Johan Nilsson. Artificial intelligence: a new synthesis. Morgan Kaufmann, 1998.
2. Johnson, Benny G., Fred Phillips, and Linda G. Chase. "An intelligent tutoring system for the accounting cycle: Enhancing textbook homework with artificial intelligence." Journal of Accounting Education 27.1 (2009): 30-39.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Online Learning Resources: http://peterindia.net/AILinks.html

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Artificial Intelligence	CO1	2	3												
	CO2	3	2	3	2	3									
	CO3	3	3	3	3	3	3		3						
	CO4		3	3		3	3		3						
	CO5	3	3	3			3		3	3			3		

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	10	19%	2	Understand	L2	PO1 PO2	Apply(L3) Review(L2)	2 3
2	13	25%	3	Apply	L3	PO1 PO2 PO3 PO4 PO5	Apply(L3) Analyze (L4) Develop (L3) Analyze (L4) Apply(L3)	3 2 3 2 3
3	10	19%	2	Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO6 PO8	Apply (L3) Analyze (L4) Develop (L3) Analyze (L4) Apply(L3) Thumb Rule Thumb Rule	3 3 3 3 3 3 3
4	9	17%	2	Evaluate	L5	PO2 PO3 PO5 PO6 PO8	Review(L2) Develop (L3) Apply(L3) Thumb Rule Thumb Rule	3 3 3 3 3
5	11	20%	3	Analyze	L4	PO1 PO2 PO3 PO6 PO8 PO9 PO12	Apply(L3) Analyze(L4) Develop(L3) Thumb Rule Thumb Rule Thumb Rule Thumb Rule	3 3 3 3 3 3 3

Justification Statements:
CO1: Understand the basic concepts of artificial intelligence and intelligent agents
Action Verb: Understand (L2)
PO1: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
CO2: Apply the searching techniques for solving searching problems.
Action Verb: Apply (L3)
PO1: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2: Analyze (L4)

CO2 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

PO3: Develop (L3)

CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)

PO5: Apply (L3)

CO2 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO3: Analyze the concepts of Reinforcement Learning and NLP Models.

Action Verb: Analyze (L4)

PO1: Apply (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO3 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

PO5: Apply (L3)

CO3 Action verb is greater than PO5 verb. Therefore, the correlation is high (3)

PO6: Thumb rule

Apply contextual knowledge is used for society to address the security issues so correlation is high (3)

PO8: Thumb rule

The ethical knowledge is used to perform operations. Hence, the correlation is high (3)

CO4: Evaluate Natural Language Interfaces and perception mechanisms for Machines understanding.

Action Verb: Evaluate (L5)

PO2: Review (L2)

CO4 Action verb is same level as PO2 verb. Therefore the correlation is high (3)

PO3: Develop (L3)

CO4 Action verb is same level as PO3 verb. Therefore the correlation is high (3)

PO5: Apply (L3)

CO4 Action verb is same level as PO5 verb. Therefore the correlation is high (3)

PO6: Thumb rule

To address the security issues we apply contextual knowledge. so correlation is high(3)

PO8: Thumb rule

The ethical knowledge is used to perform operations. Hence the correlation is high (3)

CO5: Analyze the robotic designing modules and philosophy constraints for artificial intelligence.

Action Verb: Analyze (L4)

PO1: Apply (L3)

CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO5 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

PO6: Thumb Rule

Apply contextual knowledge is used for society to address the security issues so correlation is medium (2)

PO8: Thumb Rule

Since ethical principles should be followed to create a robot. Therefore the correlation is medium (2)

PO9: Thumb rule

Teamwork is required to create robots. Hence the correlation is medium (2)

PO12: Thumb rule

For some of AI applications, AI concepts are used to create robots designs. Therefore the correlation is medium (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester**: I **Branch of Study: CE & ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0417	SENSOR NETWORKS	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the concepts of Converters and Sensor data acquisition systems
CO2. Understand the concepts of Sensor Measurements for Structural Monitoring
CO3. Analyze the commonly used sensing technologies and algorithms
CO4. Apply the piezoelectric transducers for assessing and monitoring infrastructures
CO5. Apply Fiber optic sensors for assessing and monitoring infrastructures

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the sensor data acquisition system and architecture of converters			L2
CO2	Understand	the Sensor Measurements	for Structural Monitoring		L2
CO3	Analyze	the commonly used sensing technologies and algorithms			L4
CO4	Apply	the piezoelectric transducers	for assessing and monitoring infrastructures		L3
CO5	Apply	Fiber optic sensors	for assessing and monitoring infrastructures		L3

Syllabus:

Unit-1 Sensor data acquisition systems and architectures

Introduction, General measurement system, Analog-to-digital converter architectures-Different types of ADCs– parallel comparator type ADC, Counter type ADC, successive approximation ADC and dual slope ADC Digital-to-Analog Conversion-Basic DAC techniques, Weighted resistor DAC, R-2R ladder DAC, inverted R- 2R DAC, Data acquisition systems-Analog Systems-Digital Systems

Unit-II Sensors and Sensing Technology for Structural Monitoring

Introduction, Sensor Types, Sensor Measurements in Structural Monitoring- Structural Responses- Environmental Quantities- Operational Quantities- Typical Quantities for Bridge Monitoring- Fibre Optic Sensors- Classification of Fibre Optic Sensors- Typical Fibre Optic Sensors in SHM- Fibre Optic Sensors for Structural Monitoring- Wireless Sensors- Components of Wireless Sensors- Field Deployment in Civil Infrastructure-Case Study

Unit-III Commonly used sensors for civil infrastructures and their associated algorithms

Introduction, commonly used sensing technologies- Displacement-Strain-Acceleration-Environment-Prevalence of commonly used sensors in SHM systems- Associated algorithms- Displacement sensors- Strain gages- Accelerometers- Environmental measurements- Examples of continuous monitoring systems

Unit-IV Piezoelectric transducers for assessing and monitoring civil infrastructures

Introduction, Principle of piezoelectricity, Piezoelectric materials and the fabrication of piezoelectric transducers, Piezoelectric transducers for SHM applications, Bonding effects, Limitations of piezoelectric transducers, SHM techniques using piezoelectric transducers

Unit-V Fiber optic sensors for assessing and monitoring civil infrastructures

Introduction, Optical fiber concepts, Sensing mechanisms, Sensor packaging, Cables, connectors, and splicing, Common optical fiber sensors- Coherent interferometers, Low-coherence interferometers, Fiber Bragg gratings, Brillouin and Raman scattering distributed sensors

Text Books:

1. “Sensor Technologies for Civil Infrastructures”, Volume 1 Sensing Hardware and Data CollectionMethods for Performance Assessment Woodhead Publishing in Civil and Structural Engineering Ming L. Wang Jerome

P. Lynch Hardcover ISBN: 9780857094322
2. "Wireless Sensor Networks for Civil Infrastructure Monitoring: A Best Practice Guide"ICE Publishing David Rodenas-Herráiz, Kenichi Soga, Paul R A Fidler and Nicholas de Battista

References:

1. Ghatak A and Thyagarajan K. (1998) Introduction to Fiber Optics; Cambridge University Press: Cambridge, UK.
2. Barthorpe, R.J. and Worden, K. (2009) Sensor Placement Optimization. Encyclopaedia of Structural Health Monitoring, Boller, Chang and Fujino (ed.), John Wiley & Sons, Chichester, UK.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SENSOR NETWORKS	CO1	2	2	2											
	CO2	2	3	2											
	CO3	3	3	3		3									
	CO4	3	3	3	2	3	2						1		
	CO5	3	3	3	2	3	2						1		

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	14	18	2	Understand	L2	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	2 2 2
2	17	22	3	Understand	L2	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	2 3 3
3	16	20	2	Analyze	L4	PO1 PO2 PO3 PO5	Apply (L3) Analyze (L4) Develop (L3) Apply (L3)	3 2 3 3
4	14	18	2	Apply	L3	PO1 PO2 PO3 PO4 PO5 PO6 PO12	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Apply (L3) ThumbRule ThumbRule	3 3 3 3 3 2 1
5	16	20	2	Apply	L3	PO1 PO2 PO3 PO4 PO5 PO6 PO12	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Apply (L3) ThumbRule ThumbRule	3 3 3 3 3 2 1

Justification Statements:

CO1: Understand the concepts of Converters and Sensor data acquisition systems

Action Verb: Understand (L2)

PO1 Verbs: Apply (L3)

CO1 Action Verb is less than PO1 verb by one level. Therefore, correlation is moderate (2).

PO2 Verb: Identify (L3)
CO1 Action Verb is less than PO2 verb by one level. Therefore, correlation is moderate (2).
PO3 Verb: Develop (L3)
CO1 Action Verb is less than PO3 verb by one level. Therefore, correlation is Moderate (2).
CO2: Understand the concepts of Sensor Measurements for Structural Monitoring
Action Verb: Understand (L2)
PO1 Verbs: Apply (L3)
CO2 Action Verb is less than PO1 verb by one level. Therefore, correlation is moderate (2).
PO2 Verb: Review (L2)
CO2 Action Verb is equal to PO2 verb. Therefore, correlation is high (3).
PO3 Verb: Develop (L3)
CO2 Action Verb is less than PO3 verb by one level. Therefore, correlation is Moderate (2).
CO3: Apply the concepts of commonly used sensing technologies and algorithms
Action Verb: Apply (L3)
PO1 Verbs: Apply (L3)
CO3 Action Verb is equal to PO1 verb. Therefore, correlation is high (3).
PO2 Verb: Analyze (L4)
CO3 Action Verb is less than PO2 verb by one level; Therefore, correlation is moderate (2).
PO3 Verb: Develop (L3)
CO3 Action Verb is equal to PO3 verb; Therefore, correlation is high (3).
PO5 verb: Apply (L3)
CO3 Action verb is equal to PO5 verb. Therefore, the correlation is high (3).
CO4: Analyze the concepts of piezoelectric transducers for assessing and monitoring infrastructures
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO4 Action Verb is greater than PO1 verb. Therefore, correlation is high (3).
PO2 Verb: Identify (L3)
CO4 Action Verb is greater than PO1 verb. Therefore, correlation is high (3).
PO3 Verb: Develop (L3)
CO4 Action Verb is greater than PO1 verb. Therefore, correlation is high (3).
PO4 Verb: Analyze (L4)
CO4 Action Verb is equal to PO4 verb. Therefore, correlation is high (3).
PO5 verb: Apply (L3)
CO4 Action Verb is greater than PO1 verb. Therefore, correlation is high (3).
PO6: CO4 using thumb rule Correlates PO6 as moderate (2).
PO12: CO4 using thumb rule Correlates PO12 as low (1).
CO5: Analyze the concepts of Fiber optic sensors for assessing and monitoring infrastructures
Action Verb: Analyze (L4)
PO1 Verbs: Apply (L3)
CO5 Action Verb is greater than PO1 verb. Therefore, correlation is high (3).
PO2 Verb: Identify (L3)
CO5 Action Verb is greater than PO1 verb. Therefore, correlation is high (3).
PO3 Verb: Develop (L3)
CO5 Action Verb is greater than PO1 verb. Therefore, correlation is high (3).
PO4 Verb: Analyze (L4)
CO5 Action Verb is equal to PO4 verb. Therefore, correlation is high (3).
PO5 verb: Apply (L3)
CO5 Action Verb is greater than PO1 verb. Therefore, correlation is high (3).
PO6: CO5 using thumb rule Correlates PO6 as moderate (2).
PO12: CO5 using thumb rule Correlates PO12 as low (1).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **III** Semester**: I** Branch of Study: ME

Subject Code	Subject Name	L	T	P	Credits
20APE0306	**Renewable Energy Technologies**	**3**	**0**	**0**	**3**

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the necessity of different energy sources.
CO2. Apply the solar energy concepts for generation of electricity
CO3. Analyze the anaerobic digestion for bio-gas production and the wind energy for generation of electricity
CO4. Apply the ocean thermal energy conversion and geothermal energy conversion for generation of electricity
CO5. Analyze the properties of hydrogen as fuel, production and storage process of hydrogen energy

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the necessity of different energy sources			L2
CO2	Apply	the solar energy concepts		for generation of electricity	L3
CO3	Analyze	the anaerobic digestion and wind energy		for bio-gas production for generation of electricity	L3
CO4	Apply	ocean thermal energy conversion and geothermal energy conversion		for generation of electricity	L3
CO5	Analyze	the properties of hydrogen as fuel, production and storage proces	of hydrogen energy		L4

Syllabus:

UNIT I

Classification of Energy:

Energy chain and common forms of usable energy- Present energy scenario- World energy status- Energy scenario in India- Introduction to renewable energy resources- Introduction to solar Energy- Energy from sun- Spectral distribution of Solar radiation- Instruments for measurement of solar radiation.

UNIT II

Solar Energy

Solar Radiation, Measurements of Solar Radiation, Flat Plate and Concentrating Collectors, Solar Direct Thermal Applications, Solar Thermal Power Generation, Fundamentals of Solar Photo Voltaic Conversion, Solar Cells, Solar PV Power Generation, Solar PV Applications.

UNIT III

Bio Energy Sources:

Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gasdigesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

Wind Energy:

Wind Energy Estimation, Types of Wind Energy Systems, Performance, Site Selection, Details of Wind Turbine Generator.

UNIT IV

Ocean Energy:

Ocean Thermal Energy Conversion (OTEC), Principle of operation, development of OTEC plants, Tidal and wave energy, Potential and conversion techniques, mini-hydel power plants.

Geothermal Energy:

Resources, types of wells, methods of harnessing the energy, scope in India.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Unit – V:

Hydrogen Energy:

Properties of hydrogen as fuel, Hydrogen pathways introduction-current uses, general introduction to infrastructure requirement for hydrogen production, storage, dispensing and utilization, and hydrogen production plants.

Textbooks:

1. Non-Conventional Energy Sources /G.D. Rai.
2. Renewable energy resources: Tiwari and ghosal, Narosa publication.
3. Non-conventional Energy Sources, Khanna Publication.

References:

1. Non-Conventional Energy Resources, B.H. Khan, McGrawHIll, 2015.
2. Principles of Solar Energy/ Frank Krieth & John F Kreider.
3. Fang Lin You, Hong ye (2012), Renewable Energy Systems, Advanced conversion technologies and applications, CRC Press
4. John.A.Duffie, William A.Beckman (2013), Solar Engineering of Thermal processes, Wiley
5. Godfrey Boyle (2012), Renewable Energy, power for a sustainable future, Oxford University Press.

Articulation matrix

Course Title	**COs**	**Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Renewable Energy Technologies	CO1	**2**	**3**					**2**						**2**	**2**
	CO2	**3**	**3**					**3**						**3**	**3**
	CO3	**3**	**3**					**3**						**3**	**3**
	CO4	**3**	**3**					**3**						**3**	**3**
	CO5	**3**	**3**					**3**						**3**	**3**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Understand	**L2**	**PO1** **PO2** **PO7**	**Apply-l3** **Reviev-l2** **Thumb Rule**	**2** **3** **2**
2	-	-	-	Apply	**L3**	**PO1** **PO2** **PO7**	**Apply-l3** **Reviev-l2** **Thumb Rule**	**3** **3** **3**
3	-	-	-	Analyze	**L3**	**PO1** **PO2** **PO7**	**Apply-l3** **Reviev-l2** **Thumb Rule**	**3** **3** **3**
4	-	-	-	Apply	**L3**	**PO1** **PO2** **PO7**	**Apply-l3** **Reviev-l2** **Thumb Rule**	**3** **3** **3**
5	-	-	-	Analyze	**L4**	**PO1** **PO2** **PO7**	**Apply-l3** **Reviev-l2** **Thumb Rule**	**3** **3** **3**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Understand the necessity of different energy sources**.**
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Understand (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: using thumb rule CO1 correlates PO6 as moderate (2).
CO2: Apply the solar energy concepts for generation of electricity
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is High (3)
PO2 Verb: **Review (L2)**
CO2 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: PO7 Verb: using thumb rule CO2 correlates PO6 as high (3).

CO3: Apply the anaerobic digestion for bio-gas production and the wind energy for generation of electricity
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is High (3)
PO2 Verb: **Review (L2)**
CO3 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: PO7 Verb: using thumb rule CO3 correlates PO6 as high (3).

CO4: Apply the ocean thermal energy conversion and geothermal energy conversion for generation of electricity
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is High (3)
PO2 Verb: **Review (L2)**
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: PO7 Verb: using thumb rule CO4 correlates PO6 as high (3).

CO5: Analyze the properties of hydrogen as fuel, production and storage process of hydrogen energy
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: using thumb rule CO5 correlates PO6 as high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester**: I **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0302	Introduction to CAD/CAM	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the fundamentals of CAD, CAM, CIM, and Graphics technique in manufacturing
CO2. Apply the parametric and geometric representation of curves, surfaces and solids
CO3. Apply the NC, CNC, DNC part programming, and adaptive control for machining the components
CO4. Analyze the manufacturing strategies of group technology and production flow analysis in industries
CO5. Analyze the concepts of flexible manufacturing system, rapid prototyping and quality control in automated manufacturing systems

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the fundamentals of CAD, CAM, CIM, and Graphics technique in manufacturing		in manufacturing	L2
CO2	Apply	the parametric and geometric representation of curves, surfaces and solids		-	L3
CO3	Apply	the NC, CNC, DNC part programming, and adaptive control		for machining the components	L3
CO4	Analyze	the manufacturing strategies of group technology and production flow analysis		in industries	L4
CO5	Analyze	the concepts of flexible manufacturing system, rapid prototyping and quality control		in automated manufacturing systems	L4

Syllabus:

UNIT I

Introduction: Definition and scope of CAD/CAM- Computers in industrial manufacturing, design process-Computer Aided Design (CAD)-Computer Aided Manufacturing (CAM)-Computer Integrated Manufacturing (CIM)
Graphics: Data base for graphic modeling-transformation geometry-3D transformations –Clipping-hidden line removal-Colour-shading

UNIT II

Geometric modeling: Parametric representation of curves, solids & surfaces; Geometric construction methods-Constraint based modeling- Wireframe, Surface- Bezier, B-Spline Surfaces and Solid- Constructive Solid Geometry, Boundary representation and Cellular Decomposition.

UNIT III

NC Control production systems: Introduction to NC, CNC, DNC - Manual part Programming – Computer Assisted Part Programming – Examples using NC codes- Adaptive Control – Canned cycles and subroutines – CAD/ CAM approach to NC part programming – APT language.

UNIT IV

Role of information systems in manufacturing: Discrete part manufacture-information requirements of a production organization-manufacturing strategies - Integration requirement - Group technology – coding - Production flow analysis-computer part programming - CAPP implementation techniques.

UNIT V

Automated manufacturing systems: Flexible Manufacturing systems (FMS) – the FMS concepts – transfer systems – head changing FMS – Introduction to Rapid prototyping, Knowledge Based Engineering, Virtual Reality, Augmented Reality – automated guided vehicle-Robots-automated storage and retrieval systems - computer aided quality control-CMM-Non contact inspection methods.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Textbooks:

1. P.N.Rao, CAD/CAM: Principles &Applications-3rd Edition, Tata McGraw Hill.
2. CAD/CAM Concepts & applications/Alavala/PHI

References:

1. CAD/CAM Theory and Practice / IbrahimZeid / TMH..
2. CAD/CAM/CIM Radha Krishnan & Subramanian / New age

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Introduction to CAD/CAM	CO1	**2**	**3**											**2**	**2**
	CO2	**3**		**3**		**3**								**3**	**2**
	CO3	**3**		**3**	**3**	**3**								**3**	**3**
	CO4	**2**		**3**		**3**								**3**	**2**
	CO5	**2**		**3**		**3**								**3**	**2**

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	13	17	L2	Understand	L2	PO1 PO2	Apply (L3) Review (L2)	2 3
2	13	17	L2	Apply	L3	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
3	15	20	L2	Apply	L3	PO1 PO3 PO4 PO5	Apply (L3) Develop (L3) Apply (L3) Apply (L3)	3 3 3 3
4	19	26	L3	Analyze	L4	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
5	13	17	L2	Analyze	L4	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3

Justification Statements:

CO1: Understand the fundamentals of CAD, CAM, CIM, and Graphics technique in manufacturing
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

CO2: Apply the parametric and geometric representation of curves, surfaces and solids
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

CO3: Apply the part programming (NC, CNC, DNC, and adaptive control) for machining the components
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Apply (L3)**
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO4: Analyze the manufacturing strategies of group technology and production flow analysis in industries
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO4 Action verb is greater than PO5 verb. Therefore, the correlation is high (3)

CO5: Analyze the concepts of flexible manufacturing system, rapid prototyping and quality control in automated manufacturing systems
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO5 Action verb is greater than PO5 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: **III** Semester**: I** Branch of Study: ME

Subject Code	Subject Name	L	T	P	Credits
20APE0303	**Nano Technology**	**3**	**0**	**0**	**3**

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the nano-science concepts and properties of nano-materials
CO2. Analyze the processing techniques to synthesis and fabricate nano-materials
CO3. Analyze the characterization techniques to study the morphological behaviour of nano-materials
CO4. Analyze the synthesis and characterization techniques of carbon-based materials.
CO5. Apply the nanotechnology concepts to real time applications in various fields

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the nano-science concepts and properties of nano-materials			L2
CO2	Analyze	the processing techniques		to synthesis and fabricate nano-materials	L4
CO3	Analyze	the characterization techniques	to study the morphological behaviour of nano-materials		L4
CO4	Analyze	the synthesis and characterization techniques	of carbon based materials		L2
CO5	Apply	the nanotechnology concepts to real time applications in various fields			L3

Syllabus:

UNIT-I

INTRODUCTION: History of nano science, definition of nano meter, nano materials, nano technology. Classification of nano materials. Crystal symmetries, crystal directions, crystal planes. Band structure.

PROPERTIES OF MATERIALS: Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of nano materials.

UNIT-II

SYNTHESIS AND FABRICATION: Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography. Requirements for realizing semiconductor nano structures, growth techniques for nano structures

UNIT-III

CHARECTERIZATION TECHNIQUES: X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy, piezoresponse microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy

UNIT-IV

CARBON NANO TECHNOLOGY: Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of nano crystalling diamond films, grapheme,

applications of carbon nano tubes.

UNIT-V

APPLICATIONS OF NANO TECHNOLOGY: Applications in material science, biology and medicine, surface science, energy and environment. Applications of nano structured thin fins, applications of quantum dots.

TEXT BOOK:

1. Nano science and nano technology / M.S Ramachandra Rao, Shubra Singh/Wiley publishers.
2. Introduction to Nanotechnology by Risal Singh, Shipra Mital Gupta, Oxford Higher Education, First Publication 2016.

REFERENCE BOOKS:

1. Introduction to Nano Technology /Charles P. Poole, Jr., Frank J.Owens/Wiley publishers.
2. Nanotechnology /Jermy J Ramsden/Elsevier publishers
3. Nano Materials/A.K.Bandyopadhyay/ New Age
4. Nano The Essentials, T.Pradeep, McGrawHill, 2014
5. Nanotechnology the Science of Small / M.A Shah, K.A Shah/Wiley Publisher

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Nano Technology	CO1	2			3		2						2	2	2
	CO2	3		3		3							3	2	2
	CO3	3	3	3	3	3								2	2
	CO4	3		3	3	3		2						2	2
	CO5			3			3						3	2	2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	--	--	--	Understand	2	PO1 PO4 PO6 PO12	Apply (L3) Interpret (L2) Thumb Rule Thumb Rule	2 3 2 2
2	--	--	--	Analyze	4	PO1 PO3 PO5 PO12	Apply (L3) Develop (L3) Select (L1) Thumb Rule	3 3 3 3
3	--	--	--	Analyze	4	PO1 PO2 PO3 PO4 PO5	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Thumb Rule	3 3 3 3 3
4	--	--	--	Analyze	4	PO1 PO3 PO4 PO5	Apply (L3) Develop (L3) Analyze (L4) Select (L1)	3 3 3 3

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

						PO7	Thumb Rule	2
5	--	--	--	Apply	2	PO3 PO6 PO12	Develop (L3) Thumb Rule Thumb Rule	3 3 3

Justification Statements:

CO1: Understand the nano-science concepts and properties of nano-materials
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).
PO4 Verb: **Interpret (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3).
PO6 Verb: **Thumb Rule**
CO1 As per the thumb rule, correlation is choosen as medium (2).
PO12 Verb: **Thumb Rule**
CO1 co-related moderately with PO6. Therefore, correlation is chosen as medium (2).

CO2: Analyze the processing techniques to synthesis and fabricate nano-materials
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO2 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO2 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).
PO12 Verb: **Thumb Rule**
CO2 co-related moderately with PO12. Therefore, correlation is chosen as medium (2).

CO3: Analyze the characterization techniques to study the morphological behaviour of nano-materials
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO3 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO3 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO4 Verb: **Analyze (L4)**
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO3 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

CO4: Analyze the synthesis and characterization techniques of carbon-based materials.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO4 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).
PO3 Verb: **Develop (L3)**
CO4 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).
PO4 Verb: **Analyze (L4)**
CO4 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).
PO5 Verb: **Select/Apply (L3)**
CO4 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

CO5: Apply the nanotechnology concepts to real time applications in various fields
Action Verb: **Apply (L3)**
PO3 Verb: **Develop (L3)**
CO5 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO6 Verb: **Thumb Rule**
CO5 co-related moderately with PO6. Therefore, correlation is chosen as medium (2).
PO12 Verb: **Thumb Rule**
CO5 co-related highly with PO6. Therefore, correlation is chosen as high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester**: I **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0315	Fluid Mechanics & Hydraulic Machinery Lab	0	0	3	1.5

CO Statements: After studying the course, student will be able to:

CO1. Analyze the venturi-meter and orifice-meter to measure the discharge of flowing fluid.
CO2. Analyze the small orifice and external mouth piece setup to measure coefficient of discharge.
CO3. Apply the concepts of major and minor loss in pipes to measure coefficient of loss of head.
CO4. Apply the Bernoulli's concept and forces exerted by jet on vanes to measure discharge and total head.
CO5. Evaluate the performance of pelton wheel, Francis turbine and centrifugal pump.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Analyze**	the venturi-meter and orifice-meter		to measure the discharge of flowing fluid	L4
CO2	**Analyze**	the small orifice and external mouth piece setup		to measure coefficient of discharge	L4
CO3	**Apply**	the concepts of major and minor loss in pipes		to measure coefficient of loss of head	L3
CO4	**Apply**	the Bernoulli's concept and forces exerted by jet on vanes		to measure discharge and total head	L3
CO5	**Evaluate**	the performance of pelton wheel, Francis turbine and centrifugal pump			L5

List of Experiments:

1. Calibration of Venturi meter (**CO1).**
2. Calibration of Orifice meter (**CO1).**
3. Determination of Coefficient of discharge for a small orifice by a constant head method. (**CO2).**
4. Determination of Coefficient of discharge for an external mouth piece by variable head method. (**CO2)**
5. Calibration of contracted Rectangular Notch and /or Triangular Notch. (**CO2)**
6. Determination of Coefficient of loss of head in a sudden contraction and friction factor. (**CO 3).**
7. Verification of Bernoulli"s equation. (**CO4).**
8. Impact of jet on vanes. (**CO4).**
9. Study of Hydraulic jump. (**CO4).**
10. Performance test on Pelton wheel turbine. (**CO5).**
11. Performance test on Francis turbine. (**CO5).**
12. Efficiency test on centrifugal pump. (**CO5).**

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Fluid Mechanics & Hydraulic Machinery Lab	CO1	**3**	**3**	**3**						**3**				**3**	**1**
	CO2	**3**	**3**	**3**						**3**				**3**	**2**
	CO3	**3**	**3**	**3**						**3**				**3**	**2**
	CO4	**3**	**3**	**3**						**3**				**3**	**2**
	CO5	**3**	**3**	**3**						**3**				**3**	**2**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation matrix

CO	CO Verb	CO BTL	Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
1	Analyze	L4	PO1 PO2 PO3 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 3
2	Analyze	L4	PO1 PO2 PO3 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 3
3	Apply	L3	PO1 PO2 PO3 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 3
4	Apply	L3	PO1 PO2 PO3 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 3
5	Evaluate	L5	PO1 PO2 PO3 PO9	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 3

Justification Statements:

CO1: Analyze the venturi-meter and orifice-meter to measure the discharge of flowing fluid.
Action Verb: **Analyze (L4)**
PO1Verb: **Apply (L3)**
CO1 Action verb is same level(greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO2: **Analyze** the small orifice and external mouth piece setup to measure coefficient of discharge.
Action Verb: **Analyze (L4)**
PO1Verb: **Apply (L3)**
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Apply the concepts of major and minor loss in pipes to measure coefficient of loss of head.
Action Verb: **Apply (L3)**
PO1Verb: **Apply (L3)**
CO3 Action verb is same level (same) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level (same) as PO3 verb. Therefore, the correlation is high (3)

CO4: **Apply** the Bernoulli's concept and forces exerted by jet on vanes to measure discharge and total head.
Action Verb: **Apply (L3)**
PO1Verb: **Apply (L3)**
CO4 Action verb is same level (same) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**

CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level (same) as PO3 verb. Therefore, the correlation is high (3)

CO5: Evaluate the performance of pelton wheel, Francis turbine and centrifugal pump.
Action Verb: **Evaluate (L5)**
PO1Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : III **Semester** : I **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0319	**Machine Tools – 1 Lab**	**0**	**0**	**3**	**1.5**

CO Statements: After studying the course, student will be able to:

CO1. Analyze the turning and threading operations to develop simple components on lathe machine.
CO2. Analyze the tapper-turning methods on lathe machine to produce tapered products.
CO3. Apply the milling operations to produce groove and gear cutting on the specimen
CO4. Analyze the shaping operations to produce simple components like square and hexagonal nut
CO5. Apply the grinding techniques to obtain surface finish of the component.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the turning and threading operations		to develop simple components on lathe machine	L4
CO2	Analyze	the tapper-turning methods on lathe machine		to produce tapered products	L3
CO3	Apply	the milling operations		to produce groove and gear cutting on the specimen	L3
CO4	Analyze	the shaping operations		to produce simple components like square and hexagonal nut	L3
CO5	Apply	the grinding techniques		to obtain surface finish of the component.	L3

List of Experiments:

1. Job on plain turning on lathe machine **(CO1)**
2. Job on step turning on lathe machine **(CO1)**
3. Job on threading on lathe machine **(CO1)**
4. Job on tapper turning on lathe machine in form tool method **(CO2)**
5. Job on tapper turning on lathe machine in attachment method **(CO2)**
6. Job on up and down milling **(CO3)**
7. Job on gear cutting on milling machine **(CO3)**
8. Preparation of hexagonal nut on shaper method **(CO4)**
9. Preparation of square nut on shaper method **(CO4)**
10. Job on cylindrical component in grinding machine **(CO5)**

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Machine Tools – 1 Lab	CO1	**3**	**3**	**3**						**3**				**3**	**3**
	CO2	**3**	**3**	**3**						**3**				**3**	**3**
	CO3	**3**	**3**	**3**						**3**				**3**	**3**
	CO4	**3**	**3**	**3**						**3**				**3**	**3**
	CO5	**3**	**3**	**3**						**3**				**3**	**3**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation matrix

CO	COs		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	Analyze	**4**	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L2) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3
2	Analyze	**4**	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L2) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3
3	Apply	**3**	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L2) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3
4	Analyze	**4**	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L2) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3
5	Apply	**3**	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L2) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3

Justification Statements:

CO1: Analyze the turning and treading operations to develop simple components on lathe machine.
Action Verb: Analyze (L4)
PO1Verb: **Analyze (L4)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L2)**
CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO1 co-relates highly with PO9. Therefore, the correlation is high (3)

CO2: Analyze the tapper-turning methods on lathe machine to produce tapered products.
Action Verb: Analyze (L4)
PO1Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L2)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

CO3: Apply the milling operations to produce groove and gear cutting on the specimen
Action Verb: Apply (L3)
PO1Verb: **Apply (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L2)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO3 co-relates highly with PO9. Therefore, the correlation is high (3)

CO4: Analyze the shaping operations to produce simple component like square and hexagonal nut
PO1Verb: **Analyze (L4)**
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L2)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO4 co-relates highly with PO9. Therefore, the correlation is high (3)

CO5: Apply the grinding techniques to obtain surface finish of the component.
Action Verb: Apply (L3)
PO1Verb: **Apply (L3)**
CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L2)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO5 co-relates highly with PO9. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester:** I **Branch of Study : Common to all branches**

Subject Code	Subject Name	L	T	P	Credits
20ASA0502	SOFT SKILLS LAB	1	0	2	2

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Understand the importance of verbal and non-verbal skills
CO2. Apply the interpersonal and intrapersonal skills
CO3. Apply the grammatical structures to formulate sentences and correct word forms.
CO4. Understand the trust among people and develop employability skills
CO5. Evaluate the skills needed for approaching different types of interviews.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the importance of verbal and non-verbal skills			**L2**
2	**Apply**	the interpersonal and intrapersonal skills			**L3**
3	**Apply**	the grammatical structures	to formulate sentences and correct word forms.		**L3**
4	**Understand**	the trust among people and develop employability skills			**L2**
5	**Evaluate**	the skills needed	for approaching different types of interviews.		**L5**

UNIT – I:

Grammar: Articles, Prepositions, Antonyms, Synonyms.

Vocabulary: Basics of Communication (Definition, Types of communication). Importance of body language in corporate culture, Body language (Facial expressions – eye contact – posture – gestures – Proxemics – Haptics – Dress Code – Paralanguage – Tone, pitch, pause & selection of words), Impromptu speeches.

Articles:
Web links: https://learnenglish.britishcouncil.org/grammar/a1-a2-grammar/articles-1
https://www.youtube.com/watch?v=ueEp6U8td1I
Prepositions:
Web links: https://www.grammarbook.com/grammar/probPrep.asp
Antonyms, Synonyms.
Web links: https://www.youtube.com/watch?v=-mLRoxWM8dI
https://www.youtube.com/watch?v=IEOrOPVMxiM
https://www.it.iitb.ac.in/~vijaya/ssrvm/worksheetscd/getWorksheets.com/Language%20Arts/syn_ant.pdf
Basics of Communication (Definition , Types of communication).
Web links: https://wikieducator.org/INTRODUCTION_TO_COMMUNICATION

Importance of body language in Corporate culture
Web links: https://www.forwardfocusinc.com/consciously-communicate/the-importance-of-body-language-in-the-workplace/

Body language (Facial expressions – eye contact – posture – gestures – Proxemics – Haptics – Dress Code – Paralanguage –Tone, pitch, pause & selection of words)
Web links: https://open.lib.umn.edu/communication/chapter/4-2-types-of-nonverbal-communication/
https://en.wikipedia.org/wiki/Nonverbal_communication
Impromptu speeches.
Web links: https://www.write-out-loud.com/impromptu-public-speaking-topics.html;

https://faculty.washington.edu/mcgarrit/COM220/online%20readings/sample%20critique.pdf

UNIT – II :

Grammar: Tenses, Idioms and Phrases, One word substitutes.
Vocabulary: Public speaking - *Oral presentations*, writing skills – *Short Essay writing and E- mail writing.*

Tenses
Web links: https://www.englisch-hilfen.de/en/grammar/english_tenses.htmj; https://onlymyenglish.com/tenses/; https://www.englishpage.com/verbpage/verbtenseintro.html; https://www.englishclub.com/grammar/verb-tenses.htm

Idioms and Phrases:
Web links: https://www.britannica.com/list/7-everyday-english-idioms-and-where-they-come-from https://eslexpat.com/english-idioms-and-phrases/; https://onlineteachersuk.com/english-idioms/;

One word substitutes:
Web links: https://www.careerpower.in/one-word-substitution.html; https://www.hitbullseye.com/Vocab/One-Word-Substitute-List.php; https://englishan.com/one-word-substitution-set-1/;

Public speaking - *Oral presentations*
Web links:https://egyankosh.ac.in/bitstream/123456789/26773/1/Unit-14.pdf; https://www.skillsyouneed.com/rhubarb/preparing-oral-presentations.html; https://courses.lumenlearning.com/publicspeakingprinciples/chapter/chapter-12-methods-of-delivery/

Writing skills – *Short Essay writing and E-mail writing.*
Web links: https://www.kibin.com/essay-writing-blog/important-essay-writing-skills/ https://www.scribendi.com/academy/articles/academic_essay_writing_skills.en.html ; https://www.microsoft.com/en-us/microsoft-365/business-insights-ideas/resources/improve-email-writing-skills;

UNIT – III:

Grammar: Direct and Indirect speeches, Active and Passive voice, Drawing inferences (reading comprehensions and listening comprehensions)
Vocabulary: Leadership Skills – Negotiation skills - Team-building – *Debate.* Leadership Skills – Negotiation skills - Team-building

Direct and Indirect speeches:
Web links: https://onlymyenglish.com/direct-and-indirect-speech/ https://learnenglish.britishcouncil.org/grammar/b1-b2-grammar/reported-speech-1-statements https://www.perfect-english-grammar.com/reported-speech.html

Active and Passive voice,
Web links: https://www.englishclub.com/grammar/passive-voice.htm https://www.gingersoftware.com/content/grammar-rules/verbs/passive-voice/ https://nps.edu/web/gwc/revising-passive-voice-into-active-voice

Drawing inferences (reading comprehensions and listening comprehensions)
Web links: https://www.readingrockets.org/strategies/inference https://www.thoughtco.com/making-inferences-3111201 https://www.comprehensionconnection.net/2019/03/exploring-difference-between-making.html

Vocabulary: Leadership Skills – Negotiation skills - Team-building – *Debate.*

Leadership Skills – Negotiation skills - Team-building
Web links: https://online.hbs.edu/blog/post/negotiation-skills https://www.bumc.bu.edu/facdev-medicine/files/2014/08/BUSM-Leasership-training.pdf https://in.indeed.com/career-advice/career-development/negotiation-skills https://www.thebalancecareers.com/what-is-team-building-1918270

Debate:

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Web links: https://noisyclassroom.com/debate-topics/
https://www.collegeessay.org/blog/debate-topics
https://www.edu.gov.mb.ca/k12/cur/socstud/frame_found_sr2/tns/tn-13.pdf

UNIT – IV:

Grammar: Common errors, Rearrangement of sentences.
Vocabulary: Resume writing, Pre-interview preparation , Group discussion.

Common errors, Rearrangement of sentences:
Web links: https://www.letsstudytogether.co/sentence-arrangement-questions-pdf-for-banking-exams-ibps-sbi-po-and-clerk/
https://www.youtube.com/watch?v=e8nO3zZzkZs

Vocabulary: Resume writing, Pre-interview preparation , Group discussion.
Web links: https://www.youtube.com/watch?v=PfJg-67smf4
https://www.youtube.com/watch?v=-lXjbph22Fk

UNIT – V:

Grammar : Verbal ability tests.
Vocabulary: Mock interviews, Post interview Etiquette.
Verbal ability tests.
Web links: https://prepinsta.com/infosys-english-verbal-questions/
https://www.indiabix.com/online-test/verbal-ability-test/random
https://www.allindiaexams.in/online-test/online-general-english-test/61
Vocabulary: Mock interviews, Post interview Etiquette.
Web links: https://www.youtube.com/watch?v=ZOLCMa2QbdE
https://www.ziprecruiter.com/blog/the-right-way-to-follow-up-after-a-job-interview/
https://www.youtube.com/watch?v=KIoD19uoxt8

References:

1. Barun K. Mitra, "Personality Development and Soft Skills", OXFORD Higher Education 2018.
2. Alka Wadkar, "Life Skills for Success", Sage publications 2016.
3. Robert M Sheffield, "Developing Soft Skills", Pearson, 2010.
4. Diana Booher, "Communicate with Confidence" Tata mcgraw hill, 1994.
5. B.N. Gosh, "Managing Soft skills for Personality development", Tata mcgraw hill 2012.
6. Michael Swan, "Practical English Usage", Oxford publications.
7. Raymond Murphy, "English Grammar in Use", Cambridge 5th Edition
8. Norman Lewis, "Word Power Made Easy", Penguin Publishers.
9. Advanced Grammar in Use A Self-Study Reference and Practice Book for Advanced Learners of English 3rd Edition , Cambridge

Correlation of COs with the POs & PSOs

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Soft Skills Lab	CO1						2								
	CO2									2					
	CO3										2				
	CO4									2					
	CO5												3		

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO6to PO12)	Level of Correlation (0-3)
	(Approx. Hrs)	%	corr	Verb	BTL			
1	09	21	3	Understand	L2	PO6	Thumb Rule	2
2	09	21	3	Apply	L3	PO9	Thumb Rule	2
3	06	14	2	Apply	L3	PO10	Thumb Rule	2
4	06	14	2	Understand	L2	PO9	Thumb Rule	2
5	06	14	2	Evaluate	L5	PO12	Thumb Rule	3

Justification Statements:

CO1: Understand the importance of verbal and non-verbal skills

Action Verb: Understand (L2)

CO1 Action Verb Understand is of BTL 2.

Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO2: Apply the interpersonal and intrapersonal skills

Action Verb: Apply (L3)

CO2 Action Verb Apply is of BTL 3.

Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2)

CO3: Apply grammatical structures to formulate sentences and correct word forms.

Action Verb: Apply (L3)

CO3 Action Verb Apply is of BTL 3.

Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

CO4: Understand trust among people and develop employability skills

Action Verb: Understand (L2)

CO4 Action Verb Understand is of BTL 3.

Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO5: Evaluate the skills needed for approaching different types of interviews.

Action Verb: Evaluate (L5)

CO5 Action Verb Evaluate is of BTL 5.

Using Thumb rule, L5 correlates PO6 to PO12 as high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: III **Semester**: I **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20AMC9904	PROFESSIONAL ETHICS AND HUMAN VALUES	2	0	0	0

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Understand the sustained happiness through identifying the essentials of human values and skills.
CO2. Understand the importance of Values and Ethics in their personal lives and professional careers.
CO3. Understand the rights and responsibilities as an employee, team member and a global citizen.
CO4. Understand the importance of trust, mutually satisfying human behavior and enriching interaction with nature.
CO5. Understand appropriate technologies and management patterns to create harmony in professional and personal life.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the sustained happiness	through identifying the essentials of human values and skills		**L2**
2	**Understand**	the importance of Values and Ethics		in their personal lives and professional careers.	**L2**
3	**Understand**	the rights and responsibilities	as an employee, team member and a global citizen.		**L2**
4	**Understand**	the importance of trust, mutually satisfying human behavior and enriching interaction with nature.			**L2**
5	**Understand**	appropriate technologies and management patterns		to create harmony in professional and personal life.	**L2**

Syllabus

UNIT - I:

Introduction to Human Values: Need, basic Guidelines, Content and Process for Value Education, Self Exploration - 'Natural Acceptance' and Experiential Validation. Continuous Happiness and Prosperity – A look at basic Human Aspirations. Right understanding, Relationship and Physical Facilities. Understanding Happiness and Prosperity correctly.

UNIT - II:

Understanding Harmony in the Family and Society: Harmony in Human - Human Relationship: Understanding harmony in the Family the basic unit of human interaction. Understanding values in human - human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship. Understanding the harmony in the society (society being an extension of family). Visualizing a universal harmonious order in society - Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha) - from family to world family!

UNIT – III:

Introduction to Professional Ethics: Basic Concepts, Governing Ethics, Personal & Professional Ethics, Ethical Dilemmas, Life Skills, Emotional Intelligence, Thoughts of Ethics, Value Education, Dimensions of Ethics, Profession and professionalism, Professional Associations, Professional Risks, Professional Accountabilities, Professional Success, Ethics and Profession.

UNIT – IV:

Professional Practices in Engineering: Work Place Rights & Responsibilities, Professions and Norms of Professional Conduct, Norms of Professional Conduct vs. Profession; Responsibilities, Obligations and Moral Values in Professional Ethics, Professional codes of ethics, the limits of predictability and responsibilities of the engineering profession. Central Responsibilities of Engineers – The entrality of Responsibilities of Professional Ethics; lessons from 1979 American Airlines DC-10 Crash and Kansas City Hyatt Regency Walk away

Collapse.

UNIT – V:

Global issues in Professional Ethics: Introduction – Current Scenario, Technology Globalization of MNCs, International Trade, World Summits, Issues, Business Ethics and Corporate Governance, Sustainable Development Ecosystem, Energy Concerns, Ozone Depletion, Pollution, Ethics in Manufacturing and Marketing, Media Ethics, War Ethics, Bio Ethics, Intellectual Property Rights.

Text Books:

1. R. R. Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.
2. Professional Ethics: R. Subramanian, Oxford University Press, 2015.
3. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge University Press 2015.

Reference Books:

1. Prof. K. V. Subba Raju, 2013, Success Secrets for Engineering Students, Smart Student Publications, 3rd Edition.
2. Ivan IIIich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
3. Engineering Ethics, Concepts Cases: Charles E Harris Jr., Michael S PritchaMichael J Rabins, 4e, Cengage learning, 2015.
4. Business Ethics concepts & Cases: Manuel G Velasquez, 6e, PHI, 2008

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PROFESSIONAL ETHICS AND HUMAN VALUES	CO1												2		
	CO2								2	2					
	CO3						2			2					
	CO4						2		2						
	CO5					1		2					2		

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	8	27	2	Understand	L2	PO12	Thumb Rule	2
2	8	26	2	Understand	L2	PO8, PO9	Thumb Rule Thumb Rule	2 2
3	4	13	2	Understand	L2	PO6, PO9	Thumb Rule Thumb Rule	2 2
4	5	17	2	Understand	L2	PO6, PO8	Thumb Rule Thumb Rule	2 2
5	5	17	2	Understand	L2	PO5, PO7, PO12	PO5 : APPLY Thumb Rule Thumb Rule	1 2 2

Justification Statements:

CO1: Understand sustained happiness through identifying the essentials of human values and skills.

Action Verb: Understand (L2)

CO1 Action Verb is understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO2: Understand the importance of Values and Ethics in their personal lives and professional careers.

Action Verb: Understand (L2)

CO2 Action Verb is understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO3: Understand the rights and responsibilities as an employee, team member and a global citizen.

Action Verb: Understand (L2)

CO3 Action Verb is understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO4: Understand the importance of trust, mutually satisfying human behavior and enriching interaction with nature.

Action Verb: Understand (L2)

CO4 Action Verb is understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO5: Understand appropriate technologies and management patterns to create harmony in professional and personal life.

Action Verb: Understand (L2)

CO5 Action Verb is understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).

CO5 Action Verb is understand of BTL 2. Using action verb apply, L2 correlates PO5 as low (1).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Semester VI (Third year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P	C	CIE	SEE	Total
1	Professional Core courses	20APC0317	Heat Transfer	3	-	-	3	30	70	100
2	Professional Core courses	20APC0316	Design of Machine Elements	3	-	-	3	30	70	100
3	Professional Core courses	20APC0318	Dynamics of Machines	3	-	-	3	30	70	100
4	Professional Elective courses	20APE0308	Finite Element Analysis	3	-	-	3	30	70	100
		20APE0304	Applied Thermodynamics							
		20APE0305	Composite materials							
5	Professional Core courses Lab	20APC0328	CAM Lab	-	-	3	1.5	30	70	100
6	Professional Core courses Lab	20APC0329	Heat Transfer Lab	-	-	3	1.5	30	70	100
7	Professional Core courses Lab	20APC0330	Machine Tools – 2 Lab	-	-	3	1.5	30	70	100
8	Skill advanced course/ soft skill course*	20ASC0303	Crystal structure Analysis Lab	1	-	2	2	100	-	100
9	Mandatory course (AICTE)	20AMC9901	Biology for Engineers	3	-	-	-	30	-	30
			Total credits				**18.5**	**340**	**490**	**830**
Industrial/Research Internship (Mandatory) 2 Months during summer vacation										

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : III **Semester** : II **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0317	Heat Transfer	3	0	0	3

CO Statements: After studying the course, student will be able to:

CO1. Apply the concepts of different modes of heat transfer to 1-D steady state composite systems.

CO2. Evaluate the steady state and unsteady state heat conduction problems applied to different geometries.

CO3. Evaluate the convective heat transfer rates under forced and free convection.

CO4. Analyze the concepts of heat transfer with phase change and condensation along with heat exchangers.

CO5. Analyze the concepts of black radiation and heat exchange between gray bodies.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the concepts of different modes of heat transfer to		1-D steady state composite systems	L3
CO2	Evaluate	the steady state and unsteady state heat conduction problems applied		to different geometries	L5
CO3	Evaluate	the convective heat transfer rates		under forced and free convection	L5
CO4	Analyze	the concepts of heat transfer with phase change and condensation along with heat exchangers			L4
CO5	Analyze	the concepts of black radiation and heat exchange between gray bodies			L4

Unit I

Introduction: Modes and Mechanisms of Heat Transfer – Basic Laws of Heat Transfer – General Applications of Heat Transfer.

Conduction Heat Transfer: Fourier Rate Equation – General Heat Conduction Equation In Cartesian, Cylindrical and Spherical Coordinates. Simplification and Forms of the Field Equation – Steady, Unsteady and Periodic Heat Transfer – Boundary and Initial Conditions.

One Dimensional Steady State Heat Conduction: In Homogeneous Slabs, Hollow Cylinders and Spheres.

Unit II

Heat Transfer in Extended Surface (Fins) – Types, Fin Materials, Applications , efficiency, effectiveness and temperature distribution on Long Fin, Fin with Insulated Tip and Short Fin, Application to Errors in Temperature Measurement.

One Dimensional Transient Heat Conduction: In Systems with Negligible Internal Resistance – Significance of Biot and Fourier Numbers – Chart Solutions of Transient Conduction Systems – Problems on Semi-infinite Body.

Unit III

Heat Convective Transfer: Dimensional Analysis – Buckingham Π Theorem and its Application for Developing Semi – Empirical Non-Dimensional Correlations for Convective Heat Transfer – Significance of Non-Dimensional Numbers – Concepts of Continuity, Momentum and Energy Equations.

Forced Convection: External Flows: Concepts of Hydrodynamic and Thermal Boundary Layer and Use of Empirical Correlations for Convective Heat Transfer for Flow Over – Flat Plates, Cylinders and Spheres.

Free Convection: Development of Hydrodynamic and Thermal Boundary Layer along a Vertical Plate – Use of Empirical Relations for Convective Heat Transfer on Plates and Cylinders in Horizontal and Vertical Orientation.

Unit IV Heat Transfer with Phase Change:

Boiling: Pool Boiling – Regimes, Determination of Heat Transfer Coefficient in Nucleate Boiling, Critical Heat Flux and Film Boiling.

Condensation: Filmwise and Dropwise Condensation – Nusselt's Theory of Condensation on a Vertical Plate

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

– Film Condensation on Vertical and Horizontal Cylinders Using Empirical Correlations.

Unit V

Radiative Heat Transfer: Emission Characteristics and Laws of Black-Body Radiation – Irradiation – Total and Monochromatic Quantities– Laws of Planck, Wien, Kirchoff, Lambert, Stefan And Boltzmann – Heat Exchange Between Two Black Bodies –Concepts of Shape Factor – Emissivity – Heat Exchange Between Gray Bodies – Radiation Shields – Electrical Analogy for Radiation Networks.

Text Books:

1. Heat and Mass Transfer, by Sachdeva, New age International.
2. Heat and Mass Transfer by Y.A Cengel, A J Ghajar, Mc Graw Hill education,2011.
3. Heat and Mass Transfer, R.K.Rajput, S.Chand& Company Ltd, 2001.

Reference Books:

1. Heat Transfer, P.K.Nag, 3/e, TMH, 2011.
2. Fundamentals of Heat and Mass Transfer, Kondandaraman, C.P., 3/e, New Age Publ.
3. Heat Transfer, Holman.J.P, 10/e, TMH, 2012.
4. Introduction to Heat Transfer, by lncropera and Dewitt, Wiley Publishers,2001.
5. Heat Transfer, M. Necati Ozisik, A Basic Approach, McGraw Hill, New York, 2005.

Note: - Heat and mass transfer data book by C.P. kothandaraman, New age publications is permitted for internal and external examinations.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Heat Transfer	CO1	**3**	**3**											**1**	**1**
	CO2	**3**	**3**	**2**										**2**	**2**
	CO3	**3**	**3**	**2**										**2**	**2**
	CO4	**3**	**3**	**1**										**2**	**1**
	CO5	**3**	**3**	**1**										**1**	**1**

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	**18**	21.17	**L3**	**Apply**	**3**	PO1 PO2	Apply (L3) Identify (L3)	3 3
2	**17**	20	**L2**	Evaluate	**5**	PO1 PO2 PO3	Apply (L3) Identify (L3) Design (L6)	3 3 2
3	**18**	21.17	**L3**	Evaluate	**5**	PO1 PO2 PO3	Apply (L3) Identify (L3) Design (L6)	3 3 2
4	**17**	20	**L2**	Analyze	**4**	PO1 PO2 PO3	Apply (L3) Identify (L3) Design (L6)	3 3 1
5	**15**	17.64	**L2**	Analyze	**4**	PO1 PO2 PO3	Apply (L3) Identify (L3) Design (L6)	3 3 1

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Apply the concepts of different modes of heat transfer to 1-D steady state composite systems. **(L3)**
Action Verb: Apply (L3)
PO1Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO2: **Evaluate** the steady state and unsteady state heat conduction problems applied to different geometries. (L5)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Design (L6)**
CO2 Action verb is same level (lesser) as PO3 verb. Therefore, the correlation is medium(2)

CO3: Evaluate the convective heat transfer rates under forced and free convection.
Action Verb: **Evaluate** (L5)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Design (L6)**
CO3 Action verb is same level (lesser) as PO3 verb. Therefore, the correlation is medium (2)

CO4: Analyze the concepts of heat transfer with phase change and condensation along with heat exchangers.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Design (L6)**
CO4 Action verb is same level (lesser) as PO3 verb. Therefore, the correlation is low (1)

CO5: Analyze the concepts of black radiation and heat exchange between gray bodies.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is same level (lesser) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Design (L6)**
CO5 Action verb is same level (lesser) as PO3 verb. Therefore, the correlation is low (1)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : **III** Semester **: II** Branch of Study : ME

Subject Code	Subject Name	L	T	P	Credits
20APC0316	Design of Machine Elements	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Apply the design procedures using theories of failure for different machine elements.

CO2. Evaluate the stresses induced in a machine element using Goodman's and Soderberg's criterions.

CO3. Apply the design procedures for riveted and bolted joints with direct and eccentric loadings.

CO4. Analyze the stresses in cotter and knuckle joints as well as design of shafts under bending and axial loads

CO5. Analyze the stresses in the design of keys, rigid and flexible couplings.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	design procedures	using theories of failure	for different machine elements	L3
CO2	Evaluate	the stresses induced in a machine element under cyclic loading	Goodman's and Soderberg's criterions		L5
CO3	Apply	the design procedures	for riveted and bolted joints	with direct and eccentric loadings.	L3
CO4	Analyze	the stresses in cotter and knuckle joints as well as design of shafts	under bending and axial loads		L4
CO5	Analyze	the stresses in the design of keys, rigid and flexible couplings			L4

UNIT I

INTRODUCTION: General considerations of design, design process. Selection of Engineering Materials - properties –Manufacturing considerations in the design. BIS codes of materials, preferred numbers and interchangeability.

STRESSES IN MACHINE MEMBERS: Simple stresses – Combined stresses – Torsional and bending Stresses – impact stresses – stress -strain relation – Theories of failure – factor of safety.

UNIT II

DESIGN FOR FLUCTUATING LOADS: Stress concentration –notch sensitivity – Design for fluctuating stresses – Estimation of Endurance strength – Goodman's line – Soderberg's line. Design of components for finite and infinite life.

UNIT III

DESIGN OF RIVETED JOINTS: Types of riveted joints, design of riveted joints. Boiler shell riveting design and eccentric loading design of riveted joints. DESIGN OF BOLTED JOINTS: Forms of Screw threads. Stresses in Screw fasteners. Design of bolts with pre-stresses, Design of bolted joints under eccentric loading, Bolts of uniform strength.

UNIT IV

DESIGN OF COTTERS AND KNUCKLE JOINTS: Design of Cotter joints: spigot and socket, sleeve and cotter, jib and cotter joints- Knuckle joints

DESIGN OF SHAFTS: Design of solid and hollow shafts for strength and rigidity – Design of shafts for combined bending and axial loads.

UNIT V

DESIGN OF KEYS AND COUPLINGS: Design of Rigid couplings: Muff, Split muff and Flange couplings- Design of flexible couplings.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Text Books:

1. Machine Design, Schaum'sseries, TMH Publishers, NewDelhi, 1st edition, 2011
2. Machine Design, R.S. Kurmi and J.K. Gupta, S.Chand Publishers, NewDelhi

Reference Books:

1. Machine Design, R.K.Jain, KhannaPublishaers,New Delhi.
2. Machine Design, SadhuSingh, KhannaPublishers, NewDelhi
3. Mechanical Engineering Design, JosephE.Shigely,TMH Publishers,NewDelhi, 9th edition, 2011 R
4. Design of Machine Elements, M.F. Spotts, PHIPublishers, NewDelhi.
5. Machine Design, Pandya and Shah, CharotarPublishers,Anand, 17th edition, 2009
6. Machine Design, R.L. Norton, Tata McGrawHillPublishers, 2nd edition, 2002
7. Machine Design by Groover – CBS Publications, 5th edition, 2012.
8. Machine Design Data Book, V B Bhandari, McGraw Hill,2014

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Dynamics of Machines	CO1	3	3	3										3	3
	CO2	3	3	3										3	3
	CO3	3	3	3										3	3
	CO4	3	3	3										3	3
	CO5	3	3	3										3	3

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	15	17.65	2	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
2	14	16.47	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	20	23.53	3	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
4	21	24.70	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	15	17.65	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3

Justification Statements:

CO1: Apply the design procedures using theories of failure for different machine elements.
Action Verb: Apply (L3)
PO1Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO2: Evaluate the stresses induced in a machine element under cyclic loading using Goodman's and Soderberg's criterions.
Action Verb: Evaluate (L5)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Apply the design procedures for riveted and bolted joints with direct and eccentric loadings.
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the stresses in cotter joint, knuckle joint and shafts.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Analyze the stresses in keys and couplings.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : III **Semester** : II **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0318	Dynamics of Machines	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the concepts of friction on the mechanisms of clutches and brakes
CO2. Analyze the gyroscopic root map on moving vehicles and turning moment diagrams for engines.
CO3. Analyze the function of governors on engines as well as balancing of rotating masses.
CO4. Analyze the balancing of different types of engines working condition under reciprocating masses
CO5. Analyze the sensitive responses of vibrations in different methods.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts of friction	on the mechanisms of clutches and brakes		L2
CO2	Analyze	the gyroscopic root map and turning moment diagrams	on different moving vehicles for engines.		L4
CO3	Analyze	the function of governors	on engines as well as role of rotating masses		L4
CO4	Analyze	the balancing of different types of engines working condition	under reciprocating masses		L4
CO5	Analyze	the sensitive responses of vibrations in different methods			L4

UNIT I

Friction: Types of friction, inclined plane, screw friction, screw jack, Journal bearing, concept of uniform pressure and uniform wear, pivot bearings – flat, conical and trapezoidal, flat collar bearings, friction clutches – flat, conical and centrifugal, Brakes – Block or Shoe Brake, Band Brake, Band and Block Brake, Internal Expanding Shoe Brake, Effect of Braking on vehicle, general description and method of operation of Dynamometers.

UNIT II

Gyroscope: Effect of gyroscopic couple on the stability of moving Aeroplane, ship, motor car and motor cycle.

Fluctuation of Energy: Turning moment diagrams for steam engine, IC Engine and multi cylinder engine, coefficient of Fluctuation of energy, coefficient of Fluctuation of speed, design of Fly wheels for reciprocating engines, design of Fly wheels for punching machines.

UNIT III

Governors: Watt governor, dead weight governor – Porter and Proell governors. Spring loaded governors – Hartnell, Hartung and Wilson Hartnell governors. Sensitiveness, isochronism and hunting. Effort and power of a governor.

Balancing of rotating masses: Single in single plane, multiple masses in single plane, multiple masses indifferent planes.

UNIT IV

Balancing of Reciprocating masses: Primary and Secondary balancing of reciprocating masses. Analytical and graphical methods. Balancing of Locomotives, Effects of Partial Balancing in Locomotives, Balancing of Inline Engines, V-engines, and Radial Engines. Unbalanced forces and couples for primary and secondary balancing.

UNIT V

Vibrations: Free Longitudinal Vibrations, Inertia Effect of the Mass of Spring, Damped Vibrations, Forced Vibrations, Forced-damped Vibrations, Transverse Vibrations of Shaft due to Single Load, uniformly distributed Load and Several Loads, Dunkerly‟s method, Raleigh‟s method, Whirling of Shafts, Free Torsional Vibrations in Single Rotor, Two-rotor and Three-rotor Systems, Inertia Effect of Mass of Shaft, Torsionally Equivalent Shaft.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Text Books:

1. Theory of Machines, S.S. Rattan, Tata McGraw Hill.
2. Kinematics and Dynamics of Machinery R.L. Norton, Tata McGraw Hill.

Reference Books:

1. Theory of Machines, Thomas Bevan, Pearson.
2. The theory of Machines, Ballaney, Kanna Publishers
3. Theory of Machines and Mechanisms of Shigley et.al. Oxford International.
4. Theory of Machines, Kinematics and Dynamics sadhu gingh, Pearson
5. A Text Book of Theory of Machines. R. K. Bansal, Laxmi Publications
6. Theory of Mechanisms and Machines, Jagadish Lal, Metropolitan company pvt. Ltd

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Dynamics of Machines	**CO1**	**2**	**3**	**2**			**2**							**2**	**2**
	CO2	**3**	**3**	**3**										**2**	**2**
	CO3		**3**	**3**							**3**			**2**	**2**
	CO4	**3**	**3**	**3**	**3**									**2**	**2**
	CO5	**3**	**3**					**3**						**2**	**2**

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	18	18/84=21.42	3	Understand	2	PO1 PO2 PO3 PO6	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	2 3 2 2
2	18	18/84=21.42	3	Analyze	4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	16	16/84=19.05	2	Analyze	4	PO2 PO3 PO10	Identify (L3) Develop (L3) Thumb Rule	3 3 3
4	16	16/84=19.05	2	Analyze	4	PO1 PO2 PO3 PO4	Apply (L3) Identify (L3) Develop (L3) Analyze (L4)	3 3 3 3
5	16	16/84=19.05	2	Analyze	4	PO1 PO2 PO7	Apply (L3) Identify (L3) Thumb Rule	3 3 3

Justification Statements:

CO1: Understand the concepts of friction on the mechanisms of clutches and brakes
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is one level less than PO3 verb. Therefore, the correlation is medium (2)
PO2 Verb: **Identify (L3)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO6 verb: **Thumb Rule**
CO1 correlates moderately with PO6. Therefore, the correlation is medium (2).

CO2: Analyze the gyroscopic root map on moving vehicles and turning moment diagrams for engines.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze the function of governors on engines as well as balancing of rotating masses.
Action Verb: Analyze (L4)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO10 verb: **Thumb Rule**
CO1 correlates highly with PO10. Therefore, the correlation is high (3)

CO4: Analyze the balancing of different types of engines working condition under reciprocating masses.
Action Verb: Evaluate (L5)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

CO5: Analyze the sensitive responses of vibrations in different methods.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO5 correlates moderately with PO7. Therefore, the correlation is medium (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : **III** Semester **: II** Branch of Study : ME

Subject Code	Subject Name	L	T	P	Credits
20APE0308	Finite Element Analysis	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the discrete and continuous models as well as basic concepts of Finite Element Methods
CO2. Apply the finite element formulations to solve one-dimensional second order problems.
CO3. Apply the finite element formulations to solve two-dimensional scalar variable problems.
CO4. Analyze the finite element methods to solve two-dimensional Vector variable problems.
CO5. Evaluate the isoparametric elements and dynamic problems using finite element method.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the discrete and continuous models and basic concepts of Finite Element Methods			L2
CO2	Apply	the finite element formulations	to solve one-dimensional second order problems		L3
CO3	Apply	the finite element formulations	to solve two-dimensional scalar variable problems		L3
CO4	Analyze	the finite element methods	to solve two-dimensional Vector variable problems		L4
CO5	Evaluate	the isoparametric elements and dynamic problems		using finite element method	L4

UNIT – I INTRODUCTION:

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT – II ONE-DIMENSIONAL PROBLEMS:

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer.

UNIT – III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS:

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT – IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS:

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

UNIT – V ISOPARAMETRIC FORMULATION:

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems –

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software

Text Books:

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Finite Element Analysis	CO1	2	2		1									2	2
	CO2		3		2									2	2
	CO3		3		3									2	2
	CO4		2		3									2	2
	CO5		3											2	2

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Understand	L2	PO1 PO2 PO4	Identify (L3) Apply (L3) Analyze (L4)	2 2 1
2	-	-	-	Apply	L3	PO2 PO4	Apply (L3) Analyze (L4)	3 2
3	-	-	-	Apply	L3	PO2 PO4	Apply (L3) Analyze (L4)	3 2
4	-	-	-	Analyze	L4	PO4 PO2	Analyze (L4) Apply (L3)	3 3
5	-	-	-	Evaluate	L3	PO2	Apply (L3)	3

Justifications Statements

CO1: Understand the discrete and continuous models as well as basic concepts of Finite Element Methods
Action verb: Understand (L2)
PO1 Verb: Identify (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Apply (L3)
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)
PO4 Verb: Analyze (L4)
CO1 Action verb is less than PO4 verb by two levels. Therefore, the correlation is low (1)

CO2. Apply the finite element formulations to solve one-dimensional second order problems.
Action verb: Apply (L2)
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)
CO2 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)

CO3. Apply the finite element formulations to solve two-dimensional scalar variable problems.
Action verb: Apply (L3)
PO2: Apply (L3)
CO3. Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)

CO3 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)

CO4. Analyze the finite element methods to solve two-dimensional Vector variable problems.
Action Verb: Analyze (L4)
PO4 Verb: Analyze (L4)
CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO2 Verb: Apply (L3)
CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO5. Evaluate the isoparametric elements and dynamic problems using finite element method.
Action Verb: Apply (L3)
PO2 Verb: Apply (L3)
CO5. Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : III **Semester** : II **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0304	Applied Thermodynamics	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze the testing process and performance of I.C engines and its combustion system
CO2. Analyze the working of reciprocating compressor and rotary compressor
CO3. Analyze the vapour power cycles and gas power cycles
CO4. Analyze the performance of different nozzles and working of various steam turbines
CO5. Analyze the working of VCR and VAR systems as well as psychrometry and air conditioning.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the performance of I.C engines and its combustion system			L4
CO2	Analyze	the working of reciprocating compressor and rotary compressor			L4
CO3	Analyze	the vapour power cycles and gas power cycles			L4
CO4	Analyze	the performance of different nozzles and working of various steam turbines			L4
CO5	Analyze	the working of VCR and VAR systems as well as psychrometry and air conditioning			L3

UNIT – I

IC Engines: Working and classification of IC engines, comparison of two stroke and four stroke engines, comparison of SI and CI Engines.

Testing and Performance of IC Engines: Methods of testing IC Engines, performance analysis of IC Engines.

Combustion in IC Engines: SI engine: stages of combustion, normal combustion, abnormal combustion, variables effecting delay period and knocking, pre-ignition. CI engine: stages of combustion, normal combustion, abnormal combustion, variables effecting delay period and knocking. Fuel requirements and fuel rating.

UNIT – II

Air compressors

Reciprocating Compressor: Single stage reciprocating compressors, work required, effect of clearance in compressors, volumetric efficiency, multi stage compressor, effect of inter cooling in multi stage compressors, compressor performance.

Rotary Compressor: Working principle of a rolling piston type compressor (fixed vane type), multi vane type compressors, characteristics of rotary vane type compressor, working principle of centrifugal compression and axial flow compressors, velocity triangles.

UNIT – III

Vapour Power Cycles: Vapour power cycle, simple Rankine cycle, mean temp of heat addition thermodynamic variables effecting efficiency and output of Rankine cycle

Gas power Cycle: Simple gas turbine plant, Brayton cycle, closed cycle and open cycle for gas turbines, condition for maximum pressure ratio and optimum pressure ratio, actual cycle. Methods to improve performance: regeneration, intercooling and reheating. Introduction to jet propulsion: working principle of ramjet, turbojet, turbofan, turboprop and pulse jet engines

UNIT – IV

Nozzles: Type of nozzles - air and steam nozzles. Compressible flow through nozzle- condition for maximum discharge - nozzle efficiency.

Steam Turbines: Classification of steam turbines -impulse turbine and reaction turbine -compounding in turbines - velocity diagrams in impulse and reaction turbines, efficiency, degree of reaction - governing of turbines

UNIT – V

Refrigeration: Bell-Coleman cycle - vapour compression cycle, effect of vapour condition on COP of VCR, -

vapour absorption cycle, properties of common refrigerants

Principles of Psychrometry and Air Conditioning: Psychometric terms, psychometric processes and air conditioning systems

Text Book(s)

1. Ganesan V, "Internal Combustion Engines", Tata McGraw Hill, 2017.
2. M.L.Mathur and F.S.Mehta, "Thermal Engineering", Jain brothers,2014

References:

1. Mahesh V Rathore, "Thermal Engineering", Tata McGraw Hill 2017
2. Yahya, S. M., Turbines, "Compressors and Fans", 4th edition, Tata McGraw Hill, 2010.
3. Nag P.K, "Engineering Thermodynamics", 4th edition, Tata McGraw-Hill, 2008.
4. Onkar Singh, "Thermal Turbomachines", 3rd edition, Wiley India, 2014.
5. P.L.Ballaney, "Thermal Engineering", 2nd edition, Khanna, 2005.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Applied Thermodynamics	CO1	**3**	**3**		**3**									**2**	**2**
	CO2	**3**	**3**		**3**									**2**	**2**
	CO3	**3**	**3**		**3**									**2**	**2**
	CO4	**3**	**3**		**3**									**2**	**2**
	CO5	**3**	**3**		**3**									**2**	**2**

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Analyze	L4	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **3**
2	-	-	-	Analyze	L4	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **3**
3	-	-	-	Analyze	L4	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **3**
4	-	-	-	Analyze	L4	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **3**
5	-	-	-	Analyze	L4	**PO1** **PO2** **PO4**	**Apply (L3)** **Review (L2)** **Analyze (L4)**	**3** **3** **3**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Analyze the testing process and performance of I.C engines and its combustion system
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO1 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

CO2: Analyze the working of reciprocating compressor and rotary compressor
Action Verb: **Analyze** (**L4**)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO1 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

CO3: Analyze the vapour power cycles and gas power cycles
Action Verb: **Analyze** (**L4**)
PO1 Verb: **Apply (L3)**
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO1 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

CO4: Analyze the performance of different nozzles and working of various steam turbines
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO1 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

CO5: Analyze the working of VCR and VAR systems as well as psychrometry and air conditioning
Action Verb: **Apply** (L3)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO1 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : **III** Semester **: II** Branch of Study : ME

Subject Code	Subject Name	L	T	P	Credits
20APE0305	Composite Materials	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Apply the concepts of reinforcements and matrices to produce composites
CO2. Analyze the synthesis of fibers and fiber/matrix interface
CO3. Analyze the manufacturing techniques to fabricate polymer matrix composites
CO4. Analyze the processing methods to manufacture metal matrix composites
CO5. Analyze the production approaches to produce ceramic matrix composites and carbon-carbon composites

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	Apply	concepts of reinforcements and matrices		to produce composites	L2
CO2	Analyze	the synthesis of fibers and fiber/matrix interface			L4
CO3	Analyze	the manufacturing techniques to fabricate polymer matrix composites			L4
CO4	Analyze	the processing methods to manufacture metal matrix composites			L4
CO5	Analyze	the production approaches to produce ceramic matrix composites and carbon-carbon composites			L4

Unit I:

Introduction: Definitions, Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Carbon Fibre composites, Properties of composites in comparison with standard materials, Applications of metal, ceramic and polymer matrix composites

Unit II:

Processing of Fibers: Fiber spinning process – wet, dry, melt and dry jet-wet spinning; Fabrication and Characterization of fibers - carbon fibre, glass fibre, boron fiber, polyethelyne fiber, armed fibers and ceramic fibers - oxide and non-oxide fibers, Fibre/Matrix Interface, Measurement of interface bonding.

Unit III:

Processing of Polymer Matrix Composites: Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding.

Unit IV:

Processing of Metal Matrix Composites: Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

Unit V:

Processing of Ceramic Matrix Composites and Carbon-carbon Composites: Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, mechanical properties and applications of CMCs – Carbon-carbon Composites –applications.

Text Books and Reference Books:

1. Engineering Mechanics of Composite Materials- Isaac and M Daniel, Oxford University Press, 1994

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

2. Mechanics of Composite Materials, R. M. Jones, Mc GrawHill Company, New York, 1975
3. Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers,2003.
4. Seamour, E.B. Modern Plastics Technology, Prentice Hall,2002

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Composite materials	CO1	**3**		**3**									**2**	**2**	**2**
	CO2	**3**		**3**		**3**							**2**	**3**	**3**
	CO3	**3**		**3**	**3**	**3**							**2**	**3**	**3**
	CO4	**3**		**3**	**3**	**3**							**2**	**3**	**3**
	CO5	**3**		**3**	**3**	**3**							**2**	**3**	**3**

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	10	17.8	2	Apply	3	PO1 PO3 PO12	Apply (L3) Develop (L3) Thumb Rule	3 3 2
2	10	17.8	2	Analyze	4	PO1 PO3 PO5 PO12	Apply (L3) Develop (L3) Select/Apply (L3) Thumb Rule	3 3 3 2
3	13	23.2	3	Analyze	4	PO1 PO3 PO4 PO5 PO12	Apply (L3) Develop (L3) Analyze (L4) Select/Apply (L3) Thumb Rule	3 3 3 3 2
4	13	23.2	3	Analyze	4	PO1 PO3 PO4 PO5 PO12	Apply (L3) Develop (L3) Analyze (L4) Select/Apply (L3) Thumb Rule	3 3 3 3 2
5	10	17.8	2	Analyze	4	PO1 PO3 PO4 PO5 PO12	Apply (L3) Develop (L3) Analyze (L4) Select/Apply (L3) Thumb Rule	3 3 3 3 2

Justification Statements:
CO1: Apply the concepts of reinforcements and matrices to produce composites.
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3).
PO12 Verb: **Thumb Rule**
CO1 correlates moderately with PO12. Therefore, the correlation is medium (2).

CO2: Analyze the synthesis of fibers and fiber/matrix interface
Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**
CO2 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO2 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO2 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).
PO12 Verb: **Thumb Rule**
CO2 correlates moderately with PO12. Therefore, the correlation is medium (2).

CO3: Analyze the manufacturing techniques to fabricate polymer matrix composites.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO3 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO4 Verb: **Analyze (L4)**
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO3 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).
PO12 Verb: **Thumb Rule**
CO3 correlates moderately with PO12. Therefore, the correlation is medium (2).

CO4: Analyze the processing methods to manufacture metal matrix composites
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO4 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO4 Verb: **Analyze (L4)**
CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO4 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).
PO12 Verb: **Thumb Rule**
CO4 correlates moderately with PO12. Therefore, the correlation is medium (2).

CO5: Analyze the production approaches to produce ceramic matrix composites and carbon-carbon composites
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO5 Action verb is same (greater) level as PO3verb. Therefore, the correlation is high (3).
PO4 Verb: **Analyze (L4)**
CO5 Action verb is same level as PO4 verb. Therefore, the correlation is high (3).
PO5 Verb: **Select/Apply (L3)**
CO5 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).
PO12 Verb: **Thumb Rule**
CO5 correlates moderately with PO12. Therefore, the correlation is medium (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : **III** Semester **: II** Branch of Study : ME

Subject Code	Subject Name	L	T	P	Credits
20APC0328	CAM LAB	0	0	3	1.5

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Analyze the static structural analysis of 2D and 3D structures using Finite Element Analysis.
CO2. Evaluate the stress and strains of beams under UDL and UVL conditions.
CO3. Analyze the steel bracket using plane stress condition by Finite Element Analysis
CO4. Analyze the pressure vessels on plane strain and axisymmetric condition
CO5. Analyze the curved shell due to internal pressure loading condition through FEA.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Analyze**	the static structural analysis	of 2D and 3D structures	using Finite Element Analysis.	**L4**
CO2	**Evaluate**	the stress and strains of beams	under UDL and UVL conditions.		**L5**
CO3	**Analyze**	the steel bracket	using plane stress condition	by Finite Element Analysis	**L4**
CO4	**Analyze**	the pressure vessels	on plane strain and axisymmetric condition		**L4**
CO5	**Analyze**	the curved shell	due to internal pressure loading condition	through FEA.	**L4**

List of Experiments:

1. Static Analysis of 2D Transmission Tower (CO1)
2. Static Analysis of 2D Four bar Truss (CO1)
3. Static Analysis of 3D Space Truss (CO1)
4. Static Analysis of Beam with UDL, UVL and moment (CO2)
5. Static Structural Analysis of a Steel Bracket using Plane stress condition (CO3)
6. Analysis of Pressure vessel using Plane Strain condition (CO4)
7. Static analysis of an axisymmetric pressure vessel (CO4)
8. Static analysis of a curved shell due to internal pressure (CO5)

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CAM Lab	CO1	**3**				**3**				**1**			**1**	**3**	**3**
	CO2	**3**				**3**				**1**			**1**	**3**	**3**
	CO3	**3**				**3**				**1**			**1**	**3**	**3**
	CO4	**3**				**3**				**1**			**1**	**3**	**3**
	CO5	**3**				**3**				**1**			**1**	**3**	**3**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix

CO	CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	**Analyze**	**L4**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1
2	**Evaluate**	**L5**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1
3	**Analyze**	**L4**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1
4	**Analyze**	**L4**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1
5	**Analyze**	**L4**	PO1	Identify (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	1
			PO12	Thumb Rule	1

Justification Statements:

CO1: **Analyze** the static structural analysis of 2D and 3D structures using Finite Element Analysis
Action Verb: **Analyze (L4)**
PO1 Verb: **Identify (L3)**
CO1 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO1 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO1 correlates PO9 as low (1)
PO12: Using the thumb rule, CO1 correlates PO12 as low (1)
CO2: **Evaluate** the stress and strains of beams under UDL and UVL conditions.
Action Verb: **Evaluate (L5)**
PO1 Verb: **Identify (L3)**
CO2 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO2 correlates PO9 as low (1)
PO12: Using the thumb rule, CO2 correlates PO12 as low (1)
CO3: **Analyze** the steel bracket using plane stress condition by Finite Element Analysis
Action Verb: **Analyze (L4)**
PO1 Verb: **Identify (L3)**
CO3 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO3 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO3 correlates PO9 as low (1)
PO12: Using the thumb rule, CO3 correlates PO12 as low (1)

CO4: **Analyze** the pressure vessels on plane strain and axisymmetric condition.
Action Verb: **Analyze (L4)**
PO1 Verb: **Identify (L3)**
CO4 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO4 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO4 correlates PO9 as low (1)
PO12: Using the thumb rule, CO4 correlates PO12 as low (1)
CO5: **Analyze** the curved shell due to internal pressure loading condition through FEA.
Action Verb: **Analyze (L4)**
PO1 Verb: **Identify (L3)**
CO5 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO5 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)
PO9: Using the thumb rule, CO5 correlates PO9 as low (1)
PO12: Using the thumb rule, CO5 correlates PO12 as low (1)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : III **Semester** : II **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0329	Heat Transfer Lab	0	0	3	1.5

CO Statements: After studying the course, student will be able to:

CO1. Evaluate the overall heat transfer coefficient for composite walls.

CO2. Analyze the thermal conductivities of insulating powder, insulating material and metal rod as well as heat transfer in pin-fins.

CO3. Evaluate the heat transfer coefficients in forced and natural convection heat transfer.

CO4. Evaluate the overall heat transfer coefficient of parallel and counter-flow heat exchangers using LMTD method.

CO5. Evaluate the surface emissivity and Stefan boltzman constant by comparing with the theoretical values.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Evaluate	the overall heat transfer coefficient	of composite walls.		L5
CO2	Analyze	the thermal conductivities of insulating powder, insulating material and metal rod as well as heat transfer	in pin-fins.		L4
CO3	Evaluate	the heat transfer coefficients and compare the theoretical values	in forced and natural convection		L5
CO4	Evaluate	the overall heat transfer coefficient	of parallel flow and counter-flow heat exchangers using LMTD method		L5
CO5	Evaluate	the surface emissivity and Stefan boltzman's constant by comparing with the theoretical values.			L5

List of Experiments:

1. Heat transfer coefficient in forced convection.(CO3)
2. Heat transfer coefficient in natural convection (CO3)
3. Thermal conductivity of insulating powder material through Concentric Sphere apparatus.(CO2)
4. Thermal conductivity of insulating material through lagged pipe apparatus (CO2)
5. Overall heat transfer co-efficient through Composite Slab Apparatus (CO1)
6. Thermal Conductivity of metal (conductor). (CO2)
7. Heat transfer in pin-fin (CO2)
8. Experiment on Parallel and counter flow heat exchanger. (CO4)
9. Emissivity of a gray body through Emissivity apparatus. (CO5)
10. Experiment on Stefan Boltzman Apparatus. (CO5)

Articulation matrix

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Heat Transfer Lab	CO1	**3**	**3**	**3**										**2**	**1**
	CO2	**3**	**3**	**3**										**3**	**1**
	CO3	**3**	**3**	**3**										**3**	**1**
	CO4	**3**	**3**	**3**										**3**	**1**
	CO5	**3**	**3**	**3**										**2**	**1**

Correlation matrix

CO	COs		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	Evaluate	**5**	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
2	Analyze	**4**	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	Evaluate	**5**	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
4	Evaluate	**5**	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	Evaluate	**5**	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3

Justification Statements:

CO1: Evaluate the overall heat transfer coefficient for composite walls.

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO1 Action verb is greater level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is greater level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO2: Analyze the thermal conductivities of insulating powder, insulating material and metal rod as well as heat transfer in pin-fins.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Evaluate the heat transfer coefficients in forced and natural convection and compare the theoretical values

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO4: Evaluate the overall heat transfer coefficient of parallel-flow and counter-flow heat exchangers using LMTD method

Action Verb: Evaluate (L5)
PO1 Verb: **Apply (L3)**
CO4 Action verb is greater level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4 Action verb is greater level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Evaluate the surface emissivity and Stefan boltzman's constant by comparing with the theoretical values.

Action Verb: Evaluate (L5)
PO1 Verb: **Apply (L3)**
CO5 Action verb is greater level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is greater level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : III **Semester** : II **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20APC0330	Machine Tools – 2 Lab	0	0	3	1.5

CO Statements: After studying the course, student will be able to:

CO1. Analyze the drilling machine operations like drilling, counter boring, counter sinking, tapping and so on.
CO2. Apply the slotting operations to produce internal and external slots on the component.
CO3. Analyze the functioning of tool and cutter grinder to produce single point cutting tool.
CO4. Analyze the processes parameters of surface grinding machine to obtain surface finish of the product.
CO5. Apply the planning operations to produce plane surface of the specimen.

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	Analyze	the drilling machine operations		like drilling, counter boring, counter sinking, tapping and so on	L4
CO2	Apply	the slotting operations		to produce internal and external slots on the component	L3
CO3	Analyze	the functioning of tool and cutter grinder		to produce single point cutting tool	L4
CO4	Analyze	the processes parameters of surface grinding machine		to obtain surface finish of the product	L4
CO5	Apply	the planning operations		to produce plane surface of the specimen	L3

List of Experiments:

1. Job on counter boring on drilling machine. **(CO1)**
2. Job on counter sinking on drilling machine. **(CO1)**
3. Job on drilling operations. **(CO1)**
4. Job on tapping on drilling machine. **(CO1)**
5. Preparation of key ways using slotting machine. **(CO2)**
6. Job on internal and external surfaces using slotting machine. **(CO2)**
7. Study of types of abrasive tools in tools and cutter grinder. **(CO3)**
8. Preparation of single point cutting tool in tools and cutter grinder. **(CO3)**
9. Process parameters influence on surface finish in surface grinding. **(CO4)**
10. Job on planner machine. **(CO5)**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Machine Tools – 2 Lab	CO1	**3**	**3**	**3**						**3**				**3**	**3**
	CO2	**3**	**3**	**3**						**3**				**3**	**3**
	CO3	**3**	**3**	**3**						**3**				**3**	**3**
	CO4	**3**	**3**	**3**						**3**				**3**	**3**
	CO5	**3**	**3**	**3**						**3**				**3**	**3**

Correlation matrix

CO	COs		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	Analyze	L4	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L3) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3
2	Apply	L3	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L3) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3
3	Analyze	L4	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L3) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3
4	Analyze	L4	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L3) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3
5	Apply	L3	PO1 PO2 PO3 PO5 PO9	Apply (L3) Identify (L3) Develop (L3) Select (L1) Thumb Rule	3 3 3 3 3

Justification Statements:

CO1: Analyze the drilling, counter boring, counter sinking, and tapping operations on the drilling machine.

Action Verb: Analyze (L4)

PO1 Verb: **Analyze (L4)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Select (L1)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule
CO1 co-relates highly with PO9. Therefore, the correlation is high (3)

CO2: Apply the slotting operations to produce internal and external slots on the component.
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

CO3: Analyze the functioning of tool and cutter grinder to produce single point cutting tool
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO3 co-relates highly with PO9. Therefore, the correlation is high (3)

CO4: Analyze the processes parameters of surface grinding machine to obtain surface finish of the product
PO1 Verb: **Analyze (L4)**
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO4 co-relates highly with PO9. Therefore, the correlation is high (3)

CO5: Apply the planning operations to produce plane surface of the specimen.
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO5 Verb: **Select (L1)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO9 Verb: Thumb Rule
CO5 co-relates highly with PO9. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : III **Semester** : II **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20ASC0303	Crystal structure Analysis Lab	1	0	2	2

CO Statements: After studying the course, student will be able to:

CO1. Analyze the microstructure of different steels through metallographic procedure under optical microscope

CO2. Analyze the microstructure of different aluminum alloys through metallographic procedure under optical microscope

CO3. Evaluate the average grain size for crystalline materials using line intercepts method.

CO4. Analyze the refined grain size of Al7075-T6 alloy after heat-treatment under optical microscope

CO5. Analyze the refined grain size of heat-treated steel under optical microscope

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the microstructure of different steels	through metallographic procedure under optical microscope		L4
CO2	Analyze	the microstructure of different aluminum alloys	through metallographic procedure under optical microscope		L4
CO3	Evaluate	the average grain size for crystalline materials.	using line intercepts method		L5
CO4	Analyze	the refined grain size of Al7075-T6 alloy after heat-treatment	under optical microscope		L4
CO5	Analyze	the refined grain size of heat-treated steel	under optical microscope		L4

List of Experiments:

1. Preparation and study the microstructure of Oil Hardened Non-Shrinkage (OHNS) Die-steel. **(CO1)**
2. Preparation and study the microstructure of EN-32 steels. **(CO1)**
3. Study the microstructure of stainless steel. **(CO1)**
4. Study the microstructure of Al7075-T6, Al-2XXX series alloys. **(CO2)**
5. Determination of average grain size using line intercepts method for crystalline materials. **(CO3)**
6. Determine the refined grain size of Al7075-T6 alloy after heat-treatment. **(CO4)**
7. Determine the refined grain size of heat-treated steel. **(CO5)**

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Crystal structure Analysis Lab	CO1	**3**		**3**		**3**				**3**				**3**	**3**
	CO2	**3**		**3**		**3**				**3**				**3**	**3**
	CO3	**3**	**3**	**3**	**3**	**3**				**3**				**3**	**3**
	CO4	**3**	**3**	**3**	**3**	**3**				**3**				**3**	**3**
	CO5	**3**	**3**	**3**	**3**	**3**				**3**				**3**	**3**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation matrix

CO	COs		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	**Analyze**	**L4**	PO1 PO3 PO5 PO9	Apply (L3) Develop (L3) Apply (L3) Thumb Rule	3 3 3 3
2	**Analyze**	**L4**	PO1 PO3 PO5 PO9	Apply (L3) Develop (L3) Apply (L3) Thumb Rule	3 3 3 3
3	**Evaluate**	**L5**	PO1 PO2 PO3 PO4 PO5 PO9	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Apply (L3) Thumb Rule	3 3 3 3 3 3
4	**Analyze**	**L4**	PO1 PO2 PO3 PO4 PO5 PO9	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Apply (L3) Thumb Rule	3 3 3 3 3 3
5	**Analyze**	**L4**	PO1 PO2 PO3 PO4 PO5 PO9	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Apply (L3) Thumb Rule	3 3 3 3 3 3

Justification Statements:
CO1: Analyze the microstructure of different steels through metallographic procedure under optical microscope.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same (higher) level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is same (higher) level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO1 Action verb is same (higher) level as PO5 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
CO1 co-relates highly with PO9. Therefore, the correlation is high (3)

CO2: **Analyze** the microstructure of different aluminum alloys through metallographic procedure under optical microscope
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same (higher) level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same (higher) level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2 Action verb is same (higher) level as PO5 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

CO3: Evaluate the average grain size for crystalline materials using line intercepts method.

Action Verb: Evaluate (L5)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same (higher) level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same (higher) level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same (higher) level as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO2 Action verb is same (higher) level as PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2 Action verb is same (higher) level as PO5 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

CO4: Analyze the refined grain size of Al7075-T6 alloy after heat-treatment under optical microscope
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same (higher) level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same (higher) level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same (higher) level as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO2 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2 Action verb is same (higher) level as PO5 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

CO5: Analyze the refined grain size of heat-treated steel under optical microscope**.**
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same (higher) level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO2 Action verb is same (higher) level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO2 Action verb is same (higher) level as PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2 Action verb is same (higher) level as PO5 verb. Therefore, the correlation is high (3)
PO9 Verb: **Thumb Rule**
CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year : III **Semester** : II **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
20AMC9901	BIOLOGY FOR ENGINEERS	3	0	0	0

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Understand the structure of cells and basics in living organisms
CO2. Understand the importance of various biomolecules and enzymes in living organisms
CO3. Analyze the functioning of physiology in respiratory system and digestive system.
CO4. Understand the DNA technology and gen cloning in living organisms.
CO5. Apply the biological principles in different technologies for the production of medicines and pharmaceuticals.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	**Understand**	the structure of cells and basics in living organisms			L2
2	**Understand**	the importance of various biomolecules and enzymes		in living organisms	L2
3	**Analyze**	the functioning of physiology		in respiratory system and digestive system	L4
4	**Understand**	the DNA technology and gen cloning		in living organisms	L2
5	**Apply**	the biological principles in different technologies	for the production of medicines and pharmaceuticals		L3

Unit I: Introduction to Basic Biology

Evolution: Different patterns of evolution, Darwin's theory of evolution, Cell as Basic unit of life, cell theory, Cell shapes, Cell structure, Cell cycle. Chromosomes. Prokaryotic and eukaryotic Cell. Plant Cell, Animal Cell, Plant tissues and Animal tissues, Brief introduction to five kingdoms of classification, Tissue Engineering.

Unit II: Introduction to Biomolecules

Carbohydrates, lipids, proteins, Vitamins and minerals, Nucleic acids (DNA and RNA) and their types. Enzymes, Enzyme application in Industry. Large scale production of enzymes by Fermentation.

Unit III: Human Physiology

Digestive system, Respiratory system, (aerobic and anaerobic Respiration). Respiratory organs, respiratory cycle, Central Nerves System and Excretory system.

Unit IV: Introduction to Molecular Biology and recombinant DNA Technology

Prokaryotic gene and Eukaryotic gene structure. DNA replication, Transcription and Translation. DNA technology. Introduction to gene cloning.

Unit V: Application of Biology

Brief introduction to industrial Production of Enzymes, Pharmaceutical and therapeutic Proteins, Vaccines and antibodies. Basics of biosensors, Properties and Classification of virus, Immune response to virus, Definitions-Pandemic, Epidemic and outbreak, pandemic alert system ranges, Prevention of pandemic disease and pandemic preparation.

Text books:

1. P.K.Gupta, Cell and Molecular Biology, 5th Edition, Rastogi Publications
2. U. Satyanarayana. Biotechnology, Books & Allied Ltd 2017

Reference Books:

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A Global Approach", Pearson Education Ltd, 2018.
2. T Johnson, Biology for Engineers, CRC press, 2011

3. J.M. Walker and E.B. Gingold, Molecular Biology and Biotechnology 2nd ed. Panima Publications. PP 434.
4. David Hames, Instant Notes in Biochemistry –2016
5. Phil Tunner, A. Mctennan, A. Bates & M. White, Instant Notes – Molecular Biology – 2014.
6. Richard Dawkins, River Out of Eden: A Darwinian View of Life.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
BIOLOGY FOR ENGINEERS	CO1						2								
	CO2						2						2		
	CO3						2								
	CO4						2								
	CO5						2						2		

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	**10**	20	2	**Understand**	**L2**	PO6	Thumb Rule	2
2	**10**	20	2	**Understand**	**L2**	PO6	Thumb Rule	2
3	**9**	18	1	**Analyze**	**L4**	PO6	Thumb Rule	2
4	**9**	18	1	**Understand**	**L2**	PO6	Thumb Rule	2
5	**10**	20	2	**Apply**	**L3**	PO6	Thumb Rule	2
	48							

Justification Statement:

CO1: Understand the structure of cells and basics in living organisms

Action Verb: Understand (L2)

Using Thumb rule, CO1 correlates PO6 as moderate (2).

CO2: Understand the importance of various biomolecules and enzymes in living organisms

Action Verb: Understand (L2)

Using Thumb rule, CO2 correlates PO6 as moderate (2).

CO3: Analyze the functioning of physiology in respiratory system and digestive system.

Action Verb: Analyze (L4)

Using Thumb rule, CO3 correlates PO6 as moderate (2).

CO4: Understand the DNA technology and gen cloning in living organisms.

Action Verb: Understand (L2)

Using Thumb rule, CO4 correlates PO6 as moderate (2).

CO5: Apply the biological principles in different technologies for the production of medicines and pharmaceuticals**.**

Action Verb: Apply (L3)

Using Thumb rule, CO4 correlates PO6 as moderate (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Semester VII (Fourth year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P	C	CIE	SEE	Total
1	Professional Elective courses	20APE0307	Alternative Fuels and Emission Control in Automotives	3	-	-	3	30	70	100
		20APE0311	Refrigeration & Air Conditioning							
		20APE0309	Computational Fluid Dynamics							
2	Professional Elective courses	20APE0310	Digital Manufacturing and Industry 4.0	3	-	-	3	30	70	100
		20APC0323	Operations Research							
		20APE0312	Production and Operations Management							
3	Professional Elective courses	20APE0313	Quality & Reliability Engineering	3	-	-	3	30	70	100
		20APE0314	Power Plant Engineering							
		20APE0315	Fuel cell Technologies							
4	Professional Elective courses	20APE0317	Electrical & Hybrid Vehicles	3	-	-	3	30	70	100
		20APE0301	Automobile Engineering							
		20APE0316	IC Engines & Gas Turbines							
5	Open Elective Courses/ Job oriented elective (CBCS)	20APE0119	Air Pollution and Control	3	-	-	3	30	70	100
		20AHSMB04	Intellectual Property Rights							
		20APE0117	Ground Improvement Techniques							
6	*Humanities and Social Science Elective	20AOE9901	English For Research Paper Writing	3	-	-	3	30	70	100
		20AHE9903	Professional Communication							
		20AHE9913	Effective Public Speaking Skills							
7	Skill advanced course/ soft skill course*	20AHE9902	Principles of Effective Public Speaking	1	-	2	2	100	-	100
Industrial/Research Internship 2 Months (Mandatory) after third year (to be evaluated during VII semester				-	-	-	3	100	-	100
			Total credits				**23**	**380**	**420**	**800**

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0307	Alternative Fuels and Emission Control in Automotives	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand various alcohol and gaseous fuels and their use in SI and CI engines
CO2. Analyze various vegetable oils and synthetic oils and their use in CI engines
CO3. Analyze the formation of various emissions from SI engine and their control techniques
CO4. Analyze the formation of various emissions from CI engine and their control techniques
CO5. Analyze various emission measuring instruments and test procedures for different standards.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	various alcohol and gaseous fuels and their use	in SI and CI engines		L2
CO2	Analyze	various vegetable and synthetic oils and their use	in CI engines		L4
CO3	Analyze	the formation of various emissions	from SI engine and their control techniques		L4
CO4	Analyze	the formation of various emissions	CI engine and their control techniques		L4
CO5	Analyze	various emission measuring instruments and test procedures	for different standards.		L4

Syllabus

Unit I:

Alcohol Fuels: Introduction to alternative fuels, important qualities of SI and CI engine fuels, rating of fuels, properties of alcohols -methanol, ethanol, alcohol-gasoline blends, reformulated gasoline for SI engines, alcohols for CI engines, surface ignition alcohol CI engine, spark-assisted Diesel engine, performance and emission characteristics of alcohol fuels.

Gaseous Fuels: Properties of hydrogen, storage methods, safety precautions, natural gas - advantages and disadvantages, biogas production and its properties, LPG and CNG - properties, advantages and disadvantages, LPG and CNG in SI and CI engines, performance and emissions characteristics of gaseous fuels.

UNIT- II

Vegetable Oils: Various vegetable oils for diesel engines, properties of vegetable oils, problems in using vegetable oils in diesel engines, methods to improve engine performance using vegetable oils – preheating, esterification, blending with good secondary fuels, performance and emission characteristics of biodiesel fuelled diesel engines.

Synthetic Oils: Introduction - di-methyl ether, di-ethyl ether, Biomass to liquid (BTL), Gas to liquid (GTL), Coal to liquid (CTL), Eco-friendly plastic fuel (EPF), Wood pyrolysis oil (WPO), Tyre pyrolysis oil (TPO) – Properties, applications, advantages and disadvantages in CI engines.

UNIT- III

Emissions From SI Engines and their Control: Emission formation in SI engines (CO, HC and NOx), effect of design and operating variables on emission formation, control techniques – thermal reactor, exhaust gas recirculation, catalytic convertors- types (two way and three way) and applications, charcoal canister control for evaporative emission, positive crankcase ventilation for blow by gas control.

UNIT- IV

Emissions from CI engines and their Control: Emission formation in CI engines (HC, CO, NOx, aldehydes, smoke and particulates), effect of design and operating variables on emission formation, control techniques –

exhaust gas recirculation, selective catalytic reduction, Diesel oxidation catalytic convertor, Diesel particulate filter, NOx versus particulates – trade off.

UNIT- V

Emission Measuring Instruments and Test Procedures: Principle of operation of emission measuring instruments used in SI and CI engines, measurement of CO2 and CO by Non – dispersive infrared detector (NDIR) - hydrocarbon emission by flame ionization detector (FID), Chemiluminescent analyzer for NOx, spot sampling and continuous indication type smoke meters (Bosch and Hartridge smoke meters), Euro and Bharat norms.

Text Books:

1. S.S. Thipse, *Alternative Fuels: Concepts, Technologies and Developments*, 1st Edition, Jaico Publishing House, 2010
2. V. Ganesan, *Internal combustion engines*, 4th Edition, Tata McGraw Hill Education, 2012

Reference Books:

1. Michael F. Hordeski, *Alternative Fuels: The Future of Hydrogen*, 2nd Edition, The Fairmont Press, 2008.
2. R.K. Rajput, *A textbook of Internal Combustion Engines*, 3rd Edition, Laxmi Publications, 2016.

Web Resources:

1. https://en.wikipedia.org/wiki/European_emission_standards
2. https://en.wikipedia.org/wiki/Bharat_stage_emission_standards

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Alternative Fuels and Emission Control in Automotives Calculus	CO1	2	3					3						3	1
	CO2	3	3		3			3						3	1
	CO3	3	3		3			3						3	1
	CO4	3	3		3			3						3	2
	CO5	3	3		3			3						3	1

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Understand	L2	PO1 PO2 PO7	Apply (L3) Review (L2) Thumb Rule	2 3 3
2	-	-	-	Analyze	L4	PO1 PO2 PO4 PO7	Apply (L3) Review (L2) Analyze (L4) Thumb Rule	3 3 3 3
3	-	-	-	Analyze	L4	PO1 PO2 PO4 PO7	Apply (L3) Review (L2) Analyze (L4) Thumb Rule	3 3 3 3
4	-	-	-	Analyze	L4	PO1 PO2 PO4 PO7	Apply (L3) Review (L2) Analyze (L4) Thumb Rule	3 3 3 3
5	-	-	-	Analyze	L4	PO1 PO2 PO4 PO7	Apply (L3) Review (L2) Analyze (L4) Thumb Rule	3 3 3 3

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements

CO1: Understand various alcohol and gaseous fuels and their use in SI and CI engines
Action Verb: **Understand** (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than as PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO1 Co-relates highly with PO7. Therefore, the correlation is high (3)

CO2: Analyze various vegetable and synthetic oils and their use in CI engines
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO2 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO2 Co-relates highly with PO7. Therefore, the correlation is high (3)

CO3: Analyze the formation of various emissions from SI engine and control techniques
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO3 Co-relates highly with PO7. Therefore, the correlation is high (3)

CO4: Analyze the formation of various emissions from CI engine and control techniques
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO4 Co-relates highly with PO7. Therefore, the correlation is high (3)

CO5: Analyze various emission measuring instruments, test procedures and emission norms for different standards.
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO5 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO7 Verb: **Thumb Rule**
CO5 Co-relates highly with PO7. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0311	Refrigeration & Air Conditioning	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Apply the principles of VCR for heating and cooling in Refrigeration & Air-conditioning
CO2. Analyze the gas cycle refrigeration and environmental effects of CFC refrigerants
CO3. Understand the working of various components of refrigeration system
CO4. Analyze the Vapour Absorption Refrigeration systems and few other Refrigeration systems
CO5. Evaluate the psychrometric properties based-on psychrometric charts for industrial air condition.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Bloom s level
CO1	Apply	the principles of VCR	for heating and cooling in Refrigeration & Airconditioning		3
CO2	Analyze	the gas cycle refrigeration and environmental effects	of CFC refrigerants		4
CO3	Understand	the working of various components of	refrigeration system		2
CO4	Analyze	the Vapour Absorption Refrigeration systems and few other Refrigeration systems			4
CO5	Evaluate	the psychrometric properties	based-on psychrometric charts for industrial air condition		5

Unit I:

Introduction – Thermal principles, applications of Refrigeration & Airconditioning, methods of refrigeration. **Vapor compression refrigeration (VCR) system-** Carnot refrigeration cycle, Wet compression & dry compression, Standard vapour-compression cycle, P-H, & T-S diagrams, effect of sub-cooling and super-heating, actual vapour-compression cycle.

Unit II:

Gas cycle refrigeration – Limitations of Carnot cycle, Bell Coleman cycle, analysis of simple aircraft refrigeration cycle.

Refrigerants: Classification of refrigerants, designation of refrigerants, properties of an ideal refrigerant, Environmental effects of CFC refrigerants, substitutes for CFC refrigerants

Unit – III

Components: Compressors – General classification – comparison, advantages and disadvantages, Evaporators – classification – working, Condensers – classification – working, Expansion devices- types –working.

Unit – IV

Vapour Absorption Refrigeration system: Introduction – Basic absorption refrigeration system, actual Ammonia absorption refrigeration system, Lithium-Bromide absorption refrigeration system, three fluid absorption refrigeration system, comparison of compression and absorption refrigeration systems

Other Refrigeration systems: Working principles of Steam jet refrigeration system, Thermoelectric refrigerator, Vortex & Pulse tube refrigerators (only theoretical concepts).

UNIT-V

Air conditioning: Psychrometric properties, Psychrometric chart, basic processes in conditioning of air, bypass factor, simple air conditioning system, human comfort and effective temperature, industrial air conditioning.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Text Books:

1. C.P.Arora , *Refrigeration and Air Conditioning*, TMH Publishers, New Delhi.
2. Barron R.F., *Cryogenic Systems*, Oxford University Press, New York.

Reference Books:

1 Dossat, *Principles of Refrigeration*, Pearson Education, New Delhi.
2 Manohar Prasad, *Refrigeration and Air Conditioning*, NAI Publishers, New Delhi.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Refrigeration & Air Conditioning	CO1	3	3			3								2	2
	CO2	3				3		3						2	2
	CO3	2				2								2	2
	CO4	3				3								2	2
	CO5	3	3				3	3						2	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	12/69	17	2	Apply	L3	PO1 PO2 PO5	Apply (L3) Identify (L3) Apply (L3)	3 3 3
2	15/69	22	3	Analyze	L4	PO1 PO5 PO7	Apply (L3) Apply (L3) Thumb Rule	3 3 3
3	12/69	17	2	Understand	L2	PO1 PO5	Identify (L3) Apply (L3)	2 2
4	15/69	22	3	Analyze	L4	PO1 PO5	Apply (L3) Apply (L3)	3 3
5	15/69	22	3	Evaluate	L5	PO1 PO2 PO6 PO7	Apply (L3) Analyze (L4) Thumb Rule Thumb Rule	3 3 3 3

Justification Statements

CO1. Apply the principles of VCR for heating and cooling in Refrigeration & Air-conditioning
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO1 Action verb is same level of PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO1 Action verb is same level of PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Apply (L3)
CO1 Action verb is same level of PO5 verb. Therefore, the correlation is high (3)
CO2. Analyze the gas cycle refrigeration and environmental effects of CFC refrigerants
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO2 Action verb is greater than level of PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: Apply (L3)
CO2 Action verb is greater than level of PO5 verb. Therefore, the correlation is high (3)
PO7 Verb: Thumb Rule (L3)
CO2 co-relates greater with PO7. Therefore, the correlation is high (3)

CO3. Understand the working components of refrigeration system
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO3 Action verb is less than level of PO1 verb by one level. Therefore, the correlation is Medium (2)
PO5 Verb: Apply (L3)
CO3 Action verb is less than level of PO5 verb by one level. Therefore, the correlation is Medium (2)

CO4. Analyze the Vapour Absorption Refrigeration systems and few other Refrigeration systems
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO4 Action verb is greater than level of PO1 verb. Therefore, the correlation is high (3)
PO5 Verb: Apply (L3)
CO4 Action verb is greater than level of PO5 verb. Therefore, the correlation is high (3)
CO5. Evaluate psychrometric properties based-on psychrometric charts for industrial air condition
Action Verb: Evaluate (L5)
PO1 Verb: Apply (L3)
CO5 Action verb is greater than level of PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Analyze (L4)
CO5 Action verb is greater than level of PO2 verb. Therefore, the correlation is high (3)
PO6 Verb: Thumb Rule (L3)
CO5 Action verb is greater than level as PO6 verb. Therefore, the correlation is high (3)
PO7 Verb: Thumb Rule (L3)
CO5 co-relates greater with PO7. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0309	Computational Fluid Dynamics	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze the applied numerical methods for solving algebraic equations using different methods.
CO2. Analyze the conduction and convection problems using applications of Finite Difference Method.
CO3. Analyze the hyperbolic and elliptic equations and fundamentals in fluid flow modeling.
CO4. Analyze the flow physics and mathematical properties of governing Navier-Stokes equations.
CO5. Apply the various techniques to solve fluid dynamics problems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the applied numerical methods	for solving algebraic equations in different methods		L4
CO2	Analyze	the conduction and convection problems	using finite difference method applications		L4
CO3	Analyze	the hyperbolic and elliptic equations and understand fundamentals	in fluid flow modeling		L4
CO4	Analyze	the flow physics and mathematical properties	of governing Navier-Stokes equations		L4
CO5	Apply	the various techniques	to solve fluid dynamics problems		L3

Unit I:
Applied Numerical Methods: Solution of a system of simultaneous Linear Algebraic Equations, iterative schemes of Matrix Inversion, Direct Methods for Matrix inversion, and Direct Methods for banded matrices.

Unit II:
Finite Difference Applications in Heat conduction and Convention: Heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure

Unit III:
Fluid flow modeling: Introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods, Errors and stability analysis, introduction, first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modeling, conservative property, the upwind scheme.

Unit IV:
Governing Equations of Fluid Flow and Heat Transfer: Introduction, conservation of mass Newton's second law of motion, expanded forms of Navier-stokes equations, conservation of energy principle, and special forms of the Navier-stokes equations.

Unit V:
Simple CFD Techniques, viscous flows conservation form space marching, relocation techniques, viscous flows, conservation from space marching relovation techniques, artificial viscosity, the alternating direction implicit techniques, pressure correction technique. Computer graphic techniques used in CFD, Quasi one-dimensional flow

through a nozzle, turbulence models, standard and high Reynolds number models and their applications

Text Books:

1. John.Anderson, Computational Fluid Dyanamics -The basics with applications, Mc Graw Hil Publishers, New York
2. Suhas V, Patankar Hema, Numerical Heat Transfer and Fluid Flow, Shava Publishers and Mc Graw Hill, New Delhi

Reference Books:

1. Muralidharan, Computational Fluid Flow and Heat Transfer, Narosa Publications, New Delhi
2. Tapan K. Sengupta, Fundamentals of Computational Fluid Dynamics, Universities Press, New Delhi

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Computational Fluid Dynamics	CO1	3	3	3	3									2	2
	CO2	3	3	3	3									2	2
	CO3	3	3	3	3									2	2
	CO4	3	3	3	3									2	2
	CO5	3	3	3	3									2	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Analyze	L4	PO1 PO2 PO3 PO4	Apply (L3) Review (L2) Develop (L3) Analyze (L4)	3 3 3 3
2	-	-	-	Analyze	L4	PO1 PO2 PO3 PO4	Apply (L3) Review (L2) Develop (L3) Analyze (L4)	3 3 3 3
3	-	-	-	Analyze	L4	PO1 PO2 PO3 PO4	Apply (L3) Review (L2) Develop (L3) Analyze (L4)	3 3 3 3
4	-	-	-	Analyze	L4	PO1 PO2 PO3 PO4	Apply (L3) Review (L2) Develop (L3) Analyze (L4)	3 3 3 3
5	-	-	-	Apply	L3	PO1 PO2 PO3 PO4	Apply (L3) Review (L2) Develop (L3) Analyze (L4)	3 3 3 3

Justification Statements

CO1: Analyze the applied numerical methods for solving algebraic equations using different methods.
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO1 Action verb is same level (greater) as PO4 verb. Therefore, the correlation is high (3)

CO2: Analyze the conduction and convection problems using applications of Finite Difference Method
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO2 Action verb is same level (greater) as PO4 verb. Therefore, the correlation is high (3)

CO3: Analyze the hyperbolic and elliptic equations and fundamentals in fluid flow modelling
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO3 Action verb is same level (greater) as PO4 verb. Therefore, the correlation is high (3)

CO4: Analyze the flow physics and mathematical properties of governing Navier-Stokes equations
Action Verb: **Analyze** (L4)
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)
PO1 Verb: **Develop (L3)**
CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO4 Action verb is same level (greater) as PO4 verb. Therefore, the correlation is high (3)

CO5: Apply the various techniques to solve fluid dynamics problems.
Action Verb: **Apply (L3)**
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO1 Verb: **Develop (L3)**
CO5 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO5 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0310	Digital Manufacturing and Industry 4.0	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the concepts of Digital Manufacturing and Industry 4.0 used in various industries.
CO2. Analyze the process of additive manufacturing, virtual prototyping and reverse engineering.
CO3. Apply the knowledge of digital manufacturing technologies on product life cycle and its management.
CO4. Analyze the concepts of Industry 4.0 and allied technologies used in various industries.
CO5. Apply the IoT techniques for smart manufacturing in various sectors of Industry.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	**Understand**	the concepts of Digital Manufacturing and Industry 4.0.		used in various industries.	**L2**
CO2	**Analyze**	the process of additive manufacturing, virtual prototyping and reverse engineering.			**L4**
CO3	**Apply**	the knowledge of digital manufacturing technologies		on product life cycle and its management.	**L3**
CO4	**Analyze**	the concepts of Industry 4.0 and allied technologies		used in various industries.	**L4**
CO5	**Apply**	the IoT techniques for smart manufacturing		in various sectors of Industry	**L3**

Unit I:

Introduction to digital manufacturing: Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System, Impact on manufacturing careers, Advantages of digital manufacturing and design, Information sharing in the digital thread, Digital twins and Files format (STL, AMF, 3MF), Multiple organizations in the manufacturing process. Introduction of Industry 4.0, case study on car manufacturing by Bosch.

UNIT-II

Additive Manufacturing Processes: Additive Manufacturing processes – Engineering polymers, metals and ceramics. Stereolithography, Selective Laser Sintering, Fused Deposition Modeling, Layered object manufacturing. Electronic Materials, Bio-printing, Food Printing. Preprocessing and Post processing in AM.

Virtual Prototyping & Reverse Engineering: Virtual Prototyping, Applications, Virtual Prototyping and Virtual Manufacturing. Reverse Engineering, Application of Reverse Engineering in Digital Manufacturing. Self-Learning of Manufacturing System and Intelligent Manufacturing System

UNIT-III:

Key Technology of Digital Manufacturing: Various Digital Technologies in Product Lifecycle, Digital Equipment and Digital Processing Technology, Technology of Digital Maintenance and Diagnosis.

UNIT-IV:

Industry 4.0: Various Industrial Revolutions, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, automation, data exchanges, cloud, cyber-physical systems, mobile robots, Big Data, deep machine learning, Production Systems, IoT, Challenges of implementing Industry 4.0, Impact of implementing Industry 4.0 in various sectors, Applications domains and the way forward.

UNIT –V:

Internet of Things (IoT) - IoT design methods, physical devices and enabling technologies, Industrial Internet of Things (IIoT), Smart Manufacturing.

Text Books:

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited,2012.
2. Brent Stucker, David Rosen, and Ian Gibson, Additive Manufacturing Technologies, ISBN 978-1-4419- 1120-9, Springer, 2010.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Digital Manufacturing and Industry 4.0	CO1	2	3	2										2	3
	CO2	3	3	3	3	3								3	3
	CO3	3	3	3	2	3								3	3
	CO4	3	3	3	3	3								3	3
	CO5	3	3	3	2	3								3	3

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Understand	L2	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	2 3 2
2	-	-	-	Analyze	L4	PO1 PO2 PO3 PO4 PO5	Apply (L3) Review (L2) Develop (L3) Analyze (L4) Apply (L3)	3 3 3 3 3
3	-	-	-	Apply	L3	PO1 PO2 PO3 PO4 PO5	Apply (L3) Review (L2) Develop (L3) Analyze (L4) Apply (L3)	3 3 3 2 3
4	-	-	-	Analyze	L4	PO1 PO2 PO3 PO4 PO5	Apply (L3) Review (L2) Develop (L3) Analyze (L4) Apply (L3)	3 3 3 3 3
5	-	-	-	Apply	L3	PO1 PO2 PO3 PO4 PO5	Apply (L3) Review (L2) Develop (L3) Analyze (L4) Apply (L3)	3 3 3 2 3

Justification Statements:

CO1: **Understand** the concepts of Digital Manufacturing and Industry 4.0 used in various industries.
Action Verb: **Understand (L2)**
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Review (L2)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)

CO2: **Analyze** the process of additive manufacturing, virtual prototyping and reverse engineering.
Action Verb: **Analyze (L4)**
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO2 Action verb is same level (Greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2 Action verb is same level (Greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO2 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)

CO3: **Apply** the knowledge of digital manufacturing technologies on product life cycle and its management.
Action Verb: **Apply (L3)**
PO1 Verb: **Apply (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO3 Action verb is same level (Greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO3 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO5 Verb: **Apply (L3)**
CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO4: **Analyze** the concepts of Industry 4.0 and allied technologies used in various industries.
Action Verb: **Analyze (L4)**
PO1 Verb: **Apply (L3)**
CO4 Action verb is same level (Greater) as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO4 Action verb is same level (Greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level (Greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO4 Action verb is same level (Greater) as PO5 verb. Therefore, the correlation is high (3)

CO5: **Analyze** the IoT techniques for smart manufacturing in various sectors of Industry.
Action Verb: **Apply (L3)**
PO1 Verb: **Apply (L3)**
CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Review (L2)**
CO5 Action verb is same level (Greater) as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO5 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: **Analyze (L4)**
CO5 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO5 Verb: **Apply (L3)**
CO5 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME/CE/CIC**

Subject Code	Subject Name	L	T	P	Credits
20APC0323	Operations Research	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Apply the knowledge of operations research in solving linear programming problems

CO2. Apply the mathematical procedure for solving the transportation and assignment models related to real world problems

CO3. Evaluate the decisions to replace the items that deteriorate with time and to solve the game theory models

CO4. Analyze the available resources based on the priority in solving the sequencing problems

CO5. Analyze the simulation tools to develop the queuing and other relevant models

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the knowledge of operations		research in solving linear programming problems	L3
CO2	Apply	the mathematical procedure for solving the transportation and assignment models		related to real world problems	L3
CO3	Evaluate	the decisions to replace the items that deteriorates with time and	to solve the game theory models		L5
CO4	Analyze	the available resources based on the priority		in solving sequencing problems	L4
CO5	Analyze	the simulation tools to develop the queuing and other relevant models			L3

Unit I:

Introduction*:* Definition, Basic OR models & Applications of OR

Linear Programming: Introduction, Formulation of Linear Programming (L P) problems, Graphical method of solving LP problem, simplex method, Artificial variable Technique, Degeneracy in L PP's, Duality, unbounded, infeasible and multiple optimum solution.

Unit II:

Transportation Models: Finding an initial feasible solution – North West Corner method, Least cost method, Vogel's Approximation Method; Finding the optimal solution using MODI method, Special cases in Transportation problems – Unbalanced Transportation problem, Degeneracy in transportation problem, multiple optimal solutions, prohibited routes.

Assignment problems: Hungarian method of Assignment problem, maximization in Assignment problem, unbalanced Assignment problem, prohibited Assignments, multiple optimum solutions

Unit III:

Game Theory: Introduction, Two-person zero sum games, Maxi-min and Mini-max principles, Principle of dominance, solution of mixed strategy problems, Graphical method for 2 x n and m x 2 games

Replacement Models: Introduction, replacement of items that deteriorate gradually ignoring change in money value, replacement of items that deteriorate considering change in money value with time, replacement of items that fail suddenly – Individual replacement policy, Group replacement policy

Unit IV:

Sequencing Models: Introduction, General Assumptions, Priority rules for job sequencing (Single machine Scheduling), Measures of Performance- Average Completion Time, Average Lateness; Processing n jobs thorough 2 machines, Processing n jobs through 3machines, Processing n jobs

thorough m machines, Processing 2 jobs through m machines

Unit V:

Queuing Theory: Introduction, Single Channel – Poisson arrivals – Exponential service times with infinite population & finite population, Multi-channel – Poisson arrivals – Exponential service times with infinite population

Simulation: Introduction, Definition, Types of Simulation, Monte-Carlo Simulation, Pseudo Random Numbers, Mid-square Method of Generating Random Numbers, Application of simulation to inventory control and queuing problems.

Text Books:

1. S.D. Sarma, Operations Research, Kedarnnath, Ramnath& Co.,Meerut
2. N.D. Vohra, Quantitative Techniques in Management, TMH Publishers, New Delhi

Reference Books:

1. V.K. Kapoor, Operations Research, S. Chand Publishers, New Delhi
2. Prem Kumar Gupta and Hira, Operations Research, S. Chand Publishers, New Delhi

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Operations Research	CO1	3	3	3										2	2
	CO2	3	3	3										1	2
	CO3	3	3	3	1									2	2
	CO4	3	3											2	2
	CO5		3	3		3								2	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	9/60	15	L2	Apply	L3	PO1 PO2 PO3	Apply (L3) Formulate (L3) Develop (L3)	3 3 3
2	19/60	31	L3	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	14/60	23	L3	Evaluate	L5	PO1 PO2 PO3 PO4	Apply (L3) Identify (L3) Develop (L3) Design (L6)	3 3 3 1
4	8/60	13	L2	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
5	10/60	16	L2	Analyze	L4	PO2 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Apply the knowledge of operations research in solving linear programming problems
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Formulate (L3)**
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO1: Action verb is same level as PO3 verb. Therefore, the correlation is high (3).

CO2: Apply the mathematical procedure for solving the transportation and assignment models related to real world problems.
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO2: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Develop (L3)**
CO2: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Apply (L3)**
CO2: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Evaluate the decisions to replace the items that deteriorate with time and to solve the game theory models.
Action Verb: Evaluate (L5)
PO1 Verb: **Apply (L3)**
CO3: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO3: Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO3: Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).
PO4 Verb: **Design (L6)**
CO3: Action verb is same (lower) level as PO4 verb. Therefore, the correlation is low (1).

CO4: Analyze the available resources based on the priority in solving the sequencing problems.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO5: Analyze the simulation tools to develop the queuing and other relevant models
Action Verb: Analyze (L4)
PO2 Verb: **Apply (L3)**
CO5: Action verb is same level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO5: Action verb is same level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Apply (L3)**
CO5: Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0312	Production and Operations Management	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the operations and supply management to the sustainability of an enterprise
CO2. Analyze different forecasting methods to predict the business insights (like sales, production, inventory etc.)
CO3. Apply the knowledge of facilities planning to various production and plant layouts
CO4. Analyze the quality control in the production management
CO5. Evaluate the production schedule for productivity

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the operations and supply management		to the sustainability of an enterprise	L2
CO2	Analyze	different forecasting methods		to predict the business insights (like sales, production, inventory etc.)	L4
CO3	Apply	the knowledge of facilities		to various production and plant layouts	L3
CO4	Analyze	the quality control	in the production management		L4
CO5	Evaluate	the production schedule		for productivity	L5

Unit I:

Introduction: Operations Management – Definition, Objectives, Types of Production System, Difference between OM & PM, Historical Development of Operations Management, Current Issues in Operation Management, Product Design – Requirements of Good Product Design, Product Development – Approaches, Concepts in Product Development, Standardization, Simplification, Speed to Market, Introduction to Concurrent Engineering.

UNIT – II

Forecasting: Introduction, Statistical Forecasting Techniques, Moving Average, Exponential Smoothing Technique, Errors in Forecasting and Evaluation of Forecasting Techniques

UNIT – III

Value Engineering and Plant Layout: Value Engineering – Objectives, Types of Values, Function and Cost, Product Life Cycle, Steps in Value Engineering, Methodology in Value Engineering, FAST Diagram and Matrix Method. Facility Location and Layout – Factor Considerations in Plant Location, Comparative Study of Rural and Urban Sites, Methods of Selection of Plant Layout, Objectives of Good layout, Principles, Types of Layout, Line Balancing.

UNIT – IV

Aggregate Planning and MRP: Aggregate Planning – Definition, Different Strategies, Various Models of Aggregate Planning- Transportation and Graphical Models, Master scheduling, Material Requirement Planning(MRP)- Terminology, Types of Demands, Inputs to MRP, Techniques of MRP, Lot Sizing Methods, Benefits and Drawbacks of MRP, Manufacturing Resources Planning (MRP II), Just in Time (JIT) Philosophy, Kanban System, Calculation of Number of Kanbans, Pull Systems vs. Push Systems, Requirements for Implementation of JIT, JIT Production Process, Benefits of JIT.

UNIT – V

Scheduling: Policies, Types of Scheduling, Scheduling Strategies, Scheduling and Loading Guidelines, Forward and Backward Scheduling, Grant Charts, Priority Decision Rules, Flow Shop Scheduling, Job Shop Scheduling, Line of Balance.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Text Books:

1. Buffa E.S. and Sarin R.K., "Modern Production / Operations Management", 8th Edition, Wiley India Pvt. Ltd., New Delhi, 2009.
2. Joseph G. Monks, "Operations Management-Theory and Problems", 3rd Edition, McGraw Hill Education, 1987.
3. Dipak Kumar Bhattacharyya, "Production and operations Management", University press, 2012.

Reference Books:

1. James L. Riggs, Jim Rigs, "Production Systems: Planning, Analysis and Control", 4th Edition, Wave Land Press, 1992.
2. Chary S.N., "Production and Operations Management", 5th Edition, McGraw Hill Education, 2017.
3. Richard B.Chase, Ravi Shankar, Robert Jacobs F., "Operations and Supply Chain Management", 15th Edition, McGraw Hill Education, 2018

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Production and Operations Management	CO1	2	2	2										2	2
	CO2	3		3		3								1	2
	CO3	3	3	3		3								2	2
	CO4	3	3											1	2
	CO5	3	3		2									2	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Understand	L2	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	2 2 2
2	-	-	-	Analyze	L4	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
3	-	-	-	Apply	L3	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Apply (L3)	3 3 3 3
4	-	-	-	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
5	-	-	-	Evaluate	L5	PO1 PO2 PO4	Apply (L3) Identify (L3) Design (L6)	3 3 2

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Understand the operations and supply management to the sustainability of an Enterprise
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO1 Action verb is lower level as PO1 verb. Therefore, the correlation is low (2).
PO2 Verb: **Identify (L3)**
CO1 Action verb is lower level as PO2 verb. Therefore, the correlation is low (2).
PO3 Verb: **Develop (L3)**
CO1: Action verb is lower level as PO3 verb. Therefore, the correlation is low (2).

CO2: Analyze different forecasting methods to predict the business insights (like sales, production, inventory etc.).
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO2: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO2: Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Apply (L3)**
CO2: Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

CO3: Apply CO3. Apply the knowledge of facilities planning to various production and plant layouts
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3).
PO5 Verb: **Apply (L3)**
CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

CO4: Analyze the quality control in the production management.
Action Verb: Analyze (L4)
PO1 Verb: **Apply (L3)**
CO4: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4: Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

CO5: Evaluate the production schedule for productivity.
Action Verb: Evaluate (L5)
PO1 Verb: **Apply (L3)**
CO5: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO5: Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).
PO4 Verb: **Design (L6)**
CO5: Action verb is same (lower) level as PO4 verb. Therefore, the correlation is low (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0313	Quality & Reliability Engineering	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Apply the total quality management (TQM) approaches in various sectors

CO2. Analyze the concepts of customer satisfaction and employee involvement strategies

CO3. Apply the appropriate tools and techniques of continuous process improvement for improving quality

CO4. Apply the Quality Function Deployment and Bench Marking process for improving a product or a process in industry

CO5. Evaluate the reliability of systems to improve the quality.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the total quality management (TQM) approaches		in various sectors	L3
CO2	Analyze	the concepts of customer satisfaction and employee involvement strategies			L4
CO3	Apply	the appropriate tools and techniques of continuous process improvement		for improving quality	L3
CO4	Apply	the Quality Function Deployment and Bench Marking process		for improving a product or a process in industry	L3
CO5	Evaluate	the concepts of Reliability Engineering		in manufacturing	L5

Unit I:

Introduction to T.Q.M.: Introduction to Quality; Evolution of and basic approach to Total Quality Management; Leadership concepts; The Seven habits of highly effective people; Role of TQM Leaders; Implementation of TQM; Quality council, quality statements

Unit II:

Customer Satisfaction: Types of Customers-Internal and External; Customer perception of quality; Feedback & brief discussion on Information Collecting Tools

Employee Involvement: Maslow's hierarchy of needs; Types of Teams, Stages of team development, Common barriers to team progress, Training; Benefits of Employee Involvement

Unit III:

Continuous Process Improvement: Introduction, Juron trilogy, Improvement strategies; P-D-S-A cycle & Problem-solving method; Basic concepts of Kaizen and Six sigma quality control, Taguchi method, Quality circles

Supplier Partnership: Introduction, Partnering, Sourcing, Supplier Selection, Supplier Rating, Relationship Development

Tools & Techniques of TQM: Pareto diagram, Cause & Effect diagram

Unit IV:

Benchmarking: Introduction, Benchmarking process

Quality Function Deployment: Benefits of QFD, House of Quality

Unit V:

Reliability Engineering: Introduction, Failures & failure modes, Causes of failures

Design for Reliability: Designing for higher Reliability, Reliability & Cost

Component Reliability: MTTF, Time dependent hazard models – Exponential Distribution

System Reliability: Systems with components- in Series, and in Parallel; Non-Series-Parallel systems Redundancy Techniques: Introduction, Component & Unit Redundancy, Weakest link technique

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Text Books:

1. Dale H. Bester field, Total Quality Management, Pearson Education, New Delhi
2. E. Balagurusamy, Reliability Engineering, TMH Publishers, New Delhi
3. M. Mahajan, Statistical Quality Control, Dhanapat Rai and Sons Publishers, New Delhi

Reference Books:

1. Douglas C. Montgomery, Introduction to Quality Control, John Wiley and Sons Publishers, New York
2. N. Logothetis, Managing for Total Quality, From Deming to Taguchi, PHI Publishers, New Delhi
3. L.S. Srinath, Reliability Engineering, East West Press, New Delhi

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Quality & Reliability Engineering	CO1	3			2	3								2	2
	CO2	3		3		3								1	2
	CO3	3	3			3								1	2
	CO4	3	3		2									2	2
	CO5	3	2			3								1	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Apply	L3	PO1 PO3 PO4	Apply (L3) Develop (L3) Analyze (L4)	3 3 2
2	-	-	-	Analyze	L4	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
3	-	-	-	Apply	L3	PO1 PO2 PO5	Apply (L3) Identify (L3) Apply (L3)	3 3 3
4	-	-	-	Apply	L3	PO1 PO2 PO4	Apply (L3) Identify (L3) Analyze (L4)	3 3 2
5	-	-	-	Evaluate	L5	PO1 PO2 PO5	Apply (L3) Formulate (L6) Apply (L3)	3 2 3

Justification Statements:

CO1: Apply the total quality management (TQM) approaches in various sectors

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3).

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3).

PO4 Verb: **Analyze (L4)**

CO1 Action verb is one level lower than PO4 verb. Therefore, the correlation is moderate (2).

CO2: Analyze the concepts of customer satisfaction and employee involvement

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**
CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3).
PO3 Verb: **Develop (L3)**
CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3).
PO5 Verb: **Apply (L3)**
Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3).

CO3: Apply the appropriate tools and techniques of continuous process improvement for improving quality
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3).
PO2 Verb: **Identify (L3)**
CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3).
PO5 Verb: **Apply (L3)**
CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

CO4: Apply the Quality Function Deployment and Bench Marking process for improving a product or a process in industry.
Action Verb: Apply (L3)
PO1 Verb: **Apply (L3)**
CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)
CO4: Action verb is one level lower than PO4 verb. Therefore, the correlation is moderate (2).

CO5: Evaluate the reliability of systems to improve the quality
Action Verb: Understand (L2)
PO1 Verb: **Apply (L3)**
CO5: Action verb is lower level than PO1 verb. Therefore, the correlation is low (2).
PO2 Verb: **Formulate (L6)**
CO5: Action verb is two levels lower than PO4 verb. Therefore, the correlation is low (1).
PO5 Verb: **Apply (L3)**
CO5: Action verb is lower level than PO5 verb. Therefore, the correlation is low (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0314	Power Plant Engineering	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. **Understand** the concepts of different sources of energies and basics of power generation.
CO2. **Apply** the economics of power generation and working of diesel engine power plant.
CO3. **Analyze** the working of steam power plant to generate the power.
CO4. **Analyze** the working of gas turbine power plant to produce power.
CO5. **Analyze** the working of hydroelectric and nuclear power plants to generate energy.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts of different sources of energies and basics of power			L2
CO2	Apply	the economics of power generation and		working of diesel engine power plant	L3
CO3	Apply	the working of steam power plant	to generate the power		L3
CO4	Analyze	the working of gas turbine power plant	to produce power		L4
CO5	Analyze	the working of hydro-electric and nuclear power plants	to generate energy		L3

Unit I:
Sources of Energy: Introduction, different sources of energy, types of power plants, essential requirements of a power plant.
Fuels and Combustion: Coal, fuel oil, natural and petroleum gas, industrial wastes and by-products, biomass, thermodynamic view, combustion reactions, calculation of weight of air required for combustion, heat of combustion.
Combined Cycle Power Generation: Gas turbine – Steam turbine (combined) power plant, advantages of combined cycle power generation

Unit II:
Economics of Power Generation: Terms and definitions, load duration curves, power plant economics – construction costs, Fixed cost and depreciation, fuel cost, present worth concept, incremental heat rate, input-output curves.
Diesel Engine Power Plant: Introduction, advantages and disadvantages of diesel power plant, applications of diesel power plant, general layout, essential components of diesel power plant, layout of a diesel engine power plant

Unit III:
Steam Power Plant: Introduction, classification of steam power plants, layout of a modern steam power plant, fuel handling, combustion equipment for boilers, fluidized bed combustion, advantages and disadvantages of steam power plants, efficiencies in a steam power plant – calculation of different efficiencies – simple problems

Unit IV:
Gas Turbine Power Plant: General aspects, closed cycle and open cycle plants, applications, advantages and disadvantages of a gas turbine power plant, analysis of a gas turbine power plant, gas turbine fuels, performance of gas turbine plants, components of gas turbine power plant

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Unit V:

Hydro-Electric Power Plant: Introduction, advantages and disadvantages, selection of site, essential elements of hydro-electric power plant, classification of hydro-electric power plants, calculation of available hydro power.

Nuclear Power Plant: Chemical and Nuclear reactions, Nuclear Fission, chain reaction, main components of nuclear power plant, essential components of a nuclear reactor, types of reactors, power of nuclear reactor, safety measures for nuclear power plants.

Text Books:

1. P.K Nag, Power Plant Engineering, TMH Publishers, New Delhi
2. Manoj Kumar Gupta, Power Plant Engineering, PHI Publishers, New Delhi

Reference Books:

1. R.K Rajput, Power Plant Engineering, Lakshmi Publications, Bengalore
2. G.D. Rai, Power Plant Technology, Khanna Publishers, New Delhi
3. G.R. Nagpal, Power Plant Engineering, Khanna Publishers, New Delhi

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Power Plant Engineering	CO1	2	2	2										1	1
	CO2	3	3	3										2	1
	CO3	3	3											2	3
	CO4	3	3		3									2	1
	CO5	3	3					2	2					1	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	12	17.64	L2	Understand	2	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop(L3)	2 2 2
2	11	16.17	L2	Apply	3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop(L3)	3 3 3
3	9	13.23	L2	Apply	3	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	22	32.35	L3	Analyze	4	PO1 PO2 PO4	Apply (L3) Identify (L3) Analyze(L4)	3 3 3
5	14	20.5	L3	Analyze	4	PO1 PO2 PO7 PO8	Apply (L3) Identify (L3) Thumb Rule Thumb Rule	3 3 2 2

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: **Understand** the concepts of different sources of energies and basics of power generation.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Review (L2)
CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: Understand (L2)
CO1 Action verb is same level as PO7 verb. Therefore, the correlation is medium (2)

CO2: **Apply** the economics of power generation and working of diesel engine power plant.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Review (L2)
CO2 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: Understand (L2)
CO2 Action verb is greater than PO7 verb. Therefore, the correlation is high (3)

CO3: Analyze the working of steam power plant to generate the power.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO3 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Review (L2)
CO3 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: Apply (L3)
CO3 Action verb is greater than PO7 verb. Therefore, the correlation is high (3)

CO4: Analyze the working of gas turbine power plant to produce power.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Review (L2)
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: Apply (L3)
CO4 Action verb is greater than PO7 verb. Therefore, the correlation is high (3)

CO5: Analyze the working of hydroelectric and nuclear power plants to generate energy.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Review (L2)
CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: Apply (L3)
CO5 Action verb is greater than PO7 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0315	Fuel cell Technologies	3	0	0	3

Course Outcomes**:** After studying the course, student will be able to:

CO1. Understand the fundamental concepts of different fuel cells
CO2. Analyze the fuel cells used in electrochemistry and their efficiency
CO3. Evaluate the fuel cells process design and operating conditions
CO4. Analyze the main components of solid-oxide fuel cells and advances in fuel cell technology
CO5. Analyze the different steps in fuel processing

CO	**Action Verb**	**Knowledge Statement**	**Condition**	**Criteria**	**Blooms level**
CO1	Understand	the fundamental concepts of different fuel cells			L2
CO2	Analyze	the fuel cells used in electrochemistry and their efficiency			L4
CO3	Evaluate	the fuel cells process design and operating conditions			L5
CO4	Analyze	the main components of solid-oxide fuel cells and advances in fuel cell technology			L4
CO5	Analyze	the different steps in fuel processing			L4

Unit I:
Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.
Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as Carbon oxide, Sulphur and others.

Unit II:
Fuel cell electrochemistry: Electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Nernst equation, Tafel equation, exchange currents

Unit III:
Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates
Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

Unit IV:
Main components of solid-oxide fuel cells, Cell stack and design, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modelling.
Advances in Fuel Cell Technology: Direct methanol fuel cell; microbial fuel cell; hydrogen generation and storage; limitations, recent advances and challenges in fuel cell research.

Unit V:
Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal, Using renewable fuels for SOFCs

Text Books:

1. Ryan O'Hayre, Suk-Won Cha Whitney Colella , Fuel Cell Fundamentals, second edition, John Wiley & Sons, 2009

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

2. Franno. Barbir, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 013.
3. Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers,2001

Reference Books:

1. Hoogers G., Fuel Cell Technology Hand Book, CRC Press, 2003.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Fuel Cell Technologies	CO1	2	2											2	2
	CO2	3	2	2										3	3
	CO3	3	3	3		3								3	3
	CO4	3		3	2	1	3							3	3
	CO5	3		3		1	3	3						3	3

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Understand	2	PO1 PO2	Apply (L3) Identify (L3)	2 2
2	-	-	-	Analyze	4	PO1 PO2 PO3	Apply (L3) Formulate (L5) Develop (L3)	3 2 2
3	-	-	-	Evaluate	6	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Create (L6)	3 3 3 3
4	-	-	-	Analyze	4	PO1 PO3 PO4 PO5 PO6	Apply (L3) Develop (L3) Interpret (L5) Create (L6) Thumb Rule	3 3 2 1 3
5	-	-	-	Analyze	4	PO1 PO3 PO5 PO6 PO7	Apply (L3) Develop (L3) Create (L6) Thumb Rule Thumb Rule	3 3 1 3 3

Justification Statements:

CO1**: Understand** the fundamental concepts of different fuel cells.
Action Verb: **Understand (L2)**
PO1 Verb: **Apply (L3)**
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: **Identify (L3)**
CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

CO2: **Analyze** the fuel cells used in electrochemistry and their efficiency.
Action Verb: **Analyze (L4)**
PO1 Verb: **Apply (L3)**
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Formulate (L5)**
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: **Develop (L3)**
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Evaluate the fuel cells process design and operating conditions.
ActionVerb: Apply (L3)
PO1Verb: **Apply (L3)**
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: **Identify (L3)**
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Create (L6)**
CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the main components of solid-oxide fuel cells and advances in fuel cell technology.
ActionVerb: Analyze (L4)
PO1Verb**:** Apply (L3)
CO4 Action verb is greater level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: Interpret (L5)
CO4 Action verb is less than PO4 verb by one level. Therefore, the correlation is medium (2)
PO5 Verb: **Create (L6)**
CO4 Action verb is less than PO5 verb by two level. Therefore, the correlation is low (1)
PO6: Thumb Rule
CO4 co-relates highly with PO6. Therefore, the correlation is high (3)

CO5: Analyze the different steps in fuel processing.
Action Verb: Analyze (L4)
PO1Verb: **Apply (L3)**
CO4 Action verb is greater level as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: **Develop (L3)**
CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: **Create (L6)**
CO4 Action verb is less than PO5 verb by two levels. Therefore, the correlation is low (1)
PO6: Thumb Rule
CO5 co-relates highly with PO6. Therefore, the correlation is high (3)
PO7: Thumb Rule
CO5 co-relates highly with PO7. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0317	Electrical & Hybrid Vehicles	3	0	0	3

Course Outcomes**:** After studying the course, student will be able to:

CO1. Understand the basic principles of hybrid vehicles and its impact on environment
CO2. Analyze the concepts of drive-trains for hybrid and electric vehicle
CO3. Analyze the working components involved in electric propulsion unit
CO4. Analyze the energy storage units in hybrid and electric vehicles as well as matching the drive system of hybrid vehicle to IC engines.
CO5. Analyze the energy management strategies used in hybrid and electric vehicles

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the basic principles of hybrid vehicles and		its impact on environment	L2
CO2	Analyze	the concepts of drive-trains	for hybrid and electric vehicle		L4
CO3	Analyze	the working components involved in electric propulsion unit			L4
CO4	Analyze	the energy storage units	in hybrid and electric vehicles	as well as matching the drive system of hybrid vehicle to IC engines	L4
CO5	Analyze	the energy management strategies used	in hybrid and electric vehicles		L4

Unit I:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicle Drive-trains: Basics of vehicle performance, vehicle power source characterization, transmission characteristics.

Unit II:

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Unit III:

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit IV:

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit V:

Energy Management Strategies: Introduction to energy management strategies used in hybrid and

electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Electrical and Hybrid Vehicles	CO1	2					2	2						2	2
	CO2	3		3		3								2	2
	CO3	3		3	3	3	3							2	2
	CO4	3		3	3	3	3	3						2	2
	CO5	3		3			3	3				3		2	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Understand	L2	PO1 PO6 PO7	Apply (L3) Thumb Rule Thumb Rule	2 2 2
2	-	-	-	Analyze	L4	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
3	-	-	-	Analyze	L4	PO1 PO3 PO4 PO5 PO6	Apply (L3) Develop (L3) Analyze (L4) Apply (L3) Thumb Rule	3 3 3 3 3
4	-	-	-	Analyze	L4	PO1 PO3 PO4 PO5 PO6 PO7	Apply (L3) Develop (L3) Analyze (L4) Apply (L3) Thumb Rule Thumb Rule	3 3 3 3 3 3
5	-	-	-	Analyze	L4	PO1 PO3 PO6 PO7 PO11	Apply (L3) Develop (L3) Thumb Rule Thumb Rule Thumb Rule	3 3 3 3 3

Justification Statements:

CO1: Understand the basic principles of hybrid vehicles and its impact on environment

ActionVerb: Analyze (L4)
PO1Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
PO6 Verb: Thumb Rule
CO1 correlates moderately with PO6. Therefore, the correlation is medium (2)
PO7 Verb: Thumb Rule
CO1 correlates moderately with PO7. Therefore, the correlation is medium (2)
CO2: Analyze the concepts of drive-trains for hybrid and electric vehicle
Action Verb: Analyze (L4)
PO1Verb: Apply (L3)
CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: Apply (L3)
CO2 Action verb is same level (greater) as PO5 verb. Therefore, the correlation is high (3)
CO3: Analyze the working components involved in electric propulsion unit
ActionVerb: Analyze (L4)
PO1Verb: Apply (L3)
CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: Apply (L3)
CO3 Action verb is same level (greater) as PO5 verb. Therefore, the correlation is high (3)
PO6 Verb: Thumb Rule
CO2 correlates highly with PO6. Therefore, the correlation is high (3)
CO4: Analyze the energy storage units in hybrid and electric vehicles as well as matching the drive system of hybrid vehicle to IC engines
Action Verb: Analyze (L4)
PO1Verb: Apply (L3)
CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)
CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO5 Verb: Apply (L3)
CO4 Action verb is same level (greater) as PO5 verb. Therefore, the correlation is high (3)
PO6 Verb: Thumb Rule
CO2 correlates highly with PO6. Therefore, the correlation is high (3)
PO7 Verb: Thumb Rule
CO2 correlates highly with PO7. Therefore, the correlation is high (3)
CO5: Analyze the energy management strategies used in hybrid and electric vehicles.
Action Verb: Analyze (L4)
PO1Verb: Apply (L3)
CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)
PO6 Verb: Thumb Rule
CO2 correlates highly with PO6. Therefore, the correlation is high (3)
PO7 Verb: Thumb Rule
CO2 correlates highly with PO7. Therefore, the correlation is high (3)
PO11 Verb: Thumb Rule
CO2 correlates highly with PO11. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0301	Automobile Engineering	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the operation of engine components and working of cooling and lubrication systems
CO2. Apply the concept of fuel supply system to SI and CI engines of an automobile
CO3. Apply the knowledge of various ignition systems to SI engines.
CO4. Analyze the working of various components in transmission systems
CO5. Apply the knowledge of suspension and braking systems to different kinds of engines

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the use and operation of engine components and working of cooling and lubrication systems			L2
CO2	Apply	the concept of fuel supply system	to SI and CI engines of an automobile		L3
CO3	Apply	the knowledge of ignition systems	to SI engines		L3
CO4	Analyze	the working of transmission systems			L4
CO5	Apply	the knowledge of suspension and braking systems	to different kinds of engines		L3

Unit I:

Engine Parts: Function and constructional details of Cylinder block, Cylinder liners-wet and dry types, Piston, Connecting rods, Crankshaft, Camshaft, Air cleaner, Intake and Exhaust manifolds, Mufflers.

Cooling System: Need for cooling of automobile-Types of cooling-air cooling, water-cooling. Natural circulation (Thermo-syphon system), Forced circulation and sealed Systems. Components of water- cooling system. Water pump, fan, Radiator, Thermostats and temperature indicators. Anti-freeze mixtures.

Lubricating Systems: Need for lubrication-Functions of lubricating oil. Properties of lubricating oil, and S.A.E grading of lubricants. Lubricating systems-Petroil .Splash, Pressure feed, Wet and Dry sump, Semi pressure and pre-lubrication system

Unit II:

Fuel Supply Systems: Fuel supply system of diesel engine, fuel injection pumps, Super charging of diesel engines. Fuel supply system for petrol engines-Carburetors, Air-fuel ratios at different vehicle running conditions, Working of a simple carburetor. Various carburetor systems- Float, Starting, Idle, Low speed, High speed and acceleration systems. MPFI and EFI systems. Types of carburetors- Working and constructional details of SU, Zenith and Carter carburetors

Unit III:

Ignition-System: Electronic ignition system. Storage battery, Battery rating, Dynamo, Alternators, Cut outs, Voltage and Current regulators. Starting motors. Sparkplugs-Hot and Cold, Computer controlled coil ignition sensors

Unit IV:

Transmission System: Clutch-Principle and requirements of a clutch, types of clutches-Single plate, Multi plate and Centrifugal, Semi-centrifugal clutches.

Gearbox - Requirements of a gear box, Gear selecting mechanism, Types of gear boxes -Sliding mesh, Constant mesh and Synchromesh.

Propeller shaft Functions and constructional details, Differential: Principle of working and its construction, Front axle-stub axle-types of stub axles. Rear axle –Semi floating, Three-quarter floating and Full floating axles.

Steering-Wheel alignment. Steering geometry-Camber-Castor, Kingpin inclination, Toe in, and Toe-out. Steering linkages-Under steering and over steering. Power steering.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Unit V:

Suspension: Types of suspension springs, Front axle independent suspension systems-Wishbone type. Trailing link type, Vertical link type. Rear axle suspension systems, Shock absorbers, Air suspension system

Brakes: Requirements of good braking system. Types of brakes-Mechanical, Hydraulic and pneumatic systems Emission control, environmental effects on engines, Euro Standards and Bharat Stage Emission Norms.

Text Books

1. Kirpal Singh, AutomobileEngineeringVol.1&2, Standard Publishers, New Delhi
2. R.B. Gupta, Automobile Engineering, Satya Prakasam Publishers, New Delhi

Reference Books

1. W.H.Crowse, Automotive Mechanics, TMH Publishers, New Delhi
2. Joseph Heitner, Automotive Mechanics, EWP Publishers, New Delhi
3. Heldt, High Speed Combustion Engines, Oxford and IBH Publishers, New Delhi

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Automobile Engineering	CO1	2	2	2										1	1
	CO2	3	3	3										2	2
	CO3	3	3											2	2
	CO4	3	3		3									2	2
	CO5	3	3					2	2					1	1

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	**12**	17.64	**L2**	**Understand**	**2**	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop(L3)	2 2 2
2	**11**	16.17	**L2**	Apply	**3**	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop(L3)	3 3 3
3	**9**	13.23	**L2**	Apply	**3**	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	**22**	32.35	**L3**	Analyze	**4**	PO1 PO2 PO4	Apply (L3) Identify (L3) Analyze (L4)	3 3 3
5	**14**	20.5	**L3**	Apply	**3**	PO1 PO2 PO7 PO8	Apply (L3) Identify (L3) Thumb Rule Thumb Rule	3 3 2 2

Justification Statements:

CO1: **Understand** the operation of engine components and working of cooling and lubrication systems.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Identify (L3)

CO1 Action verb is one level than as PO2 verb. Therefore, the correlation is medium (2)
PO3 Verb: Develop (L3)
CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)
CO2: **Apply** the concept of fuel supply system to SI and CI engines of an automobile
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)
CO3: **Apply** the knowledge of various ignition systems to SI engines.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
CO4: **Analyze** the working of various components in transmission systems.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO4 Action verb is greater level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO4 Action verb is greater level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)
CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
CO5: **Apply** the knowledge of suspension and braking systems to different kinds of engines
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO5 Action verb is greater level as PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: Thumb Rule
CO5 In addition to reducing carbon emissions sustainable practices can help the automobile industry become more efficient and reduce waste. Therefore, the correlation is medium (2)
PO8 Verb: Thumb Rule
CO5 Emissions from vehicles are a major cause of Environmental pollution. Therefore, the correlation is medium (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0316	IC Engines & Gas Turbines	3	0	0	3

Course Outcomes: After studying the course, student will be able to:
CO1. Evaluate the engine performance parameters for solving numerical problems in IC engines
CO2. Analyze the concepts of combustion process, carburetion, and emissions of engines
CO3. Analyze the engine electronics concepts to design the modern engines and concepts of supercharging
CO4. Evaluate the performance parameters of gas turbines
CO5. Analyze the working of jet propulsion engines and its parameters.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Evaluate	the engine performance parameters	for solving numerical problems in IC engines		L5
CO2	Analyze	the concepts of combustion process, carburetion, and emissions of engines			L4
CO3	Analyze	the engine electronics concepts to design the modern engines and concepts of supercharging			L3
CO4	Evaluate	the performance parameters of gas turbines			L5
CO5	Analyze	the working of jet propulsion engines and its parameters			L4

Unit I:
IC Engines: Introduction, Engine performance parameters, Calculation of engine power and efficiencies, Performance characteristics, Heat balance calculation, Measurement of friction power and brake power
Unit II:
Carburetion: Air-fuel mixtures and its requirements, Principle of carburetion, Working of simple carburetor, Basic principle of mechanical and electronic fuel injection
Combustion: Stages of combustion in SI engines and CI engines
Emissions: Basic categories of engine emissions, causes of HC, CO, and NOx emissions and control methods
Unit III:
Engine Electronics: Introduction, Engine management system, Position displacement and speed sensing sensors, Temperature and Intake air flow measurement
Supercharging: Introduction, advantages and limitations, types of superchargers, Turbo charging.
Unit IV:
Gas Turbines: Simple Gas Turbine, ideal cycle, essential components, open and closed cycle arrangements, requirements of working medium, applications of Gas Turbines, comparison of Gas Turbines with reciprocating engines, work output and efficiency of a simple Gas Turbine cycle, optimum pressure ratio for maximum specific output, Gas Turbines with regeneration, reheating and inter cooling
Unit V:
Jet Propulsion: Introduction to Propeller engines and Gas Turbine engines, working principle of Ramjet engine, Pulse jet engine, Turboprop engine and Turbojet engine, Thrust and thrust equation, specific thrust, parameters affecting flight performance, introduction to Rocket propulsion, classification of Rockets and principle of Rocket propulsion
Text Books

1. Ganesan, Internal Combustion Engines, TMH Publishers, New Delhi
2. V. Ganesan, Gas Turbines, TMH Publishers, New Delhi.

Reference Books

1. R.K Rajput , Thermal Engineering, Lakshmi Publications, New Delhi
2. S.L. Soma Sundaran, Gas dynamics and Jet Propulsion, NAI Publishers, New Delhi
3. P.L. Ballaney, Thermal Engineering, Khanna Publishers, New Delhi
4. Sarvanamutto and GFC Rogers, Gas Turbine Theory, Pearson Education, New Delhi

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
IC Engines & Gas Turbines	CO1	3	3	2										2	1
	CO2	3	3	3	3			3	3					1	1
	CO3	3	3	3										2	
	CO4	2	3	2										2	1
	CO5	3	3	1	3									2	

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Evaluate	5	PO1 PO2 PO3	Apply (L3) Identify (L3) Design(L6)	3 3 2
2	-	-	-	Analyze	4	PO1 PO2 PO3 PO4 PO7 PO8	Apply (L3) Identify (L3) Develop(L3) Analyze(L4) Thumb Rule Thumb Rule	3 3 3 3 3 3
3	-	-	-	Analyze	4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop(L3)	3 3 3
4	--	-	-	Evaluate	5	PO1 PO2 PO3	Apply (L3) Identify (L3) Design(L6)	3 3 2
5	-	-	-	Analyze	4	PO1 PO2 PO3 PO4	Apply (L3) Identify (L3) Design(L6) Analyze(L4)	3 3 1 3

Justification Statements:

CO1: **Evaluate** the engine performance parameters for solving numerical problems in IC engines.
ActionVerb: Evaluate (L5)
PO1Verb: Apply (L3)
CO1 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO1 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Design (L6)
CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)
CO2: **Analyze** the concepts of combustion process, carburetion, and emissions of engines.

Action Verb: Analyze (L4)
PO1Verb: Apply (L3)
CO2 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO2 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO2 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)
CO2 Action verb is same level than PO4 verb. Therefore, the correlation is high (3)
PO7 Verb: Thumb rule (TR)
CO2 In addition to reducing carbon emissions sustainable practices can help the automobile industry become more efficient and reduce waste. Therefore, the correlation is high (3)
PO8 Verb: Thumb rule (TR)
CO2 Emissions from vehicles are a major cause of Environmental pollution. Emission control systems limit the release of harmful gases from automobiles into the atmosphere. Therefore, the correlation is high (3)

CO3: **Analyze** the engine electronics concepts to design the modern engines and concepts of supercharging.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO3 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO3 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO3 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

CO4: **Evaluate** the performance parameters of gas turbines.
Action Verb: Evaluate (L5)
PO1Verb: Apply (L3)
CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Design (L6)
CO4 Action verb is one level lesser than PO3 verb. Therefore, the correlation is medium (2)

CO5: **Analyze** the working of jet propulsion engines and its parameters
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Identify (L3)
CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO3 Verb: Design (L6)
CO5 Action verb is two level lesser than PO3 verb. Therefore, the correlation is low (1)
PO4 Verb: Analyze (L4)
CO5 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0119	Air Pollution & Control	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the fundamentals of air pollution and effects of air pollution.
CO2. Understand the sources, types, lapse rate and decreasing measures of air pollution
CO3. Analyze the mechanisms of various particulate devices of pollution control
CO4. Apply the design principles of particulate and gaseous control
CO5. Analyze the causes and their effects of air pollution

COs	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Understand	the fundamentals and effects		of air pollution	L2
CO2	Understand	the sources, types, lapse rate and decreasing measures		of air pollution	L2
CO3	Analyze	the mechanisms of various particulate devices		of pollution control	L4
CO4	Apply	the design principles of particulate and gaseous control.			L3
CO5	Analyze	the causes and their effects		of air pollution	L4

UNIT I

INTRODUCTION: Definition - Sources and classification of Air Pollutants - Photochemical smog - Effects of air pollution on health of Human & Animals, vegetation & materials, air quality standards, Global effects of air pollution.

EFFECTS OF AIR POLLUTION: Effects of Air pollutants on man, material and vegetation: Global effects of air pollution – Green House effect, Heat Islands, Acid Rains, Ozone Holes etc.

UNIT II

THERMODYNAMIC OF AIR POLLUTION: Meteorology and Dispersion of air pollutants: Temperature lapse rates and Stability, Wind velocity and turbulence, Wind Rose, plume behavior, Measurement of meteorological variables.

DISPERSION OF AIR POLLUTANTS: Gaussian Dispersion model - Equations for the estimation of pollutant concentrations of emissions - Plume Rise –Effective stack height and mixing depths.

UNIT III

SAMPLING, ANALYSIS AND PARTICULATE POLLUTION CONTROL METHODS: Ambient air quality monitoring -High volume sampler- stack monitoring train and stack monitoring - Principles and design aspects of different types of particulate pollution control equipment– Settling chambers, Cyclone separators, Scrubbers, Filters and Electrostatic precipitators.

UNIT IV

GASEOUS POLLUTION CONTROL METHODS AND AUTOMOBILE POLLUTION: Gaseous pollutants' sampling and analysis- Types of gaseous pollution control methods – absorption, adsorption and combustion processes. Automobile pollution, sources of pollution, composition of auto exhausts, Control methods.

UNIT V

AIR QUALITY MANAGEMENT: Air Quality Management – Monitoring of SPM, SO; NO and CO Emission

Standards.

TEXT BOOKS:

1. Air Quality by Thodgodish, Levis Publishers, Special India Edition, New Delhi
2. Air pollution By M.N.Rao and H.V.N.Rao – Tata Mc.Graw Hill Company.
3. Air pollution by Wark and Warner.- Harper & Row, New York.

REFERENCES:

1. An introduction to Air pollution by R.K.Trivedy and P.K. Goel, B.S. Publications.
2. Air Pollution and Control by K.V.S.G.Murali Krishna, Kousal& Co. Publications, New Delhi. 3. Environmental meteorology by S.Padmanabhammurthy , I.K.Internationals Pvt Ltd,New Delhi. 4. Environmental Engineering by Peavy and Rowe, McGraw Hill Publication.
5. Air Pollution Control Engineering by N.D. Nevers, McGraw Hill Publication.
6. Air Pollution control engineering by Noel de Nevers, McGraw Hill Publication, and New 1. York.
7. Fundamentals of Air Pollution by Richard W. Boubel et al, Academic Press, New York.
8. Air Pollution: Physical and Chemical Fundamentals by John H. Seinfeld, McGraw Hill 2. bookCo. 1988.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Air Pollution & Control	CO1	2	2					2							
	CO2	2	2					2							
	CO3	2	3		3		3								
	CO4	3	2				2								
	CO5	2	3		3		3								

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	11/65	18	2	Understand	L2	PO1 PO2 PO7	Apply (L3) Analyze (L4) Thumb Rule	2 2 2
2	12/65	18	2	Understand	L2	PO1 PO2 PO7	Apply (L3) Analyze (L4) Thumb Rule	2 2 2
3	13/65	20	3	Analyze	L4	PO1 PO2 PO4 PO6	Apply (L3) Analyze (L4) Analyze (L4) Thumb Rule	2 3 3 3
4	14/65	21	3	Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2
5	15/65	23	3	Analyze	L4	PO1 PO2 PO4 PO6	Apply (L3) Analyze (L4) Analyze (L4) Thumb Rule	2 3 3 3

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Justification Statements:

CO1: Understand the fundamentals of air pollution and effects of air pollution.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is not same level as PO1 verb. Therefore, the correlation is medium (2)
PO2 Verb: Analyze (L4)
CO1 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)
PO7 Verb: Thumb Rule
CO1 Action verb is not same level as PO7 verb. Therefore, the correlation is medium (2)

CO2 Understand the sources, types, lapse rate and decreasing measures of air pollution
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is not same level as PO1 verb. Therefore, the correlation is medium (2)
PO2 Verb: Analyze (L4)
CO1 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)
PO7 Verb: Thumb Rule
CO1 Action verb is not same level as PO7 verb. Therefore, the correlation is medium (2)

CO3 Analyze the mechanisms of various particulate devices of pollution control
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO3 Action verb is not same level as PO1 verb. Therefore, the correlation is medium (2)
PO2 Verb: Analyze (L4)
CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)
CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO7 Verb: Thumb Rule
CO3 correlates highly with PO7. Therefore, the correlation is high (3)

CO4 Apply the design principles of particulate and gaseous control.
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Analyze (L4)
CO4 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)
PO6 Verb: Thumb Rule
CO4 correlates medium with PO6. Therefore, the correlation is medium (2)

CO5 Analyze the causes and their effects of air pollutions.
Action Verb: Analyze (L4)
PO1 Verb: Apply (L3)
CO5 Action verb is not same level as PO1 verb. Therefore, the correlation is medium (2)
PO2 Verb: Analyze (L4)
CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyze (L4)
CO5 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO7 Verb: Thumb Rule
CO5 correlates highly with PO7. Therefore, the correlation is high (3)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20AHSMB04	INTELLECTUAL PROPERTY RIGHTS	3	0	0	3

Course Outcomes: After studying the course, student will be able to:
CO1. Understand the fundamental concepts and importance of intellectual property rights
CO2. Understand the process of acquisition of trade mark rights and registration process
CO3. Analyze the copy right principles and the law of patents
CO4. Understand the protection of Trade secretes for business
CO5. Understand the intellectual property laws at the international level.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the fundamental concepts and importance of intellectual property rights			L2
CO2	Understand	the process of acquisition of trade mark rights and registration process			L2
CO3	Analyze	the copy right principles and the law of patents			L4
CO4	Understand	the protection of Trade secretes for business			L2
CO5	Understand	the intellectual property laws at the international level.			L2

UNIT-I
Introduction to Intellectual Property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT-II
Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

UNIT-III
Law of Copy Rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of Patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT-IV
Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secret elitigation. Unfair Competition: Misappropriation right of publicity, false advertising.

UNIT-V
New Development Of Intellectual Property: New developments in trade mark law; copy right law, patent law, intellectual property audits -International overview on intellectual property, international - trade mark law, copy right law, international patent law, international development in trade secrets law.

TEXT BOOKS
1. Intellectual property right, Deborah, E. Bouchoux, Cengage learning
2. Intellectual property rights: Protection and Management. India, Nityananda KV, Cengage Learning India Private Limited.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

REFERENCES

1. Intellectual property right - Unleashing the knowledge economy, Prabuddhaganguli, Tata McGraw Hill Publishing Company Ltd.
2. Law relating to Intellectual Property rights. India. Ahuja VK IN: Lexis Nexis
3. Intellectual Property Rights, India. Neeraj P &Khushdeep D, PHI learning pvt limited

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Intellectual Property Rights	CO1	2													
	CO2						2								
	CO3		3												
	CO4					1									
	CO5	2													

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Understand	L2	PO1	Apply (L3)	2
2	-	-	-	Understand	L2	PO6	Thumb Rule	2
3	-	-	-	Analyze	L4	PO2	Analyze (L4)	3
4	-	-	-	Understand	L2	PO5	Create (L6)	1
5	-	-	-	Understand	L2	PO1	Apply (L3)	2

Justification Statements:

CO1: Understand the fundamental concepts and importance of intellectual property rights
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)
CO2: Understand the process of acquisition of trade mark rights and registration process
Action Verb: Understand (L2)
PO6: Thumb rule
CO2 Action verb blooms level 2 correlates with PO6. Therefore, the correlation is medium (2)
CO3: Analyze the copy right principles and the law of patents
Action Verb: Analyze (L4)
PO2: Analyze (L4)
CO3 Action verb is same as PO2 verb. Therefore, the correlation is high (3)
CO4: Understand the protection of Trade secretes for business
Action Verb: Understand (L2)
PO5: create (L6)
CO3 Action verb is less than PO5 verb by four levels. Therefore, the correlation is low (1)
CO5: Understand the intellectual property laws at the international level.
Action Verb: Understand (L2)
PO1: Apply (L3)
CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APE0117	GROUND IMPROVEMENT TECHNIQUES	3	0	0	3

Course Outcomes: After studying the course, student will be able to:

CO1. Understand the grouting techniques and their applications
CO2. Apply the densification methods in granular and cohesive soils
CO3. Apply the ground improvement methods to stabilize soil
CO4. Apply the reinforcement principles of earth wall
CO5. Apply the techniques for improvement of expansive soils and foundations

COs	Action Verb	Knowledge Statement	Condition	Criteria	Blooms Level
CO1	Understand	the grouting techniques and their applications			L2
CO2	Apply	the densification methods		in granular and cohesive soils	L3
CO3	Apply	the ground improvement methods to stabilize soil			L3
CO4	Apply	the reinforcement principles		of earth wall	L3
CO5	Apply	the techniques for improvement		of expansive soils and Foundations	L3

UNIT – I GROUTING

Introduction to ground modification, need and objectives of Grouting- Grouts and Their Properties- Grouting Methods Ascending, Descending and Stage Grouting- Hydraulic Fracturing in Soils And Rocks Post Grout Test.

UNIT – II IN-SITU DENSIFICATION OF COHESIVE AND COHESIONLESS SOILS

In situ densification methods- in situ densification of granular soils- vibration at ground surface and at depth, impact at ground and at depth – in situ densification of cohesive soils – pre loading – vertical drains – sand drains and geo drains – stone columns.

UNIT – III STABILISATION

Methods of Stabilization-Mechanical-Cement- Lime, Chemical Stabilization with Calcium Chloride, Sodium Silicate and Gypsum

UNIT – IV REINFORCED EARTH

Principles – Components of Reinforced Earth – Factors Governing Design of Reinforced Earth Walls –Design Principles Of Reinforced Earth Walls.

GEOSYNTHETICS: Geotextiles- Types, Functions and Applications – Geogrids and Geomembranes –Functions and Applications.

UNIT - V EXPANSIVE SOILS

Problems Of Expansive Soils – Tests for Identification – Methods of Determination Of Swell Pressure. Improvement Of Expansive Soils – Foundation Techniques in Expansive Soils – Under Reamed Piles.

TEXT BOOKS

1. Engineering Principles of Ground Modification, Haussmann M.R. (1990), McGraw-Hill International Edition.
2. Ground Improvement Techniques by Dr.P.Purushotham Raj, Laxmi Publications, New Delhi / University Science Press, New Delhi
3. Ground Improvement Techniques by NiharRanajanPatra. Vikas Publications, New Delhi

REFERENCES

1. Ground Improvement, Blackie Academic and Professional by Moseley M.P. (1993), Boca Taton, Florida, USA.
2. Ground Control and Improvement by Xanthakos P.P, Abramson, L.W and Brucwe, D.A (1994), John Wiley and Sons, New York, USA.
3. Designing with Geosynthetics by Robert M. Koerner, Prentice Hall New Jercy, USA

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
GROUND IMPROVEMENT TECHNIQUES	CO1	2	1					2							
	CO2	3	2				2								
	CO3	3	2				2								
	CO4	3	2				2								
	CO5	3	2				2								

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	10/62	16	2	Understand	L2	PO1 PO2 PO7	Apply (L3) Analyze (L4) Thumb Rule	2 1 2
2	13/62	21	3	Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2
3	13/62	21	3	Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2
4	13/62	21	3	Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2
5	13/62	21	3	Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2

Justification Statements:

CO1 Understand the grouting techniques and their applications.
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO1 Action verb is two levels lower than PO1 verb. Therefore, the correlation is low (1)
PO2 Verb: Analyze (L4)
CO1 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)
PO7 Verb: Thumb Rule
CO1 correlates moderately with PO7 verb. Therefore, the correlation is medium (2)

CO2 Apply the densification methods in granular and cohesive soils
Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Analyze (L4)
CO2 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)
PO6 Verb: Thumb Rule
CO2 correlates moderately with PO6 verb. Therefore, the correlation is medium (2)

CO3 **Apply** the ground improvement methods to stabilize soil

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Analyze (L4)

CO3 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: Thumb Rule

CO3 correlates moderately with PO6 verb. Therefore, the correlation is medium (2)

CO4 **Apply** the reinforcement principles of earth wall

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Analyze (L4)

CO4 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: Thumb Rule

CO4 correlates moderately with PO6 verb. Therefore, the correlation is medium (2)

CO5 **Apply** the techniques for improvement of expansive soils and foundations

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Analyze (L4)

CO5 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: Thumb Rule

CO5 correlates moderately with PO6 verb. Therefore, the correlation is medium (2)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20AOE9901	**English For Research Paper Writing**	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:
CO1. Understand the writing skills and level of readability.
CO2. Apply the rules, principles for writing abstract and introduction part of research article.
CO3. Apply the right methods to write the review of literature, results and conclusions.
CO4. Apply the special skills for writing a title, abstract, review and introduction of literature.
CO5. Apply the key skills for results in discussion and conclusion.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the writing skills and level of readability			L2
2	Apply	the rules, principles	for writing abstract and introduction part of research article		L3
3	Apply	the right methods	to write the review of literature, results and conclusions		L3
4	Apply	the special skills.	for writing a title, abstract, review and introduction of literature		L3
5	Apply	the key skills	for results in discussion and conclusion.		L3

Syllabus:

Unit -1

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit -2

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

Unit -3

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit – 4

Key skills for writing a title– an abstract – an introduction – review of literature

Unit:5

Key skills for writing methodology – results – discussions – conclusions.

References:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. AdrianWallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
English For Research Paper Writing	CO1										2		2		
	CO2					3					2				
	CO3		2										2		
	CO4										2				
	CO5										2		2		

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	15	20	**2**	**Understand**	**L2**	PO10, PO12	Thumb Rule Thumb Rule	2, 2
2	18	23	**3**	**Apply**	**L3**	PO5, PO10	Thumb Rule Thumb Rule	2, 1
3	14	18.4	**2**	**Apply**	**L3**	PO2, PO12	Thumb Rule Thumb Rule	2, 2
4	14	18.4	**2**	**Apply**	**L3**	PO10	Thumb Rule	2
5	14	18.4	**2**	**Apply**	**L3**	PO10, PO12	Thumb Rule Thumb Rule	2, 2

Justification Statements:

CO1: Understand the writing skills and level of readability.
Action Verb: Understand (L2)
CO1 Action Verb is Understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).
CO2: Apply the rules, principles for writing abstract and introduction part of research article **Action Verb: Apply (L3)**
CO2 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).
CO2 Action Verb is Apply of BTL 3. Using Action verb, Modern Tool usage L3 correlates PO5, CO level is two less than PO, so correlation is low(1).
CO3: Apply the right methods to write the review of literature, results and conclusions.
Action Verb: Apply (L3)
CO3 Action Verb is Apply of BTL 3. Using Action verb, Problem Analysis L3 correlates PO2, CO level is one less than PO, so Correlation is Moderate (2)
CO3 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2)
CO4: Apply the special skills for writing a title, abstract, review and introduction of literature.
Action Verb: Apply (L3)
CO4 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).
CO5: Apply the key skills for results in discussion and conclusion.
Action Verb: Apply (L3)
CO5 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20AHE9903	**Professional Communication**	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:
CO1. Understand the communication skills effectively for professional success.
CO2. Analyze the communication skills clearly and concisely in formal and informal conversations.
CO3. Apply the information through drafting, editing and presentation.
CO4. Apply the interpersonal skills in appropriate manner towards the growth of best career.
CO5. Apply the sentence structures using correct vocabulary and without any grammatical errors.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the communication skills effectively		for professional success	L2
2	Analyze	the communication skills clearly and concisely	in formal and informal conversations		L4
3	Apply	the information	through drafting, editing and presentation		L3
4	Apply	the interpersonal skills		in appropriate manner towards the growth of best career	L3
5	Apply	the sentence structures	using correct vocabulary and without any grammatical errors		L3

Syllabus:

Unit: 1- Grammar & Vocabulary

Parts of Speech
Articles
The Prepositions
Subject-Verb agreement
Tenses
Active and Passive Voice
Direct & Indirect Speech
Degrees of Comparison
Punctuation
Vocabulary

Unit: 2 - Communication Skills:

Importance of Communication
Non-verbal Communication
- Introduction
- Kinesics
- Proxemics
- Chronemics

Basics of Technical Communication
- Group Discussion
- Interviews
- Conversations

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Unit:3 – **Telephone Skills:**

Understanding Telephone Communication
Types of calls
Handling calls
Leaving a message
Making requests
Asking for and giving information
Giving Instructions
Making or changing appointments

Unit:4 – Interpersonal Skills

Team management
Problem solving and Decision Making
Managing Time and Stress
Technology @ work
Etiquette

Unit:5 – **Written Communication**

Email
Professional Letters
(a) Letters of application
(b) Business letters
(c) Using Salutations
(d) Routine letters
(e) Request letters
(f) Persuasive letters
Report writing
Note making
Meetings, Agenda, Notice

Suggested books for reading:

1. Meenakshi Raman, Sangeeta Sharma, Technical Communication – Principles and Practice, 3rd Edition, Oxford University Press, 2015.
2. Professional Communication Skills, Er A.K. Jain, Dr. Pravin S.R. Bhatia, Dr. A.M. Sheikh, S.Chand & Company Ltd, New Delhi, 2011.
3. Soft Skills for everyone, Jeff Butterfield, Cengage Learning India Private Ltd, New Delhi, 2014.
4. Basic communication Skills P. Kiranmai Dutt, Geetha Rajeevan, Cambridge University Press India Pvt. Ltd, New Delhi, 2010.
5. A Course in Communication Skils, P.Kiranmai Dutt, Geetha Rajeevan, CLN Prakash, Cambridge University Press India Pvt Ltd, New Delhi, 2013

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Professional Communication	CO1						2				2		2		
	CO2									2	2		2		
	CO3									2	2		2		
	CO4									2	2		2		
	CO5										2				

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

*3: Highly Correlated, 2: Moderately Correlated, 1: Weakly Correlated

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	16	25	2, 2. 2	Understand	L2	PO6 PO10, PO12,	Thumb Rule Thumb Rule Thumb Rule	2 2 2
2	12	19	2, 2, 2	Analyze	L4	PO9, PO10, PO12	Thumb Rule Thumb Rule Thumb Rule	3, 3, 3
3	10	15	2, 2, 2	Apply	L3	PO9, PO10, PO12	Thumb Rule Thumb Rule Thumb Rule	2, 2, 2
4	10	15	2, 2, 2	Apply	L3	PO9, PO10, PO12	Thumb Rule Thumb Rule Thumb Rule	2, 2, 2
5	17	26	2	Apply	L3	PO10	Thumb Rule	2

Justification Statements:

CO1: Understand the communication skills effectively for professional success.
Action Verb: Understand
CO1 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2).
CO2: Analyze communication skills clearly and concisely in formal and informal conversations.

Action Verb: Analyze (L4)
CO2 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO12 as high (3)

CO3: Apply and communicate the information through drafting, editing and presentation.
Action Verb: Apply (L3)
CO3 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

CO4: Apply interpersonal skills in appropriate manner towards the growth of best career.
Action Verb: Apply (L3)
CO4 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

CO5: Apply sentence structures using correct vocabulary and without any grammatical errors.
Action Verb: Apply (L3)
CO5 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: I** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20AHE9913	**EFFECTIVE PUBLIC SPEAKING**	3	0	0	3

Course Outcomes (CO): After studying the course, student will be able to:

CO1. Apply the knowledge of principles, concepts and skills in speech preparation.
CO2. Understand the listening skills and styles in effective listening and speech techniques.
CO3. Analyze the techniques of knowing audience and refining the speech.
CO4. Apply the guidelines and efficient organizational skills in speech composition.
CO5. Apply the supporting materials and presentation aids in speech preparation.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	the knowledge of principles, concepts and skills	in speech preparation		L3
2	Understand	the listening skills and styles in effective listening		and speech techniques	L2
3	Analyze	the techniques of knowing audience and in refining speech			L4
4	Apply	the guidelines and efficient organizational skills		in speech composition	L3
5	Apply	the supporting materials and presentation aids		in speech preparation.	L3

Syllabus

Unit -1 Introduction to Public Speaking:

Basic communication concepts, processes, and models Communication concepts and principles and public speaking Steps and methods of speech preparation; Ethics in public speaking

Unit -2 Listening and Speech Criticism:

Effective listening, the listening process, and types of listening; Listening barriers; Identifying and improving listening styles; Evaluating speech and effective speech techniques.

Unit -3 Selecting Topic and Knowing your Audience:

Identifying sources; Tools and techniques for selecting and refining speech topics; Identifying speech purposes; Central idea statement; The central idea; Audience analysis techniques.

Unit – 4 Speaking with a Purpose:

Efficient organizational methods; Good form in speech preparation; Guidelines for organizing components and main points in a speech; Patterns of organization; Constructing an outline Informative, persuasive, and ceremonial speeches.

Unit –5 Delivering your speech and using Visual Aids.

The mechanics of verbal and nonverbal communication in speech delivery; Modes of speech delivery; Speaking style and language; Effective delivery techniques; Incorporating presentation aids

References:

1. DeVito, J.A. (2009). The Essential Elements of Public Speaking. (3rd ed.) Boston: Pearson Education, Inc.
2. Lucas, S.E. (2009). The Art of Public Speaking. (10th ed.) New York: McGraw - Hill Co.
3. Zarefsky, D. (2011). Public Speaking: Strategies for Success. (6th ed. Boston: Pearson Education, Inc).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Effective Public Speaking	CO1									2	2				
	CO2									2	2				
	CO3									3	3				
	CO4									2	2				
	CO5									2	2				

*3: Highly Correlated, 2: Moderately Correlated, 1: Weakly Correlated

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	12	24	3	Apply	L3	PO9 PO10	Thumb rule Thumb rule	2 2
2	6	12	1	Understand	L2	PO9 PO10	Thumb rule Thumb rule	2 2
3	9	18	2	Analyze	L4	PO9 PO10	Thumb rule Thumb rule	3 3
4	9	18	2	Apply	L3	PO9 PO10	Thumb rule Thumb rule	2 2
5	9	18	2	Apply	L3	PO9 PO10	Thumb rule Thumb rule	2 2

Justification Statements:

CO1: Apply knowledge of principles, concepts and skills learned in speech preparation
Action Verb: Apply (L3)
CO1 : **Apply** is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).
CO2: Understand listening skills and styles in effective listening and speech techniques.
Action Verb: Understand(L2)
CO2 : **Understand** is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO12 as moderate (2)
CO3: Analyze the techniques of knowing audience and in refining speech..
Action Verb: Analyze (L4)
CO3 :**Analyze** is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO12 as high (3).
CO4: Apply the guidelines and efficient organizational skills in speech composition.
Action Verb: Apply (L3)
CO4 : **Apply** is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).
CO5: Apply supporting materials and presentation aids in speech preparation.
Action Verb: Apply (L3)
CO5 :**Apply** is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV Semester: I Branch of Study: ME

Subject Code	Subject Name	L	T	P	Credits
20AHE9902	**Principles of Effective Public Speaking**	1	0	2	2

Course Outcomes (CO): After studying the course, student will be able to:
CO1. Apply the knowledge of principles, concepts and skills learned in speech preparation.
CO2. Analyze the techniques of knowing audiences and in refining the speech
CO3. Understand the listening skills and styles in effective listening.
CO4. Analyze the diverse methods of speech in speech composition
CO5. Apply the supporting materials and presentation aids in speech preparation.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	the knowledge of principles, concepts and skills learned	in speech preparation		**L3**
2	Analyze	the techniques of knowing audiences and	in refining the speech		**L4**
3	Understand	the listening skills and styles	in effective listening		**L2**
4	Analyze	the diverse methods of speech	in speech composition		**L4**
5	Apply	the supporting materials and presentation aids	in speech preparation		**L3**

Syllabus

Unit -1 Introduction to Public Speaking:
Basic communication concepts, processes – Models of Communication, concepts and principles of public speaking - Steps and methods of speech preparation.

Unit -2 Selecting Topic and Knowing your Audience:
Identifying sources; Tools and techniques for selecting and refining speech topics - Identifying speech purposes - Central idea statement - Audience analysis techniques.

Unit – 3 Listening with a purpose:
Effective listening, the listening process, and types of listening; Listening barriers; Identifying and improving listening styles.

Unit – 4 Speaking with a purpose:
Methods of speech preparation - Informative, persuasive, and ceremonial speeches.

Unit -5 Delivering your speech and using Visual Aids:
The mechanics of verbal and nonverbal communication in speech delivery - Effective delivery techniques - Incorporating presentation aids in presentation.

References:

1. DeVito, J.A. (2009). The Essential Elements of Public Speaking. (3rd ed.) Boston: Pearson Education, Inc.
2. Lucas, S.E. (2009). The Art of Public Speaking. (10th ed.) New York: McGraw - Hill Co.
3. Zarefsky, D. (2011). Public Speaking: Strategies for Success. (6th ed. Boston: Pearson Education, Inc).

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Principles of Effective Public Speaking	CO1										2				
	CO2										3				
	CO3										2				
	CO4										3				
	CO5										2				

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				**Apply**	**L3**	10	Thumb Rule	2
2				**Analyze**	**L4**	10	Thumb Rule	3
3				**Understand**	**L2**	10	Thumb Rule	2
4				**Analyze**	**L4**	10	Thumb Rule	3
5				**Apply**	**L3**	10	Thumb Rule	2

Justification Statements:

CO1: Apply the knowledge of principles, concepts and skills learned in speech preparation**.**
Action Verb: Apply (L3)
CO1 Action Verb is Apply of BTL3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2).
CO2: Analyze the techniques of knowing audiences and in refining the speech
Action Verb: Analyze (L4)
CO2 Action Verb is Analyze of BTL4. Using Thumb rule, L4 correlates PO6 to PO12 as high (3).
CO3: Understand the listening skills and styles in effective listening**.**
Action Verb: Apply (L3)
CO3 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2)
CO4: Analyze the diverse methods of speech in speech composition**.**
CO4 Action Verb is Evaluate of BTL5. Using Thumb rule, L5 correlates PO6 to PO12 as high (3)
CO5: **Apply** the supporting materials and presentation aids in speech preparation**.**
CO5 Action Verb is Apply of BTL3. Using Thumb rule, L3 correlates PO6 to PO12 as moderate (2)

Semester II (Fourth year)

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P	C	CIE	SEE	Total
1	Major Project	20APR0301	Project work	-	-	-	9	60	140	200
2	PR	20APR0302	Internship	-	-	-	3	100	-	100
3	MOOC	OE / PE	MOOC – NPTEL (12 Week)	-	-	-	3	25	75	100
			Total credits				**15**	185	215	400

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Year: IV **Semester: II** **Branch of Study: ME**

Subject Code	Subject Name	L	T	P	Credits
20APR0301	Project work	-	-	-	9

Course Outcomes: After studying the course, student will be able to:

CO1. Apply the mechanical engineering concepts (both theoretical and practical) to design and develop innovative project useful to the society.

CO2. Analyze the complex engineering problems, identify feasible solutions and implement the best possible approach using modern engineering tools and techniques

CO3. Create an effective plan, manage and execute project activities, ensuring adherence to timelines, resource constraints and project specifications

CO4. Create the strong communication skills to do project reports in-detail and to deliver concise presentation

CO5. Create the sustainable and eco-friendly engineering solutions and follow the ethical standards to deploy the project.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the mechanical engineering concepts (both theoretical and practical)	to design and develop innovative project useful to the society	in society and in industry	**L3**
CO2	Analyze	the complex engineering problems, identify feasible solutions and implement the best possible approach	using modern engineering tools and techniques		**L4**
CO3	Create	an effective plan, manage and execute project activities, ensuring adherence	to timelines, resource constraints and project specifications		**L6**
CO4	Create	the strong communication skills	to do project reports in-detail and to deliver concise presentation		**L6**
CO5	Create	the sustainable and eco-friendly engineering solutions and follow the ethical standards		to deploy the project.	**L6**

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PROJECT WORK 20APR0301	CO1	3	3	3	2	3	3	2	2				2	3	3
	CO2	3	3	3	3	3	2	2	2				2	2	2
	CO3	3		3	3				2			2		2	2
	CO4	3		3						3	3	2	2	2	2
	CO5	3					3	3	3	2	2	2		2	2

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Apply	**L3**	PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO12	Apply (L3) Review (L2) Develop (L3) Analyze (L4) Apply (L3) Thumb Rule Thumb Rule Thumb Rule Thumb Rule	3 3 3 2 3 3 2 2 2
2	-	-	-	Analyze	**L4**	PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO12	Apply (L3) Review (L2) Develop (L3) Analyze (L4) Apply (L3) Thumb Rule Thumb Rule Thumb Rule Thumb Rule	3 3 3 3 3 3 2 2 2
3	-	-	-	Create	**L6**	PO1 PO3 PO4 PO8 PO11	Apply (L3) Design (L6) Design (L6) Thumb Rule Thumb Rule	3 3 3 2 2
4	-	-	-	Create	**L6**	PO1 PO3 PO9 PO10	Apply (L3) Design (L6) Thumb Rule Thumb Rule	3 3 3 3
5	-	-	-	Create	**L6**	PO1 PO6 PO7 PO8 PO9 PO11	Apply-L3 Thumb Rule Thumb Rule Thumb Rule Thumb Rule Thumb Rule	3 3 2 3 2 2

Justification Statements:

CO1: Apply the mechanical engineering concepts (both theoretical and practical) to design and develop innovative project useful to the society

Action Verb: Apply (L3)

PO2 Verb: Review (L2)

CO1 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).

PO2 Verb: Formulate (L3)

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: Develop (L3)

CO1: Action verb is same level as PO3 verb. Therefore, the correlation is high (3).

CO2: Analyze the complex engineering problems, identify feasible solutions and implement the best possible approach using modern engineering tools and techniques

Action Verb: Analyze (L4)

PO4 Verb: Analyze (L4)

CO2: Action verb is same level as PO4 verb. Therefore, the correlation is high (3).

PO5 Verb: Create (L6)
CO2: Action verb is same (lower) level as PO5 verb. Therefore, the correlation is low (1)
PO3 Verb: Develop (L3)
CO2: Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)
CO3: Create an effective plan, manage and execute project activities, ensuring adherence to timelines, resource constraints and project specifications.
Action Verb: Create (L6)
PO1 Verb: Identify (L3)
CO3: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).
PO4 Verb: Design (L6)
CO3: Action verb is same (greater) level as PO4 verb. Therefore, the correlation is high (3).
PO4 Verb: Interpret (L2)
CO3: Action verb is same (greater) level as PO4 verb. Therefore, the correlation is high (3).
CO4: Create the strong communication skills to do project reports in-detail and to deliver concise presentation.
Action Verb: Create (L6)
PO4 Verb: Design (L6)
CO4: Action verb is same level as PO4 verb. Therefore, the correlation is high (3)
PO3 Verb: Develop (L3)
CO4: Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)
PO5 Verb: Apply (L3)
CO4: Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)
CO5: Create the sustainable and eco-friendly engineering solutions and follow the ethical standards to deploy the project.
Action Verb: Create (L6)
PO5 Verb: Select (L1)
CO5: Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).
PO5 Verb: Apply (L3)
CO5: Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2020-21)
MECHANICAL ENGINEERING (ME)