TEACHING SCHEME & SYLLABI

(First Year)

As per AICTE Curriculum

w. e. f. 2019-20

BACHELOR OF TECHNOLOGY

(Mechanical Engineering)

Shobhit DEEMED UNIVERSITY
EDUCATION EMPOWERS
A NAAC ACCREDITED UNIVERSITY

School of Engineering & Technology

Shobhit Institute of Engineering and Technology, Meerut

(Deemed to-be University)

Approved and adopted in year 2018 (Board of Studies, August 3, 2018)
by 23rd Academic council (Agenda no-03)

Scheme of Teaching – B.Tech. 1st Year

Structure in accordance with AICTE

Effective w.e.f. Academic Session 2019-20

Branch: CS, ME, EC

SEMESTER –I

Subject Code	Subject Name	L	T	P	Cr
BAS 101/ BAS 102	Physics/ Chemistry	3	1	0	4
BAS 103	Mathematics-I	3	1	0	4
ECC 101/ CSC 101	Basic Electrical Engineering/ Programming for Problem Solving	3	1	0	4
BAS 151/ BAS 152	Physics Lab./ Chemistry Lab.	0	0	3	1.5
ECC 151/ CSC 151	Electrical Engineering Lab./ Programming for Problem Solving Lab.	0	0	2	1
MEC 151/ MEC 152	Engineering Graphics & Design/ Workshop Practice	0	1	4	3
AOC 101 Add on Course	Basics of Communication				
	MOOCs (For B.Tech. Hons. Degree**)***				
	Total	**9**	**4**	**9**	**17.5**

SEMESTER –II

Subject Code	Subject Name	L	T	P	Cr
BAS 201/ BAS 202	Physics/ Chemistry	3	1	0	4
BAS 204	Mathematics-II	3	1	0	4
ECC 201/ CSC 201	Basic Electrical Engineering/ Programming for Problem Solving	3	1	0	4
HSM 201	Professional Communication and Soft Skills	2	0	0	2
BAS 251/ BAS 252	Physics Lab./ Chemistry Lab.	0	0	3	1.5
ECC 251/ CSC 251	Electrical Engineering Lab./ Programming for Problem Solving Lab.	0	0	2	1
MEC 251/ MEC 252	Engineering Graphics & Design/ Workshop Practice	0	1	4	3
HSM 251	Communication Lab.	0	0	2	1
	MOOCs (For B.Tech. Hons. Degree**)***	0	0	0	0

	Total	**11**	**4**	**11**	**20.5**

Branch:-AI, BI, BM, BT

SEMESTER –I

Subject Code	Subject Name	L	T	P	Cr
BAS 101/ BAS 102	Physics/ Chemistry	3	1	0	4
BAS 105	Remedial Mathematics-I	3	1	0	4
ECC 101/ CSC 101	Basic Electrical Engineering/ Programming for Problem Solving	3	1	0	4
BAS 151/ BAS 152	Physics Lab./ Chemistry Lab.	0	0	3	1.5
ECC 151/ CSC 151	Electrical Engineering Lab./ Programming for Problem Solving Lab.	0	0	2	1
MEC 151/ MEC 152	Engineering Graphics & Design/ Workshop Practice	0	1	4	3
AOC 101 Add on Course	Basics of Communication				
	MOOCs (For B.Tech. Hons. Degree**)***				
	Total	**9**	**4**	**9**	**17.5**

SEMESTER –II

Subject Code	Subject Name	L	T	P	Cr
BAS 201/ BAS 202	Physics/ Chemistry	3	1	0	4
BAS 206	Remedial Mathematics-II	3	1	0	4
ECC 201/ CSC 201	Basic Electrical Engineering/ Programming for Problem Solving	3	1	0	4
HSM 201	Professional Communication and Soft Skills	2	0	0	2
BAS 251/ BAS 252	Physics Lab./ Chemistry Lab.	0	0	3	1.5
ECC 251/ CSC 251	Electrical Engineering Lab./ Programming for Problem Solving Lab.	0	0	2	1
MEC 251/ MEC 252	Engineering Graphics & Design/ Workshop Practice	0	1	4	3
HSM 251	Communication Lab.	0	0	2	1
	MOOCs (For B.Tech. Hons. Degree**)***	0	0	0	0
	Total	**11**	**4**	**11**	**20.5**

List of MOOCs (NPTL) Based Recommended Courses for first year B. Tech Students

Developing Soft Skills and personality-Odd Semester-8 Weeks-3 Credits

Enhancing Soft Skills and personality-Even Semester-8 Weeks-3 Credits

AICTE Guidelines in Model Curriculum: After successful completion of 160 credits, a student shall be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours only, if he/she completes additional university recommended courses only (Equivalent to 20 credits; NPTEL Courses of 4 Weeks, 8 Weeks and 12 Weeks shall be of 2, 3 and 4 Credits respectively) through MOOCs.

For registration to MOOCs Courses, the students shall follow NPTEL Site http://nptel.ac.in/ as per the NPTEL policy and norms. The students can register for these courses through NPTEL directly as per the course offering in Odd/Even Semesters at NPTEL. These NPTEL courses (recommended by the University) may be cleared during the B. Tech degree program (not necessary one course in each semester). After successful completion of these MooCs courses the students, shall, provide their successful completion NPTEL status/certificates to the University (COE) through their college of study only. The student shall be awarded Hons. Degree (on successful completion of MOOCS based 20 credit) only if he/she secures 7.50 or above CGPA and passed each subject of that Degree Programme in single attempt without any grace marks.

BAS 101	Physics	L-3 T-1 P-0	4 credits

Pre-requisites: Physics as one subject in 12th standard or equivalent level.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concepts of quantum physics for materials.
CO2	Use of equipment for low and high energy applications.
CO3	Solve engineering problems by applying the concepts of wave and particle nature of radiant energy.
CO4	Apply the concept of energy band for semiconductors.
CO5	Construct a quantum mechanical model to explain the behavior of a system at microscopic level.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2		1	1	1										
CO2	3	2		1	1	1										
CO3	3	3		1	1	1										
CO4	3	2		1	1	1										
CO5	3	2		1	1	1										
Average	**3**	**2.2**		**1**	**1**	**1**										

Course Contents **Contact Hours**

Unit 1 **Waves & Optics:** Coherent sources; Superposition of waves and interference of light; interference due to thin film; Newton's rings; Fraunhofer diffraction from a single slit; the Rayleigh criterion for limit of resolution; Diffraction gratings and their resolving power; phenomenon of Double Refraction; ordinary and extra-ordinary rays; Nicol prism; Circularly and Elliptically polarized light; Optical Rotation, Specific Rotation; Einstein's theory of matter radiation interaction and A and B Coefficients; population inversion; Ruby and He-Ne lasers **L-12**

Unit 2 **Electromagnetic:** Bio-Savart law; Divergence and curl of static magnetic field; Continuity equation for current densities; Displace current and magnetic field arising from time-

dependent electric field; Maxwell's equations in differential and integral form; Maxwell's equations in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples; Momentum carried by electromagnetic wave; skin depth **L-8**

Unit 3 **Relativistic Mechanics:** Frame of reference; Inertial & non-inertial frames; Galilean transformations; Michelson-Morley experiment; Postulates of special theory of relativity; Lorentz transformations; Length contraction; Time dilation; Velocity addition theorem; Variation of mass with velocity; Einstein's mass energy relation; Relativistic relation between energy and momentum; Massless particle. **L-8**

Unit 4 **Quantum Mechanics:** Introduction to quantum mechanics; wave nature of particles (de-Broglie waves); phase velocity and group velocity; Heisenberg's uncertainty principle and applications; Time-dependent and time-independent Schrodinger equations for wave function; **L-8** Born interpretation, probability current; expectation values; Solution of stationary-state Schrodinger equation for one dimensional problems-particle in a box.

Unit 5 **Semiconductor Physics:** Intrinsic and extrinsic semiconductors; Free electron theory; KronigPenny Model (to introduce origin of band gap); Energy bands in solids, E-k diagram, Direct and indirect band gaps; Types of electronic materials: metals, semiconductors, and insulators; **L-8** Density of states, occupation probability; Fermi level; Effective mass, phonons.

Readings:

1. Beiser Arthur, Concepts of Modern Physics, TMH, New Delhi
2. Avadhanulu M.N. and Kshirsagar P.G., A Text Book of Engineering Physics, 8th edition, S. Chand, New Delhi
3. De Anuradha, Optical Fibre & Laser, New Age, New Delhi
4. Ghatak Ajoy, optics, Tata McGraw Hill Education Private Ltd., New Delhi
5. Brijlal & Subramanian, Optics, S. Chand Publication, New Delhi
6. Pillai, S.O., Solid State Physics, New Age International Ltd, New Delhi
7. Griffiths David J., Introduction to Electrodynamics, PHI Learning, New Delhi
8. Gaur R.K. and Gupta S.L., Engineering Physics, Dhanpat Rai Publication

Reference video Lectures from Swayam portal: *https://onlinecourses.nptel.ac.in/noc21_mm02/preview*

BAS 151	**Physics Lab.**	**L-0 T-0 P-3**	**1.5 credit**

Pre-requisites: Physics as one subject in 12th standard or equivalent level.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Develop skills to impart practical knowledge in real time solutions.
CO2	Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.
CO3	Design new experiments/instruments with practical knowledge.
CO4	Gain knowledge of new concept in the solution of practical oriented problems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	1	3	2		1		1	1		1				
CO2	2	2	1	3	2		1		1	1		1				
CO3	2	2	1	3	2		1		1	1		1				
CO4	2	2	1	3	2		1		1	1		1				
Average	**2**	**2**	**1**	**3**	**2**		**1**		**1**	**1**		**1**				

Course Contents **Contact Hours**

Complete atleast 10 experiments from the following:

Experiment 1 To determine the wavelength of monochromatic light (sodium light) by Newton's Rings. **P-2**

Experiment 2 To determine the Specific Rotation of Plane of Polarization of cane sugar solution using Bi-quartz Polarimeter. **P-2**

Experiment 3 To determine the wavelength of spectral lines using plane transmission (diffraction) grating. **P-2**

Experiment 4 To determine the specific resistance of the material of given wire using Carey-Foster's bridge. **P-2**

Experiment 5 To study the variation of magnetic field with distance along the axis of a current carrying coil and to estimate the radius of the coil. **P-2**

Experiment 6 To calibrate the given voltmeter with the help of a potentiometer. **P-2**

Experiment 7 To calibrate given ammeter with the help of a potentiometer. **P-2**

Experiment 8 (a) To measure the resistivity of the given semiconductor material and (b) To determine the band gap of the semiconducting material. **P-2**

Experiment 9 To study the Hall Effect and to determine the Hall coefficient & carrier density in a given semiconductor (N-type) material used in Hall effect set-up. **P-2**

Experiment 10 To determine the value of the acceleration due to gravity (g), using a bar pendulum. **P-2**

Experiment 11 To determine the Planck's constant 'h' by using radiation in a fixed spectral range. **P-2**

Experiment 12 To verify the Stefan's law by electrical method. **P-2**

Experiment 13 To determine the Fermi energy of copper. **P-2**

Experiment 14 To study the response condition of a series LCR circuit with inbuilt AF oscillator. **P-2**

Experiment 15 To measure the high resistance by leakage method. **P-2**

Experiment 16 To measure the wavelength of He-Ne laser by diffraction at a single slit. **P-2**

Readings:

1. Printed manual provided to students.

Reference video Lectures from Swayam portal: *https://onlinecourses.nptel.ac.in/noc21_mm02/preview*

BAS 103	Mathematics-I	L-3 T-1 P-0	4 credits

Pre-requisites: Mathematics as one subject in 12th standard or equivalent level.

Course Outcomes: At the end of the course, the student will be able to:

CO1	The essential tools of matrices and linear algebra, eigen values and diagonalization in a comprehensive manner are required.
CO2	Understand the concept of limit, continuity and differentiability and apply in the study of Rolle's , Lagrange's and Cauchy mean value theorem and Leibnitz theorems
CO3	Identify the application of partial differentiation and apply for evaluating maxima, minima, series and Jacobians
CO4	Illustrate the working methods of multiple integral and apply for finding area, volume, centre of mass and centre of gravity
CO5	Recall the concept of vector and apply for directional derivatives, tangent and normal planes. Also evaluate line, surface and volume integrals

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2		2							1				
CO2	3	2	2	2	1							1				
CO3	2	3	2	1	1	1	1					1				
CO4	2	3	2	1	1	1	1					1				
CO5	3	2	2		2							1				
Average	**2.6**	**2.4**	**1.6**	**0.8**	**1.4**	**0.4**	**0.4**					**1**				

Course Contents — **Contact Hours**

Unit I **Matrices:** Types of Matrices: Symmetric, Skew-symmetric and Orthogonal Matrices; Complex Matrices, Inverse and Rank of matrix using elementary transformations, Rank-Nullity theorem; System of linear equations, Characteristic equation, Cayley-Hamilton Theorem and its application, Eigen values and eigenvectors; Diagonalisation of a Matrix. ***8 hrs***

Unit II **Differential Calculus- I**: Introduction to limits, continuity and differentiability, Rolle's Theorem, Lagrange's Mean value theorem and

Cauchy mean value theorem, Successive Differentiation (n^{th} order derivatives), Leibnitz theorem and its application, Envelope, Involutes and Evolutes, Curve tracing: Cartesian and Polar co-ordinates ***9 hrs.***

Unit III **Differential Calculus-II:** Partial derivatives, Total derivative, Euler's Theorem for homogeneous functions, Taylor and Maclaurin's theorems for a function of one and two variables, Maxima and Minima of functions of several variables, Lagrange Method of Multipliers, Jacobians, Approximation of errors. ***9 hrs.***

Unit IV **Multivariable Calculus-I:**

Multiple integration: Double integral, Triple integral, Change of order of integration, Change of variables ***8 hrs.***

Application: Areas and volumes, Centre of mass and centre of gravity.

Unit V **Vector Calculus:**

Vector differentiation: Gradient, Curl and Divergence and their Physical interpretation, Directional derivatives, Tangent and Normal planes.

Vector Integration: Line integral, Surface integral, Volume integral, Gauss's Divergence theorem, Green's theorem, Stokes theorem (without proof) and their applications. ***8 hrs.***

Text Books:

1. B. V. Ramana, Higher Engineering Mathematics, Tata Mc Graw-Hill Publishing Company Ltd., 2008.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.
3. R K. Jain & S R K. Iyenger , Advance Engineering Mathematics, Narosa Publishing House 2002.

Reference Books:

1. E. Kreyszig, Advance Engineering Mathematics, John Wiley & Sons, 2005.
2. Peter V. O'Neil, Advance Engineering Mathematics, Thomson (Cengage) Learning, 2007.
3. Maurice D. Weir, Joel Hass, Frank R. Giordano, Thomas, Calculus, Eleventh Edition, Pearson.
4. D. Poole, Linear Algebra : A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. Ray Wylie C and Louis C Barret, Advanced Engineering Mathematics, Tata Mc-Graw-Hill; Sixth Edition.
7. P. Sivaramakrishna Das and C. Vijayakumari, Engineering Mathematics, 1st Edition, Pearson India Education Services Pvt. Ltd
8. Advanced Engineering Mathematics. Chandrika Prasad, Reena Garg, 2018.

ECC 101	**Basic Electrical Engineering**	L-3 T-1 P-0	4 credits

Pre-requisites: PCM as one subject in 12^{th} standard or equivalent level.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Memorize the the concepts of KVL/KCL and network theorems in solving DC circuits
CO2	Define the steady state behavior of single phase and three phase AC electrical circuits.

CO3	Recall the application areas of a single phase two winding transformer as well as an auto transformer and calculate their efficiency. Also identify the connections of a three phase transformer
CO4	Illustrate the working principles of induction motor, synchronous machine as well as DC machine and employ them in different area of applications.
CO5	To apply the components of low voltage electrical installations and perform elementary calculations for energy consumption

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2		1	1	1										
CO2	3	2		1	1	1										
CO3	3	3		1	1	1										
CO4	3	2		1	1	1										
CO5	3	2		1	1	1										
Average	**3**	**2.2**		**1**	**1**	**1**										

Course Contents **Contact Hours**

Unit I **DC Circuits:** Electrical circuit elements (R, L and C), Concept of active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, Kirchhoff‟s laws, Loop and nodal methods of analysis, Star-delta transformation, Superposition theorem, Thevenin theorem, Norton theorem. ***10 hrs***

Unit II **AC Circuits:** 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 R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections. ***7 hrs.***

Unit III **Transformers:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, transformation ratio, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections. ***8 hrs.***

Unit IV **Electrical Machines:** Rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic, Applications, starting and speed control of induction motor. Single-phase induction motor, Construction, working, Applications, Construction and working of dc motor, Construction and working of synchronous generators. ***10 hrs.***

Unit V **Electrical Installations:** Tools and Accessories, causes and prevention of accidents, Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. ***7 hrs.***

Text Books:

1. D. P. Kothari and I. J. Nagrath, "*Basic Electrical Engineering*", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "*Basic Electrical Engineering*", McGraw Hill, 2009. **Reference Books**
3. L. S. Bobrow, "*Fundamentals of Electrical Engineering*", Oxford University Press, 2011.
4. V. D. Toro, "*Electrical Engineering Fundamentals*", Prentice Hall India, 1989.
5. E. Hughes, "*Electrical and Electronics Technology*", Pearson, 2010.

ECC 151	**Electrical Engineering Lab.**	**L-0 T-0 P-3**	**1.5 credit**

Pre-requisites: PCM as one subject in 12th standard or equivalent level.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Get an exposure to common electrical components and their ratings.
CO2	Make electrical connections by wires of appropriate ratings.
CO3	Understand the usage of common electrical measuring instruments.
CO4	Understand the basic characteristics of transformers and electrical machines.

Mapping of course outcomes with program outcomes

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PEO 1**	**PEO 2**	**PEO 3**	**PEO 4**
CO1	2	2	1	3	2		1		1	1		1				
CO2	2	2	1	3	2		1		1	1		1				
CO3	2	2	1	3	2		1		1	1		1				
CO4	2	2	1	3	2		1		1	1		1				
Average	**2**	**2**	**1**	**3**	**2**		**1**		**1**	**1**		**1**				

Course Contents		**Contact Hours**
Complete at least 10 experiments from the following:		
Experiment 1	Verification of Kirchhoff"s laws	**P-2**
Experiment 2	Verification of Superposition Theorem	**P-2**
Experiment 3	Verification of Thevenin Theorem.	**P-2**
Experiment 4	Verification of Norton Theorem.	**P-2**
Experiment 5	To perform open circuit test on a single phase transformer.	**P-2**
Experiment 6	To perform short circuit test on a single phase transformer.	**P-2**
Experiment 7	To plot the B-H curve of a single phase transformer.	**P-2**

Experiment 8	Determination of (i) Percentage Regulation and (ii) efficiency by load test of a single phase transformer	**P-2**
Experiment 9	Determination of efficiency of a dc shunt motor by load test	**P-2**
Experiment 10	To study running and speed reversal of a three phase induction motor and record speed in both directions.	**P-2**

Readings:

1. Printed manual provided to students.

Reference video Lectures from Swayam portal:

MEC 151	**Engineering Graphics and Design**	**L-0 T-1 P-4**	**3 credits**

Pre-requisites: Knowledge of Mathematics, Computer, Geometry & Drawing.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Draw orthographic projections of lines, planes and solids.
CO2	Construct isometric scale, isometric projections and views.
CO3	Draw sections of solids including cylinders, cones, prisms and pyramids.
CO4	Draw projections of lines, planes, solids, isometric projections and sections of solids including cylinders, cones, prisms and pyramids using AutoCAD

Mapping of course outcomes with program outcomes

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PEO 1**	**PEO 2**	**PEO 3**	**PEO 4**
CO1	3	3	1	3	1						1	1				
CO2	3	3	1	3	1						1	1				
CO3	3	3	1	3	1						1	1				
CO4	3	2	1	3	3						1	1				
Average	**3**	**2.75**	**1**	**3**	**1.5**						**1**	**1**				

Course Contents **Contact Hours**

Unit 1	Introduction to Engineering Drawing, Orthographic Projections Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Scales – Plain and Diagonal Scales, Principles of Orthographic Projections – Conventions – Projections of Points and Lines inclined to both planes; Projections of planes inclined Planes – Auxiliary Planes.	1L-5P

Unit 2 Projections and Sections of Regular Solids Sections in lined to both the Planes – Auxiliary Views; Simple annotation, dimensioning and scale. Floor plans that include: windows, doors and fixtures such as WC, sink, shower, etc. Prism, Cylinder, Pyramid, Cone – Auxiliary Vies: Development of surfaces of Right Regular Solids–Prism, Pyramid, Cylinder and Cone. 1L-5P

Unit 3 Isometric Projections Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conversions. 1L-5P

Unit 4 Computer Graphics Listing the computer technologies the impact on graphical communication, Demonstration knowledge of the theory of CAD software, Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, applying various ways of drawing, Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, Printing documents to pater using the print command: orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface, Computer-aided design (CAD) software modeling of parts and assemblies. 1L-5P

Unit 5 Demonstration of a simple team design project Geometry and topology of engineered 1L-5P components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerance; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying color coding according to building drawing practice, drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modeling (BIM)

Readings:

1. Bhatt N.D., Panchal V.M. & Ingle P.R. (2014), Engineering Drawing, Charotar Publishing House
2. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. Agrawal B. & Agrawal C.M. (2012), Engineering Graphics, TMH Publication
4. Engineering Graphics & Design, A.P. Gautam & Pradeep Jain, Khanna Publishing House *5*. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing

Reference video Lectures from Swayam/Nptel portal: *https://nptel.ac.in/courses/112/105/112105294/*

BAS 105	Remedial Mathematics-I	L-3 T-1 P-0	4 credits

Pre-requisites: Mathematics as one subject in 10th standard or equivalent level.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Recall the the set, relation, function mapping and Complex numbers
CO2	Learn the Roots of the quadratic equations, concept of A.P., G.P. and H.P
CO3	Discuss the vector and trigonometry
CO4	Operate the limit, continuity, differentiability and integration
CO5	Apply the concept of two dimensional geometry

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	CO1	3	2	2		2							1			
CO2	CO2	3	2	2	2	1							1			
CO3	CO3	2	3	2	1	1	1	1					1			
CO4	CO4	2	3	2	1	1	1	1					1			
CO5	CO5	3	2	2		2							1			
Average	**Average**	**2.6**	**2.4**	**1.6**	**0.8**	**1.4**	**0.4**	**0.4**					**1**			

Course Contents **Contact Hours**

Unit I **Sets, Relations and Functions Mappings:** Sets and their representations; Union, Intersection and Complements of sets and their algebraic properties; Relations, Equivalence relations; Mappings one-one, into and onto mapping. ***8***

Complex Numbers: Complex numbers in the form a ± ib and their representation in a plane; Argand diagram; Algebra of complex numbers, Modulus and Argument of complex number, Square root of a complex number. Cube roots of unity, Triangle inequality.

Unit II	**Quadratic Equations:** Quadratic equations in real number system and their solutions; Relation between roots and coefficients, Nature of roots, Formation of quadratic equations with given roots. **Sequences and Series:** Arithmetic, Geometric and Harmonic progressions; Insertion of Arithmetic Geometric and Harmonic means between two given numbers; Relation between A.M., G.M. and H.M. Special series: $\sum n$, $\sum n^2$, $\sum n^3$.	***8***
Unit III	**Vector Algebra:** Vectors and Scalars, Components of vector in two dimensional and three dimensional space, Addition of vectors, Scalar and vector products. **Trigonometry:** Trigonometrical ratios and their values, Trigonometrical identities and equations; Inverse trigonometric functions and their properties.	***8***
Unit IV	**Differential Calculus:** Introduction to limits, continuity and differentiability; Differentiation of algebraic, polynomial, trigonometric, logarithmic, exponential functions; Simple applications of derivatives, Increasing and decreasing functions, Maxima and Minima of functions of one variable. **Integral Calculus:** Integration operation as an anti-derivative, Integration of algebraic, polynomial, trigonometric, exponential and logarithmic functions; Integration by substitution and by parts; Properties of definite integrals; Evaluation of definite integrals.	***10***
Unit V	**Two Dimensional Geometry:** Cartesian system of rectangular coordinates in a plane, Distance formula and section formula; Straight line and a pair of straight lines; Equations of a line, Slope and intercept of a line. Various forms of equations of a line, Intersection of lines, Angles between two lines, Conditions for concurrence of three lines, Distance of a point from a line, Parallel and perpendicular lines; Condition for co linearity of three points; Standard and general form of equation of circle, its radius and centre, Equation of a circle when the end points of a diameter are given, Condition for a line to be tangent to the circle, Condition for two intersecting orthogonal circles.	***10***

Reference Books:

1. *Mathematics* for Class IX, NCERT
2. *Mathematics* for Class X, NCERT
3. *Mathematics* for Class XI, NCERT
4. *Mathematics* for Class XII, NCERT

AOC 101	**Basics of Communication**	L-2 T-2 P-0	4 credits

Course Outcomes: At the end of the course, the student will be able to:

CO1	The student will able to basic knowledge of English language including listening, speaking, reading and writing skills.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4

CO1	1							3	3	2		2				
Average	**1**							**3**	**3**	**2**		**2**				

Course Contents **Contact Hours**

Unit I **Essentials of Communication:** Introducing Communication, Objectives of Communication, Media of Communication, Types of communication, Principles of Communication and Barriers to Communication ***10 hrs***

Unit II **Language Skills:** Reading, Writing, Listening and Speaking Skills. ***7 hrs.***

Unit III **Guidelines of Writing:** Paragraph Writing, Correct use of Punctuation Marks, Effective Sentence Structure. ***8 hrs.***

Unit IV **Vocabulary:** Word formation, Prefix, Suffix, Synonyms, Antonyms, Homophones. One word substitution, Idioms and Phrases, Technical Vocabulary. ***10 hrs.***

Unit V **Effective Writing:** Formal and Informal Letters, Personal Profiles: CV and Resume writing, Applications for Job. ***7 hrs.***

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Text Books:

1. Singh, R.P. and Kavita Tyagi. *Asset of General English*. Pragati Prakashan, Meerut, 2001.
2. Mohan, Krishna and Meenakshi Raman. *Effective English Communication*.

Reference Books:

1. Rizvi, M.Asharf . *Effective Technical Communication.* TMH, New Delhi, 2007.
2. Agarwal, Malti. *Professional Communication.* Krishna Prakashan, Meerut, 2009 .

AOC 102	**Fundamentals of Computer**	**L-2 T-2 P-0**	**4 credits**

Course Outcomes: At the end of the course, the student will be able to:

CO1	The student will able to basic knowledge of Computer and Ms Office etc

Mapping of course outcomes with program outcomes

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PEO 1**	**PEO 2**	**PEO 3**	**PEO 4**
CO1	3	3		3			2					2				
Average	**3**	**3**		**3**			**2**					**2**				

Course Contents **Contact Hours**

Unit I **Introduction to Computer:** Generations of Computer (I-V), Computer Definition, Block Diagram of a Computer, Advantages of Computer, Limitation of Computer, Characteristics of Computer, Application of Computer. ***5 hrs***

Unit II **Input and Output Devices:** Functions of the Different Units, Input unit, Output unit, Memory unit, CPU (ALU+CU), Input & Output Devices Input Devices, Data Scanning devices, Output Devices ***4 hrs.***

Unit III **Memories:** RAM/ROM, Binary Number System, Bits, Bytes.
Software: System Software, Utility Programs, Application Software ***6hrs.***

Unit IV **Internet:** WWW, Domain name, IP Address, MAC address, Create E-Mail ID, Write a mail, attachment, send a mail, and read a mail, CC, BCC ***6 hrs.***

Unit V **MS office**: Microsoft Word, Microsoft Excel, Microsoft PowerPoint Microsoft Flash, and Paint Brush. ***4 hrs.***
.

Reference Books:

1. Sharma, A.K. *Fundamentals of Computers and Programming with C*. Dhanpat Rai Publications, New Delhi, 2005.

BAS 202	Chemistry	L-3 T-1 P-0	4 credits

Pre-requisites: Chemistry as one subject in 12th standard or equivalent level.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Recall the instruments for atomic and molecular structure
CO2	Determine Structure of Compound by spectroscopic methods.
CO3	analyze the importance of Chemical Industry
CO4	understand the basic concept of hardness of water and its removal techniques.
CO5	Study the manufacture of different products like fuel, cement, polymer, glass, soap and detergents by modern methods

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	2		2	1	2					1				
CO2	2	2	2	2	1							1				

CO3	2	3	2	1	1	1	1					1				
CO4	2	3	2	1	1	1	1					1				
CO5	2	2	2		2							1				
Average	**2**	**2.4**	**2**	**0.8**	**1.4**	**0.6**	**0.8**					**1**				

Course Contents **Contact Hours**

Unit I **Atomic and Molecular Structure:** Molecular orbital's of diatomic molecules. Band theory of solids. Liquid crystal and its applications. Point defects in solids. Structure and applications of Graphite and Fullerenes. Concepts of Nanomaterials and its application. ***10 hrs***

Unit II **Spectroscopic techniques and Applications:** Elementary idea and simple applications of Rotational, Vibrational, Ultraviolet& Visible and Raman spectroscopy ***7 hrs.***

Unit III **Electrochemistry:** Nernst Equation and application, relation of EMF with thermodynamic functions (ΔH, ΔF and Δ S). Lead storage battery.

Corrosion ; causes, effects and its prevention. ***8 hrs.***
Phase Rule and its application to water system..
Software: System Software, Utility Programs, Application Software

Unit IV **Water Analysis:** Hardness of water, Techniques for water softening (Lime-soda, Zeolite, Ion exchange resin and Reverse osmosis method). ***10 hrs.***
Fuels: Classification of fuels, Analysis of coal, Determination of calorific value (Bomb calorimeterand Dulong‟smethos).

Unit V **Polymer:** Basic concepts of polymer-Blend and composites, Conducting and biodegradable polymers. Preparation and application of some industrially important polymers (Buna-S, Buna-N, Neoprene, Nylon-6, ***7 hrs.***
nylon-6,6 and Terylene). General methods of synthesis of organometallic compounds (Grignard reagent) and their applications.
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Reference Books:

1. University Chemistry By B.H. Mahan
2. University Chemistry By C.N.R. Rao
3. Organic Chemistry By I.L. Finar
4. Physical Chemistry By S. Glasstone
5. Engineering Chemistry By S.S. Dara
6. Polymer Chemistry ByFre W., Billmeyer
7. Engineering ChemistryBy Satya Prakash

BAS 251	**Chemistry Lab.**	**L-0 T-0 P-3**	**1.5 credit**

Pre-requisites: Chemistry as one subject in 12th standard or equivalent level.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Use of different analytical instruments..
CO2	Measure molecular/system properties such as surface tension, viscosity, conductance of solution, chloride and iron content in water
CO3	Measure hardness of water.
CO4	Estimate the rate constant of reaction.
CO5	Determine Structure of Compound by spectroscopic methods.

Mapping of course outcomes with program outcomes

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PEO 1**	**PEO 2**	**PEO 3**	**PEO 4**
CO1	2	2	2		2	1	2					1				
CO2	2	2	2	2	1							1				
CO3	2	3	2	1	1	1	1					1				
CO4	2	3	2	1	1	1	1					1				
CO5	2	2	2		2							1				
Average	**2**	**2.4**	**2**	**0.8**	**1.4**	**0.6**	**0.8**					**1**				

Course Contents **Contact Hours**

Complete at least 10 experiments from the following:

Experiment 1 Determination of alkalinity in the given water sample.
Determination of temporary and permanent hardness in water sample using EDTA. **P-2**

Experiment 2 Determination of temporary and permanent hardness in water sample using EDTA. **P-2**

Experiment 3 Determination of iron content in the given solution by Mohr's method. **P-2**

Experiment 4 Determination of viscosity of given liquid. **P-2**

Experiment 5	Determination of surface tension of given liquid.	**P-2**
Experiment 6	Determination of chloride content in water sample.	**P-2**
Experiment 7	Determination of available chlorine in bleaching powder.	**P-2**
Experiment 8	Determination of pH by pH-metric titration.	**P-2**
Experiment 9	Preparation of Phenol-formaldehyde and Urea-formaldehyde resin.	**P-2**
Experiment 10	Determination of Cell constant and conductance of a solution.	**P-2**
Experiment 11	Determination of rate constant of hydrolysis of esters.	**P-2**
Experiment 12	Verification of Beer's law.	**P-2**

Readings:

1. Printed manual provided to students.

Reference video Lectures from Swayam portal: *https://onlinecourses.nptel.ac.in/noc21_mm02/preview*

BAS 204	Mathematics-II	L-3 T-1 P-0	4 credits

Pre-requisites: Mathematics as one subject in 12th standard or equivalent level.

Purpose: To develop a mathematical capability in the engineering students through the learning of basic concepts of mathematics and their applications in engineering & technology. A student will able to think logically the solution of engineering problems to develop new technology **Course Outcomes:** At the end of the course, the student will be able to:

CO1	Recall the differentiation and apply for solving differential equations
CO2	Learn definite integral and apply for evaluating surface areas and volumes
CO3	Discuss the concept of convergence of sequence and series. Also evaluate Fourier series
CO4	Operate of Laplace transforms and apply to solve ODE and PDE
CO5	Solution of engineering problems with Fourier and Z-transform

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2		2							1				
CO2	3	2	2	2	1							1				
CO3	2	3	2	1	1	1	1					1				
CO4	3	3	2	1	1	1	1					1				
CO5	3	2	2		2							1				
Average	**2.8**	**2.4**	**1.6**	**0.8**	**1.4**	**0.4**	**0.4**					**1**				

Course Contents **Contact Hours**

Unit I **Ordinary Differential Equation**: Linear differential equation of n^{th} order with constant coefficients, Simultaneous linear differential equations, Second order linear differential equations with variable coefficients, Solution by changing independent variable, Reduction of order, Normal form, Method of variation of parameters, Cauchy-Euler equation, Series solutions (Frobenius Method). ***10 hrs***

Unit II **Multivariable Calculus-II**: Improper integrals, Beta & Gama function and

their properties, Dirichlet's integral and its applications, Application of definite integrals to evaluate surface areas and volume of revolutions. ***7 hrs.***

Unit III **Sequences and Series:** Definition of Sequence and series with examples, Convergence of sequence and series, Tests for convergence of series, (Comparison Test, Ratio test, Cauchy Root Test, Raabe's test). ***8 hrs.***

Fourier series: Half range sine and cosine series, Parseval's theorem.

Unit IV **Transform Calculus-1:** Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method. ***10 hrs.***

Unit V Transform Calculus-2: Fourier transforms and Z-transform: properties, methods, inverses and their applications. ***7 hrs.***

Text Books:

1. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Ltd., 2008.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.
3. R. K. Jain & S. R. K. Iyenger , Advance Engineering Mathematics , Narosa Publishing House, 2002

Reference Books:

1. E. Kreyszig, Advance Engineering Mathematics, John Wiley & Sons, 2005.
2. Peter V. O'Neil, Advance Engineering Mathematics, Thomson (Cengage) Learning, 2007.
3. Maurice D. Weir, Joel Hass, Frank R.Giordano, Thomas, Calculus, Eleventh Edition, Pearson.
4. G.B Thomas, R L Finney, Calculus and Analytical Geometry, Ninth Edition Pearson, 2002.
5. James Ward Brown and Ruel V Churchill, Fourier Series and Boundary Value Problems, 8th Edition-Tata McGraw-Hill
6. D. Poole , Linear Algebra : A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
7. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
8. Charles E Roberts Jr, Ordinary Diffrential Equations, Application, Model and Computing, CRC Press T&F Group.
9. Ray Wylie C and Louis C Barret, Advanced Engineering Mathematics, 6th Edition, Tata McGraw-Hill.
10. James Ward Brown and Ruel V Churchill, Complex Variable and Applications, 8th Edition, Tata McGraw-Hill.
11. P. Sivaramakrishna Das and C. Vijayakumari, Engineering Mathematics, 1st Edition, Pearson India Education Services Pvt. Ltd.
12. Advanced Engineering Mathematics By Chandrika Prasad, Reena Garg Khanna Publishing House, Delhi

CSC 201	Programming for Problem Solving	L-3 T-1 P-0	4 credits

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the basics of Computer System and Hardware Organization
CO2	Learn the different tests of Memory Units, Input and Output Devices and Input Output Ports.
CO3	Understand Basics of Programming Languages and Operating Systems and Graphical User Interface and Windows
CO4	Solve Programming Methodology, Arrays and Structures
CO5	Apply techniques of Operations and Expressions.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2		2							1				
CO2	3	2	2	2	1							1				
CO3	2	3	2	1	1	1	1					1				
CO4	3	3	2	1	1	1	1					1				
CO5	3	2	2		2							1				
Average	**2.8**	**2.4**	**1.6**	**0.8**	**1.4**	**0.4**	**0.4**					**1**				

Contact Hours

Course Contents

Unit I **Computer System**: Components of computer systems, history; Operating system, Input and output devices, memory units, Processor, Compiler, Assembler, Interpreter, Loader, Linker, System software and Application software. ***10 hrs***

Algorithm: Steps to solve logical and numerical problems, Representation of Algorithm: Flow Chart and Pseudo code with examples, from algorithm to Program, Source Code

Unit II **Programming Languages:** Low level programming languages, High level languages.

Introduction to 'C': History, Structure of a C program,Use of Editor, Compilation and execution of program, Syntax and Logical errors in compilation, object and executable code, Data types, C tokens, Basic input output through printf( ) and scanf( ), Comments. ***7 hrs.***

Unit III

Operations and Expressions: Operators- arithmetic, relational and logical, Order of evaluation of expression, Special Operators: assignment, bitwise shift Operators, type conversion. ***8 hrs.***

Conditional Branching: Applying if and switch statements, nested if and else, use of break and default with switch, Compound statements.

Iterations and loops: Use of for, while and do-while loops, Use of break and continue statements

Unit IV

Functions: Introduction, Functions prototypes, Parameters passing in functions: call by value and call by reference, Returning values from functions, Scope rules of variables, Storage class specifiers, Recursion.

Arrays : Array notaion and representation, One dimensional array, Strings, Multidimensional arrays, Passing arrays to function. ***10 hrs.***

Structures:Structure, Defining structure, Nested structures, Array of structure, Passing structures to functions,User defined data types, Enumerated data types, Unions.

Unit V

Basic Algorithms: Searching: Linear and Binary Search; Sorting: Bubble sort.

Pointers and Functions: Idea of Pointers, Defining Pointer, Pointer notation, Declaration, applications, Introduction to Dynamic memory allocation and library functions, introduction to linked lists. ***7 hrs.***

File Handling in C: Data and information, File concepts, File organization, Files in C, Files and streams, Stream I/O.

Reference Books:

1. Sharma, A.K. *Fundamentals of Computers and Programming with C*. Dhanpat Rai Publications, New Delhi, 2005.
2. Ritchie, Dennis M. and Brian W. Kernigham. *The C Programming Language*. PHI, New Delhi, 1988.
3. Williams, Brian K. and Stacy C. Sawyer. *Using Information Technology*. TMH, New Delhi, 2003.
4. Curtin, Dennis P., Kim Foley, Kunal Sen, and Cathleen Morin. *Information Technology.* TMH, 1998.
5. King, K.N. *C Programming – A Modern Approach*. WW Norton & Co., 1996.

CSC 251	Programming for Problem Solving Lab	L-0 T-0 P-3	1.5 credit

Course Outcomes: At the end of the course, the student will be able to:

CO1	Explain the basic syntax, structure and execution of programs written in C language.
CO2	Develop the C code for a given algorithm.
CO3	Implement Programs with pointers and arrays, perform pointer arithmetic, and use the pre-processor.
CO4	Write programs that perform operations using derived data types.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	1									1	1				
CO2	2	2	3			1			1			1				
CO3	2	2										1				
CO4	3	3	3			1					1	2				
Average	**2.25**	**2**	**1.5**			**0.5**			**0.25**		**0.5**	**1.75**				

Course Contents **Contact Hours**

Complete at least 10 experiments from the following:

Experiment 1 **Familiarization with programming environment (Choose any two programs)**

1. WAP that calculates the Simple Interest and Compound Interest. The Principal, Amount, Rate of Interest and Time are entered through the keyboard. **P-2**
2. WAP to calculate the area and circumference of a circle.
3. WAP that accepts the temperature in Centigrade and converts into Fahrenheit using the formula C/5=(F-32)/9.

Experiment 2 **Simple computational problems using arithmetic expressions** **P-2**

4. WAP that accepts the marks of 5 subjects and finds the sum and percentage marks obtained by the student.
5. WAP that swaps values of two variables using/without using a third variable.

Experiment 3 **Problems involving if-then-else structures (Choose any three programs)** **P-2**

6. WAP that checks whether the two numbers entered by the user are equal or not.
7. WAP to find the greatest of three numbers.
8. WAP that finds whether a given number is even or odd.
9. WAP that tells whether a given year is a leap year or not

Experiment 4 **Problems involving Switch-case (Choose any two programs)** **P-2**

10. WAP that accepts marks of five subjects and finds percentage and prints

grades according to the following criteria:

Between 90-100%----------Print ‘A’

80-90%----------Print ‘B’
60-80%----------Print ‘C’ Below
60%----------Print ‘D’

11. WAP that takes two operands and one operator from the user and perform the operation and prints the result by using Switch statement.

12. A program to input any number from 0 to 9, and display it in the form of words (using switch case)..

Experiment 5 **Loops, while and for loops (Choose any three programs)** **P-2**

1. A program to input any ten numbers and find highest & lowest from them.
2. A program to input a number and display its Table.
3. WAP to print the sum of all numbers up to a given number.
4. WAP to find the factorial of a given number.
5. WAP to print sum of even and odd numbers from 1 to N numbers.
6. WAP to print the Fibonacci series.
7. WAP to check whether the entered number is prime or not.
8. WAP to find the sum of digits of the entered number.
9. WAP to find the reverse of a number.
10. WAP to print Armstrong numbers from 1 to 100.
11. WAP to convert binary number into decimal number and vice versa.

Experiment 6 **1D Array manipulation (Choose any two programs)** **P-2**

1. WAP that simply takes elements of the array from the user and finds the sum of these elements.
2. WAP that inputs two arrays and saves sum of corresponding elements of these arrays in a third array and prints them.
3. WAP to find the minimum and maximum element of the array.
4. WAP to search an element in an array using Linear Search.
5. WAP to sort the elements of the array in ascending order using Bubble Sort technique.

Experiment 7 **Strings (Choose any two programs)** **P-2**

1. A program to check whether given string is palindrome or not.
2. A program to input a string and find its length.

WAP to implement strlen(), strcat(),strcpy() using the concept of Functions.

Experiment 8 **2D arrays (Choose any one program)** **P-2**

1. WAP to add and multiply two matrices of order nxn.
2. WAP that finds the sum of diagonal elements of a mxn matrix.

Experiment 9 **Functions, Recursive functions (Choose any three programs)** **P-2**

1. A Function to find factorial value of a given number.
2. A Function that returns sum of values from one to a given number.
3. A program to interchange values of two variables using Call by value.
4. A program to interchange values of two variables using Call by reference.
5. A program to find factorial of a number using recursive functions.

Experiment 10 **Pointers and dynamic memory allocation** **P-2**

1. WAP to swap two elements using the concept of pointers.

Experiment 11 **Structures** **P-2**

2. Define a structure data type TRAIN_INFO. The type contain Train No.: integer type Train name: string Departure Time: aggregate type TIME Arrival Time: aggregate type TIME Start station: string End station: string The structure type Time contains two integer members: hour and minute. Maintain a train timetable and implement the following operations:

(i) List all the trains (sorted according to train number) that depart from a particular section.

(ii) List all the trains that depart from a particular station at a particular time.

(iii) List all he trains that depart from a particular station within the next one hour of a given time.

List all the trains between a pair of start station and end station

Experiment 12 **Lab 12: File handling (Choose any one program)** **P-2**

1. WAP to compare the contents of two files and determine whether they are same or not.

WAP to check whether a given word exists in a file or not. If yes then find the number of times it occurs

MEC 252	Workshop Practices	L-0 T-1 P-4	3 credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Study and practice on machine tools and their operations
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply suitable tools for machining processes including turning, facing, thread cutting and tapping

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2	2	1							1				
CO2	3	2	2	2	1							1				
CO3	2	3	2	1	1	1	1					1				
CO4	2	3	2	1	1	1	1					1				
Average	**2.5**	**2.5**	**2**	**1.5**	**1**	**1**	**1**					**1**				

Course Contents **Contact Hours**

Complete at least 10 experiments from the following:

Machine shop:

Experiment 1	Study of machine tools in particular Lathe machine	**P-2**
Experiment 2	Demonstration of different operations on Lathe machine	**P-2**
Experiment 3	Practice of Facing, Plane Turning, step turning.	**P-4**
Experiment 4	Practice of taper turning, knurling and parting.	**P-4**

Fitting shop

Experiment 5	Preparation of T-Shape Work piece as per the given specifications.	**P-4**
Experiment 6	Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding.	**P-4**
Experiment 7	Practice marking operations.	**P-2**

Carpentry

Experiment 8 Study of Carpentry Tools, Equipment and different joints. **P-2**

Experiment 9 Practice of Cross Half lap joint, Half lap Dovetail joint and Mortise Tenon Joint **P-6**

Electrical & Electronics

Experiment 10 Introduction to House wiring, different types of cables. Types of power supply, types of motors, Starters, distribution of power supply, types of bulbs, parts of tube light, Electrical wiring symbols. **P-2**

Experiment 11 Soldering and de-soldering of Resistor, IC and Capacitor in PCB. **P-6**

Welding

Experiment 12 Instruction of BI standards and reading of welding drawings. **P-2**

Experiment 13 Practice of Butt Joint **P-2**

Experiment 14 Practice of Lap Joint **P-2**

Plumbing

Experiment 15 Practice of Internal threading, external threading, pipe bending, pipe fitting. **P-4**

Experiment 16 Pipes with coupling for same diameter and with reducer for different diameters. **P-4**

Readings:

1. Raghuwanshi B.S., Workshop Technology Vol. I & II, Dhanpath Rai & Sons.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2nd Edn, Scitech publishers.
3. John K.C., Mechanical Workshop Practice. 2nd Edn. PHI 2010.
4. Jeyapoovan T.and Pranitha S., Engineering Practices Lab Manual, 3rd Edn. Vikas Pub.2008.

Reference video Lectures from Swayam portal: *NA*

HSM 201	**Professional Communication and Soft Skills**	L-0 T-1 P-4	3 credits

Course Outcomes: At the end of the course, the student will be able to:

CO1	The student will acquire basic proficiency in English language including listening, speaking, reading and writing skills.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1					1	2	1	1	2	3		2				
Average					**1**	**2**	**1**	**1**	**2**	**3**		**2**				

Course Contents

		Contact Hours
Unit I	**Essential Vocabulary:** The concept of word Formation, Root words from foreign languages and their use in English, Basic words, Synonyms, Antonyms, Homophones, One word substitutes, Idioms and Phrases, and Technical Vocabulary.	***10 hrs***
Unit II	**Reading Techniques:** Approaches of reading, top down, bottom up, skimming, scanning, analyzing, summarizing, unseen passage	***7 hrs.***
Unit III	**Essential Grammar:** Phrase, Basic Clause, Sentence Patterns, Correct Usage of Different Word-Classes, Articles, Tense, Concord, Prepositions, and Transformation, Punctuation Marks.	***8 hrs.***
Unit IV	**Basic Technical Writing Skills:** Letter Writing Skills, Form & Structure, Writing Personal & Official Letters, Letters of Inquiry, Instruction Letters, Quotations, Supply Orders, Complaint and Adjustment Letters, Designing Resume, CV, Bio-Data and Job Application, Notices, Agenda, Minutes of Meeting.	***10 hrs.***
Unit V	**Nature and Style of sensible Writing:** Describing, Defining, Providing examples or evidence, Writing introduction and conclusion, Précis Writing, Essay Writing.	***7 hrs.***

Reference Books:

1. Rizvi, M. Ashraf. *Effective Technical Communication*. Tata McGraw-Hill, New Delhi, 2005.
2. Singh, R.P. and Kavita Tyagi .*Assets of General English*. Pragati Prakashan, Meerut, 2001.
3. Anderson, Paul V., *Technical Communication: A Reader-Centered Approach*. Cengage Learning, New Delhi, 2007.

HSM 251	Communication Lab.	L-0 T-1 P-4	3 credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	International Phonetic Alphabet, Phonemes, Allophones, Phonetic Transcription, Organs of Speech, Places and Manners of Articulation, Syllable
CO2	Practising the Accentual Patterns in English
CO3	Practising Strong and Weak-forms of Words
CO4	Practising Patterns of Tones in English
CO 5	Situational Dialogues, Telephonic Conversations
CO 6	Comprehending Online/Offline Audio or Video

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4

CO1					1	2	1	1	2	3		2				
CO2					1	2	1	1	2	3		2				
CO3					1	2	1	1	2	3		2				
CO4					1	2	1	1	2	3		2				
CO5					1	2	1	1	3	3		2				
CO6					1	2	1	1	3	3		2				
Average					**1**	**2**	**1**	**1**	**2.33**	**3**		**2**				

Course Contents		**Contact Hours**
Complete at least 10 experiments from the following:		
Experiment 1	Basics of Phonetics	**P-2**
Experiment 2	Stress in Speech	**P-2**
Experiment 3	Rhythm in Speech	**P-4**
Experiment 4	Intonation in Speech	**P-4**
Experiment 5	Conversational Skills	
Experiment 6	Listening Comprehension	
Experiment 7	Group Discussion, Non-verbal Communication, Presentation Skills, Job Interview, Debate, Extempore	

Reference Books:

1. Sethi, J. and P.V. Dhamija. *A Course in Phonetics & Spoken English*. 2nd Ed. New Delhi: Prentice Hall of India, 2008. Print
2. Roach, Peter. *English Phonetics & Phonology: A Practical Course*. 4th Ed. New Delhi: Cambridge University Press, 2009. CD-ROM, Print
3. Hornby, A.S. *Oxford Advanced Learner's Dictionary*. 8th Ed. New Delhi: Oxford University Press, 2010. CD-ROM, Print.
4. Dutt, P.K., G. Rajeevan and C.L.N. Prakash. *A Course in Communication Skills*. New Delhi: Cambridge University Press, 2008. CD-ROM, Print.

5. Kumar, E. Suresh and P. Sreehari. *A Handbook for English Language Laboratories*. New Delhi: Cambridge University Press, 2007. Print.
6. Sethi, J., K. Sadanand and D.V. Jindal. *A Practical Course in English Pronunciation*. New Delhi: Prentice Hall of India, 2004. CD-ROM, Print.
7. Kumar,E. Suresh. *A Handbook for English Language Laboratories*. Foundation Books; New Delhi, 2007.

BAS 206	Remedial Mathematics-II	L-3 T-1 P-0	4 credits

Course Outcomes: At the end of the course, the student will be able to:

CO1	Recall the differentiation & its applications
CO2	Learn the concept of three dimensional geometry.
CO3	Discuss the determinants and Matrices
CO4	Operate the Numerical techniques.
CO5	Apply the interpolation formulae & numerical integration

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2		2							1				
CO2	3	2	2	2	1							1				
CO3	2	3	2	1	1	1	1					1				
CO4	2	3	2	1	1	1	1				1	1				
CO5	3	2	2		2						1	1				
Average	**2.6**	**2.4**	**1.6**	**0.8**	**1.4**	**0.4**	**0.4**				**0.4**	**1**				

Course Contents **Contact Hours**

Unit I **Calculus:** Rolle's Theorem, Lagrange's Mean value theorem and Cauchy mean value theorem, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and L'Hospital's rule. ***10 hrs***

Unit II **Three Dimensional Geometry:** Concept of direction ratios and direction cosines; Distance between two points; Section formula. Equation of a plane; Various forms of equation of plane; Direction cosines of the normal to as plane; Parallel and perpendicular planes. ***7 hrs.***

Unit III **Matrices:** Addition and scalar multiplication, matrix multiplication; linear Independence, rank of a matrix, Cramer's Rule, inverse of a matrix, Consistency of linear systems of equations Eigen values and Eigen vectors of rectangular matrices. ***8 hrs.***

Unit IV **Numerical Methods:** Solution of linear equations: Gauss elimination

method, Gauss-Jordan method, Gauss-Seidel method, Regula Falsi method; Newton-Raphson's method. ***10 hrs.***

Unit V **Interpolation:** Newton's forward and backward difference formulae, Newton's divided difference formula, Stirling's and Bessel's central difference formulae, Lagrange's interpolation formula, Numerical differentiation with interpolation formulae. ***7 hrs.***

Numerical Integration: Simpson's rule (1/3 and 3/8 rule), Trapezoidal rule, Romberg's method.

Reference Books:

1. Grewal, B.S. *Higher Engineering Mathematics*. Khanna Publishers, Delhi.
2. Ramanna, B.V. *Higher Engineering Mathematics*. Tata-McGraw Hill, India.
3. Chapra, Stevan C. and Raymond P. Canale. *Numerical Methods for Engineers*. TataMcGraw Hill, India.
4. Haribaskaran, G. *Numerical Methods*. Laxmi Publications, New Delhi.

Shobhit
Institute of Engineering & Technology
Deemed to-be-University
EDUCATION EMPOWERS

CURRICULUM

For

BACHELOR OF TECHNOLOGY

IN

MECHANICAL ENGINEERING

(School of Engineering and Technology)

Prepared by:

Department of Mechanical Engineering

Shobhit Institute of Engineering and Technology

(Deemed to be University)

*In accordance with **AICTE** guidelines*
*In reference with **NIT Warangal***

Department of Mechanical Engineering
School of Engineering and Technology
Shobhit Institute of Engineering and Technology (Deemed to be University)

DEPARTMENT OF MECHANICAL ENGINEERING

Vision Statement of Mechanical Engineering Department

To be a global knowledge hub in mechanical engineering education, research, entrepreneurship and industry outreach services.

Mission Statement of Mechanical Engineering Department

- Impart quality education and training to the nurture globally competitive mechanical engineers.
- Provide vital state of the art research facilities to create, interpret, apply and disseminate knowledge.
- Develop linkages with world class educational institutions and R&D organizations for excellence in teaching, research and consultancy services.

Objectives of Mechanical Engineering Department

- To maintain a high standard of mechanical engineering education through outstanding teaching, innovative curricula, and research training that reflect the changing needs of society.
- To attract highly motivated students with enthusiasm, aptitude and interest in mechanical engineering.
- To recruit, retain, and develop the members of the Department.
- To increase the public awareness of Departmental activities and the Mechanical Engineering profession.

Program Outcomes (POs)

The Program Outcomes are the knowledge skills and attitudes which the students have at the time of graduation.

PO 1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO.1	Plan, design, construct, maintain and improve mechanical engineering systems that are technically sound, economically feasible and socially acceptable to enhance quality of life.
PEO.2	Apply modern computational, analytical, simulation tools and techniques to address the challenges faced in mechanical and allied engineering streams.
PEO.3	Communicate effectively using innovative tools and demonstrate leadership & entrepreneurial skills.
PEO.4	Exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning to achieve career and organizational goals.

Mapping of program educational objectives with Program Outcomes

(1: weak, 2: Moderate and 3: High)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
PEO1	3	3	3	2	2	3	-	1	1	2	2	2
PEO2	3	3	3	3	3	2	1	1	1	-	1	2
PEO3	2	2	2	2	3	3	2	2	2	3	-	1
PEO4	1	1	1	-	1	2	2	1	3	3	2	2

CURRICULAR COMPONENTS

Requirements for B. Tech in Mechanical Engineering Degree

Category of Courses	Credits Offered	Minimum credits required to be earned
Humanities and Social Sciences including Management courses (HSM)	09	09
Basic Science Courses (BAS)	23	23
Engineering Science Courses	24	24
Professional core courses (MEC)	53	53
Professional Elective courses (MEC)	19	19
Open Elective courses	15	15
Project Work, Seminar and Internship	17	17
Mandatory Courses (MCC)	0	0
Total	**160**	**160**

Semester wise Course credit distribution:

Sr. No.	Course Work - Subject Area	Credits / Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences including Management courses (HSM)	0	3	3	3	_	_	_	_	**09**
2	Basic Science Courses (BAS)	9.5	9.5	4	_	_	_	_	_	**23**
3	Engineering Science Courses	8	8	8	_	_	_	_	_	**24**
4	Professional core courses (MEC)	_	_	7	15	16	9	6	_	**53**

5	Professional Elective courses (MEC)	_	_	_	3	3	6	7	_	**19**
6	Open Elective courses	_	_	_	_	3	6	6	_	**15**
7	Project Work, Seminar and Internship	_	_	_	_	_	_	2	15	**17**
8	Mandatory Courses (MCC)	_	0	_	0	_	0	0	_	**0**
	Total	**17.5**	**20.5**	**22**	**21**	**22**	**21**	**21**	**15**	**160**

SCHEME OF TEACHING – B. TECH. MECHANICAL I YEAR

Semester I						
S.No.	**Subject**	**Subject Code**	**Credit**	**L**	**T**	**P**
1	Physics	BAS 101	4	3	1	0
2	Physics Lab.	BAS 151	1.5	0	0	3
3	Mathematics I	BAS 103	4	3	1	0
4	Basic Electrical Engineering	EEC 101	4	3	1	0
5	Basic Electrical Engineering Lab.	EEC 151	1	0	0	2
6	Engineering Graphics & Design	MEC 151	3	0	1	4
	MOOCs (For B.Tech. Hons. Degree**) ***					
		Total	**17.5**	**9**	**4**	**9**

Semester II						
S.No.	**Subject**	**Subject Code**	**Credit**	**L**	**T**	**P**
1	Chemistry	BAS 202	4	3	1	0
2	Chemistry Lab	BAS 252	1.5	0	0	3
3	Mathematics II	BAS 204	4	3	1	0
4	Programming for Problem Solving	CSC 201	3	3	0	0
5	Programming for Problem Solving Lab.	CSC 251	2	0	0	4
6	Workshop Practices	MEC 252	3	0	1	4

7	English	HSM 201	2	2	0	0
8	English Lab.	HSM 251	1	0	0	2
	MOOCs (For B.Tech. Hons. Degree**) ***					
		Total	**20.5**	**11**	**3**	**13**
	Mandatory Course I	**MCC 2__**		**2**	**0**	**0**

SCHEME OF TEACHING – B. TECH. MECHANICAL II YEAR

Semester III						
S.No.	**Subject**	**Subject Code**	**Credit**	**L**	**T**	**P**
1	Mathematics III	BAS 308	4	3	1	0
2	Managerial Economics	HSM 302	3	3	0	0
3	Basic Electronics Engineering	ECC 306	4	3	1	0
4	Engineering Mechanics	MEC 303	4	3	1	2#
5	Thermodynamics	MEC 304	4	3	1	2#
6	Materials Engineering	MEC 305	3	3	0	2#
	MOOCs (For B.Tech. Hons. Degree**) ***					
		Total	**22**	**18**	**4**	**0**

Semester IV						
S.No.	**Subject**	**Subject Code**	**Credit**	**L**	**T**	**P**
1	Industrial Psychology	HSM 403	3	3	0	0
2	Applied Thermodynamics	MEC 406	4	3	1	2#
3	Fluid Mechanics & Fluid Machines	MEC 407	4	3	1	2#
4	Strength of Materials	MEC 408	4	3	1	2#
5	Instrumentation & Control	MEC 409	3	3	0	0
6	Departmental Elective I	MEC 4__	3	3	0	0
	MOOCs (For B.Tech. Hons. Degree**) ***					
		Total	**21**	**18**	**4**	**0**

	Mandatory Course II	**MCC 4__**		**2**	**0**	**0**

List of Departmental Electives for fourth Semester

Sl. No	Code No.	Subject
1.	MEC 410	Internal Combustion Engines
2.	MEC 411	Machine tools and Machining
3.	MEC 418	Flexible Manufacturing System
4.	MEC 432	Advanced Thermodynamics
5.	MEC 433	Finite Element Method
6.	MEC 434	Advanced Welding Technology

SCHEME OF TEACHING –

MECHANICAL III YEAR

Semester V						
S.No.	**Subject**	**Subject Code**	**Credit**	**L**	**T**	**P**
1	Heat Transfer	MEC 512	4	3	1	2#
2	Solid Mechanics	MEC 513	4	3	1	2#
3	Manufacturing Processes	MEC 514	3	3	0	2#
4	Kinematics & Theory of Machines	MEC 515	4	3	1	2#
5	Departmental Elective II	MEC 5__	3	3	0	0
6	Open Elective I	___ 5__	3	3	0	0
7	Thermal Engineering Laboratory	MEC 553	1	0	0	2
	MOOCs (For B.Tech. Hons. Degree**) ***					
		Total	**22**	**18**	**3**	**2**

List of Departmental Electives for fifth Semester

Sl. No	**Code No.**	**Subject**
1.	MEC 516	Automotive Chassis
2.	MEC 517	Computer Integrated Manufacturing
3.	MEC 535	Computational Fluid Dynamics
4.	MEC 536	Mechanical Vibrations
5.	MEC 537	Design of Mechanisms
6.	MEC 538	Advanced Metal Forming

Note: Open Elective to be chosen from list provided for courses available for B.Tech. Programme

MECHANICAL III YEAR

Semester VI						
S.No.	**Subject**	**Subject Code**	**Credit**	**L**	**T**	**P**
1	Manufacturing Technology	MEC 619	4	4	0	2#
2	Design of Machine Elements	MEC 620	4	3	1	2#

SCHEME OF TEACHING –

3	Departmental Elective III	MEC 6__	3	3	0	0
4	Departmental Elective IV	MEC 6__	3	3	0	0
5	Open Elective II	___ 6__	3	3	0	0
6	Open Elective III	___ 6__	3	3	0	0
7	Design Engineering Laboratory	MEC 654	1	0	0	2
	MOOCs (For B.Tech. Hons. Degree**) ***					
	Mandatory Course III	**MCC 6__**		**2**	**0**	**0**
		Total	**21**	**19**	**1**	**2**

List of Departmental Electives for sixth Semester

Sl. No	Code No.	Subject
1.	MEC 621	Non-Destructive Evaluation and Testing
2.	MEC 622	Mechatronics Systems
3.	MEC 623	Vehicle Dynamics
4.	MEC 639	Rotor Dynamics
5.	MEC 640	Mechanics of Composite Materials
6.	MEC 641	Advanced Manufacturing Processes
7.	MEC 642	Micro and Nano Manufacturing
8.	MEC 643	Refrigeration and Air Conditioning
9.	MEC 644	New Venture Creation
10.	MEC 645	Energy Systems and Management

Note: Open Elective to be chosen from list provided for courses available for B.Tech. Programme

MECHANICAL IV YEAR

Semester VII						
S.No.	**Subject**	**Subject Code**	**Credit**	**L**	**T**	**P**
1	Operations Research	MEC 724	3	3	0	0
2	Industrial Automation	MEC 725	3	3	0	0
3	Departmental Elective V	MEC 7__	3	3	0	0

SCHEME OF TEACHING –

4	Departmental Elective VI	MEC 7__	3	3	0	0
5	Open Elective IV	___ 7__	3	3	0	0
6	Open Elective V	___ 7__	3	3	0	0
7	Mechanical Engineering Laboratory (Departmental Elective Specific)	MEC 75_	1	0	0	2
8	Project	MEC 771	2	0	0	4
	MOOCs (For B.Tech. Hons. Degree**) ***					
		Total	**21**	**18**	**0**	**6**
	Mandatory Course IV	**MCC 7__**		**2**	**0**	**0**

List of Departmental Electives for Seventh Semester

Sl. No	Code No.	Subject
1.	MEC 726	Automobile Engineering
2.	MEC 727	Tool Design
3.	MEC 728	New Venture Creation
4.	MEC 729	Industrial Robotics
5.	MEC 730	Supply Chain Management
6.	MEC 731	Rapid Prototyping
7.	MEC 746	Power Plant Engineering
8.	MEC 747	Gas Dynamics
9.	MEC 748	Innovative Design
10.	MEC 749	Theory of Constraints

Note: Open Elective to be chosen from list provided for courses available for B.Tech. Programme **List of Departmental Electives Laboratories for Seventh Semester**

Sl. No	Code No.	Subject
1.	MEC 755	Automobile Engineering Laboratory
2.	MEC 756	Production Engineering Laboratory

Semester VIII						
S.No.	**Subject**	**Subject Code**	**Credit**	**L**	**T**	**P**
1	Internship	MEC 881	15	0	0	0
		Total	**15**	**0**	**0**	**0**

List of Open Electives for B.Tech. Programme in School of Engineering and Technology

Sl. No	Code No.	Subject	Department offering the Course
1.	OME 01	Industrial Safety	Department of Mechanical Engineering
2.	OME 02	Total Quality Management	Department of Mechanical Engineering
3.	OME 03	Maintenance and Reliability	Department of Mechanical Engineering
4.	OME 04	Engineering Acoustics	Department of Mechanical Engineering
5.	OME 05	Project Management	Department of Mechanical Engineering
6.	OCS 01	Artificial Intelligence	Department of Computer Science and Engineering
7.	OCS 02	Data Warehousing & Data Mining	Department of Computer Science and Engineering
8.	OCS 03	Cloud Computing	Department of Computer Science and Engineering
9.	OCS 04	Cryptography and Network Security	Department of Computer Science and Engineering
10.	OCS 05	Internet-of-Things	Department of Computer Science and Engineering
11.	OEC 01	Digital Electronics	Department of Electronics and Communication Engineering
12.	OEC 02	Electronic Measurement & Instrumentation	Department of Electronics and Communication Engineering
13.	OEC 03	Signals and Systems	Department of Electronics and Communication Engineering
14.	OEC 04	MATLAB Programming for Engineers	Department of Electronics and Communication Engineering
15.	OEC 05	Communication Systems	Department of Electronics and Communication Engineering

List of Mandatory Courses:

Sl. No	Code No.	Subject	Department offering the Course
1.	MCC 01	Environmental Studies	Applied Science Department
2.	MCC 02	Human Rights	School of Law and Constitutional Studies
3.	MCC 03	Indian Civilization	School of Law and Constitutional Studies
4.	MCC 04	Skill development	University Training and Development Cell
5.	MCC 05	Personality Development & Soft Skill	University Training and Development Cell
6.	MCC 06	Technical Seminar	Department of Mechanical Engineering
7.	MCC 07	Knowledge Enhancement	Applied Science Department
8.	MCC 08	Technical Report Writing	Department of Mechanical Engineering
9.	MCC 09	Foreign Language	Applied Science Department
10.	MCC 10	Energy Studies	Department of Mechanical Engineering

*** Optional for B.Tech. Hons. Degree minimum 20 credits required (5 subjects of 4 credits each)**

 # Non-Credit but mandatory to complete minimum 5 experiments for Subject.

Detailed Syllabus
Year 2 and Semester 3

BAS 308	Mathematics III	L-3 T-1 P-0	4 credits

Pre-requisites:

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve field problems in engineering involving PDEs
CO2	Formulate and solve problems involving random variables
CO3	Apply statistical methods for analyzing experimental data

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	1	2	1	2		1					1		2		3
CO2	3	3	3	2		1						1		2		2
CO3	3	3	2	3	1	1	1					1		3		2
Average	**3**	**2.33**	**2.33**	**2**	**1.5**	**1**	**1**					**1**		**2.66**		**2.33**

Course Contents **Contact Hours**

Unit 1 Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and boundary conditions, D' Alembert's solution of the wave equation. **L-**

Unit 2 Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. Wave equations upto to dimensions. **L-**

Unit 3 Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution. **L-**

Unit 4 Measure of central tendency (Mean, Median and Mode) and Dispersion (Range, Deviation from the mean, Variance, Standard deviation, Coefficient of variation), Moments, skewness and Kurtosis, Correlation and Regression analysis. **L-**

Unit 5 Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes. **L-**

Readings:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
3. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Reference video Lectures from Swayam portal:

HSM 302	Managerial Economics	L-3 T-0 P-0	3 credits

Pre-requisites:

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the roles of managers in firms and make optimal business decisions by integrating the concepts of economics, mathematics and statistics and analyze real-world business problems with a systematic theoretical framework.
CO2	Examine the internal and external decisions to be made by managers.
CO3	Critical analyze the demand and supply conditions and assess the position of a company.
CO4	Design competition strategies, including costing, pricing, product differentiation, and market environment according to the natures of products and the structures of the markets.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	3	1	1	1										2	3
CO2	1	2	3	1	2										3	3
CO3					2									2	1	2
CO4	1	1	1	2	2										2	3
Average	**1.33**	**2**	**1.66**	**1.33**	**1.75**									**2**	**2**	**2.75**

Course Contents **Contact Hours**

Unit 1 Introduction of Engineering Economics and Demand Analysis: Meaning and nature of Economics, Relation between science, engineering, technology and economics; Meaning of Demand, Determinants of Demand, shifts in demand, Law of Demand, Price Elasticity of Demand &Types, Income Elasticity, Cross price Elasticity, Determinants of Elasticity, uses and importance of elasticity. **L-**

Unit 2 Concept of Supply: Law of Supply, Factors affecting Supply, Elasticity of supply. Demand Forecasting: Introduction, Meaning and Forecasting, Methods or Techniques of Demand Forecasting, Criteria for Good Demand Forecasting, Demand Forecasting for a New Product. **L-**

Unit 3 Cost Analysis - Introduction, Types of Costs, Cost - Output Relationship: Cost Function, Cost - Output Relationships in the Short Run, and Cost - Output Relationships in the Long Run; Short run and long run, Break-Even Analysis; Production functions: laws of variable proportions, law of returns; Economies of scale: Internal and external. **L-**

Unit 4 Market Structure: Market Structure Perfect Competition, Imperfect competition – Monopolistic, Oligopoly, duopoly sorbent features of price determination and various market conditions. **L-**

Unit 5 Nature and characteristics of Indian economy, concepts of LPG, elementary concepts of National Income, **L-** Inflation and Business Cycles ,Concept of N.I. and Measurement., Meaning of Inflation, Types and causes , Phases of business cycle .Investment decisions for boosting economy(National income and per capital income).

Readings:

1. Premvir Kapoor, Sociology and Economics for Engineers, Khanna Publishing House (Edition 2018)
2. Salvatore D, "Principles of Microeconomics", Oxford University Press.
3. Koutsoyiannis A, "Modern Microeconomic", Macmillan Education Ltd.
4. Dwivedi DN, "Principles of Microeconomics", Pearson Education.
5. Cowell, FA, "Microeconomic Principles and Analysis", Oxford University Press. **Reference video Lectures from**

Swayam portal:

ECC 306	Basic Electronics Engineering	L-3 T-1 P-0	4 credits

Pre-requisites:

Course Outcomes: At the end of the course, the student will be able to:

CO1	Acquire basic knowledge on the working of various semi-conductor devices
CO2	Develop analysis capability in BJT and FET Amplifier Circuits
CO3	Develop competence in frequency response analysis of discrete amplifiers
CO4	Understand design competence in signal and power amplifiers using BJT and FET
CO5	Acquire knowledge on basic digital electronic gates
CO6	Develop knowledge on design trade-offs in various digital electronic families with a view towards reduced power consumption

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	1			1								1			1
CO2	2	2	1	2	1									2		
CO3	2	2	1	2	1									2		1
CO4	2	2	2	2	2								2			
CO5	2	2	1	1									1			1
CO6	2	2	2	2	1								2			1
Average	**2**	**1.83**	**1.4**	**1.8**	**1.2**								**1.5**	**2**		**1**

Course Contents **Contact Hours**

Unit 1 Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth. **L-**

Unit 2 Operational amplifier and its applications: Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier **L-**

applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

Unit 3 Timing Circuits and Oscillators: RC-timing circuits, IC 555 and its applications as a stable and mono-stable multi-vibrator, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator. **L-**

Unit 4 Digital Electronics Fundamentals: Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, de-multiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications. **L-**

Unit 5 Electronic Communication Systems: The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system. **L-**

Readings:

1. Floyd, “Electronic Devices” Pearson Education 9th edition, 2012.
2. R.P. Jain, “Modern Digital Electronics”, Tata Mc Graw Hill, 3rd Edition, 2007.
3. Frenzel, “Communication Electronics: Principles and Applications”, Tata Mc Graw Hill, 3rd Edition, 2001. **Reference**

video Lectures from Swayam portal:

MEC 303	Engineering Mechanics	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Mathematics and Physics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine the resultant force and moment for a given force system.
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction.
CO3	Calculate the motion parameters for a body subjected to a given force system.
CO4	Determine the deformation of a shaft and understand the relationship between material constants.
CO5	Determine the centroid and second moment of area

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2	1								1		2		2
CO2	3	3	2	2								1	1	3	2	1
CO3	3	3	2	1								1	3	2		
CO4	3	3	3	1								1	3			
CO 5	3	3	3	1								1	3	1		1
Average	**3**	**3**	**2.4**	**1.8**								**1**	**2.5**	**2**	**2**	**1.33**

Course Contents **Contact Hours**

Unit 1 Introduction to Engineering Mechanics: Force System's Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy. **L-6, T-2**

Unit 2 Friction: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack. **L-6, T-2**

Unit 3 Basic Structural Analysis: Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines **L-6, T-2**

Unit 4 Centroid and Centre of Gravity: Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, **L-6, T-2**

	Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.	
Unit 5	Virtual Work and Energy Method: Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.	**L-6, T-2**

Readings:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press.

Reference video Lectures from Swayam portal: *https://nptel.ac.in/courses/112/103/112103109/*

MEC 304	Thermodynamics	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Mathematics and Physics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concepts of continuum, system, control volume, thermodynamic properties, thermodynamic equilibrium, work and heat.
CO2	Apply the laws of thermodynamics to analyze boilers, heat pumps, refrigerators, heat engines, compressors and nozzles.
CO3	Evaluate the performance of steam power cycles.
CO4	Evaluate the available energy and irreversibility.
CO5	Evaluate properties of pure substances and gas mixtures.
CO 6	Analyze air standard cycles applied in prime movers.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	3	3	2	1	2	1	2			2	1		2	1
CO2	3	3	2	3	3	1	2		2			2		3		1
CO3	3	2	1	2	1	1	1		2			2	3	1		
CO4	3	3	3		1	1	1		2			2	3	1		
CO5	3	3	1	3	1	1	2		2			2	3		1	
CO6	3	3	1	3	2	1	2		1			2	2			
Average	**3**	**2.83**	**1.83**	**2.8**	**1.66**	**1**	**1.66**	**1**	**1.83**			**2**	**2.4**	**1.67**	**1.5**	**1**

Course Contents **Contact Hours**

Unit 1 Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers **L-6, T-2**

Unit 2 Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; **L-6, T-2**

Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

Unit 3 Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale. **L-6, T-2**

Unit 4 Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Principle of increase of entropy; Illustration of processes in T-s coordinates **L-6, T-2**

Unit 5 Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle. **L-6, T-2**

Readings:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

Reference video Lectures from Swayam portal:

MEC 305	Material Engineering	L-3 T-0 P-0	3 credits

Pre-requisites: Basic knowledge of Chemistry and Materials.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the crystal structure and classification of materials.
CO2	Understand methods of determining mechanical properties and their suitability for applications.
CO3	Classify cast irons and study their applications.
CO4	Interpret the phase diagrams of materials.
CO5	Select suitable heat-treatment process to achieve desired properties of metals and alloys.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	3	2	1	2		1					1	1		2	
CO2	2	3	2	1	2		1					1	2	3		
CO3	2	3	1	1	1		3					1	1			
CO4	2	3	1	1	2		1					1	2	1		
CO5	2	3	2	1	2		3					1	2		1	
Average	**2**	**3**	**1.6**	**1**	**1.8**		**1.8**					**1**	**1.6**	**2**	**1.5**	

Course Contents **Contact Hours**

Unit 1 Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. **8 L**

Unit 2 Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. **8 L**

Unit 3 Static failure theories: Ductile and brittle failure mechanisms, Tresca's, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fatigue: low and high cycle fatigue test, S-N Curve, Endurance and Fatigue limits, Crack initiation and propagation mechanisms and Paris law, Effect of surface and metallurgical parameters on fatigue, Failure analysis, sources of failure, procedure of failure analysis. **8 L**

Unit 4	Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.	**8 L**
Unit 5	Heat treatment of Steel: Annealing, tempering, normalizing and spheroidizing, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening	**8 L**

Readings:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

Reference video Lectures from Swayam portal:

HSM 403	Industrial Psychology	**L-3 T-0 P-0**	**3 credits**

Pre-requisites:

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understanding the various methods of Training
CO2	Knowledge of the Training calendar
CO3	Understand the training need assessment and analysis
CO4	Understanding the concepts, the concepts of quality of work life

Mapping of course outcomes with program outcomes

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PEO 1**	**PEO 2**	**PEO 3**	**PEO 4**
CO1	3					2			3						3	2
CO2		2	3		2				2	3					2	2
CO3		2		3		2									1	2
CO4	3		2	2			2			2				1	1	1
Average	**3**	**2**	**2.5**	**2.5**	**2**	**2**	**2**		**2.5**	**2.5**				**1**	**1.75**	**1.75**

Course Contents **Contact Hours**

Unit 1 **L-12**

Unit 2 **L-8**

Unit 3 **L-8**

Unit 4 **L-8**

Unit 5 **L-8**

Readings:

1.

Reference video Lectures from Swayam portal:

MEC 406	Applied Thermodynamics	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Thermodynamics and Mechanics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply thermodynamic concepts to analyze turbo machines.
CO2	Analyze power plant and propulsion cycles.
CO3	Analyze impulse and reaction machines for energy transfer.
CO4	Design gas turbine and steam turbine components.
CO5	Evaluate the thermal performance of machines components.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2	3	1							1	1	3		
CO2	3	3	3	2	1							1		2		1
CO3	3	2	2	2	1							1		3		1
CO4	3	3	3	2	2							1	3			
CO5	3	2	2	2	2							1	2			1
Average	**3**	**2.6**	**2.4**	**2.2**	**1.4**							**1**	**2**	**2.66**		**1**

Course Contents **Contact Hours**

Unit 1 Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy. **L-6, T-2**

Unit 2 Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Super-critical and ultra-super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual Cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties. **L-6, T-2**

Unit 3 Properties of dry and wet air, use of psychrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point. **L-6, T-2**

Unit 4 Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a

nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, supersaturation- compressible flow in diffusers, efficiency of nozzle and diffuser. **L-6, T-2**

Unit 5 Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors. Analysis of steam turbines, velocity and pressure compounding of steam turbines. **L-6, T-2**

Readings:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals ofThermodynamics*, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd.

Reference video Lectures from Swayam portal:

MEC 407	Fluid Mechanics and Fluid Machines	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Physics, Mathematics, Thermodynamics and Mechanics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply conservation laws to fluid flow problems in engineering applications.
CO2	Design experimental procedure for physical model studies.
CO3	Design the working proportions of hydraulic machines.
CO4	Compute drag and lift coefficients using the theory of boundary layer flows.
CO5	Analyze and design free surface and pipe flows
CO6	Formulate and solve one dimensional compressible fluid flow problems

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2	2								2		2		2
CO2	3	3	3	3								2	3			2
CO3	2	1	3	1	1							1	3			2
CO4	2	1	3	2				1				1	3			
CO5	3	2	3	2	1							1		3		2
CO6	3	2	2	2	1							2	2			
Average	**2.66**	**2**	**2.66**	**2**	**1**			**1**				**1.5**	**2.75**	**2.5**		**2**

Course Contents **Contact Hours**

Unit 1 Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications **L-6, T-2**

Unit 2 Exact flow solutions in channels and ducts, Couette and Poiseuille flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram **L-6, T-2**

Unit 3 Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model **L-6, T-2**

analysis

Unit 4 Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working **L-6, T-2** principle, work done by the impeller, performance curves – Cavitation in pumps-Reciprocating pump – working principle.

Unit 5 Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – **L-6, T-2** draft tube- Specific speed, unit quantities, performance curves for turbines – governing of turbines

Readings:

1. Bansal, R. K. A textbook of fluid mechanics and hydraulic machines: (in S.I. units): Laxmi Publications
2. Som, S. K., & Biswas, G. Introduction to fluid mechanics and fluid machines: Tata McGraw-Hill
3. Fox, R. W., McDonald, A. T., & Pritchard, P. J. Introduction to fluid mechanics: Wiley
4. Munson, B. R., Young, D. F., &Okiishi, T. H. Fundamentals of fluid mechanics: Student solutions manual: Wiley 5. Massey, B. S., & Ward-Smith, J. Mechanics of fluids: Stanley Thornes.

Reference video Lectures from Swayam portal:

MEC 408	Strength of Materials	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Physics, Mathematics and Mechanics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Recognize various types of loads applied on machine components of simple geometry and identify the nature of internal stresses that will develop within the components
CO2	Solve real life problems based on stress generation in machine components.
CO3	Examine the possibilities that arise due to different end conditions and load variations in machine components.
CO4	Evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2	1			2					1	1			1
CO2	3	3	2	2			2					1	3	2		2
CO3	3	3	2	1			2					1	3	2		1
CO4	3	3	3	1			2					1	3	1		
Average	**3**	**3**	**2.25**	**1.25**			**2**					**1**	**2.5**	**1.66**		**1.33**

Course Contents **Contact Hours**

Unit 1

Simple Stress and Strain: Introduction, Stress, Saint-Venant's Principle, Strain, Elastic Constants, Principle of superposition, Bars of Tapering section, Elongation due to self-weight, Column of Uniform Strength, Statically Indeterminate Systems, Thermal Stresses, Strain Analysis, Tensile test diagram, Factor of Safety, Relation between Elastic Constants, Three-dimensional Stress system. **L-10, T-4**

Compound Stress and Strain: Stress analysis, Principal stresses, Maximum shear stresses, Mohr's Stress circle, Three coplanar Stresses, Ellipse of Stress, Strain analysis, Principal Strain, Principal Shear strain, Mohr's Strain Circle, Principal stresses from Principal Strains, Strain Rosette.

Unit 2

Strain Energy: Strain energy (2D and 3D), Shear strain Energy (2D and 3D), Strain energy due to bending and torsion, Strain Energy due to various types of loading.

Shear force and Bending moment: Types of Supports and beams, Shear Force, bending

L-10, T-4

moment, Relation between load, shear force and bending moment, Shear force and Bending

moment diagrams for Cantilever and Simply supported beams, overhanging beams, Inclined

loadings, Loading and Shear force diagrams from shear force Diagrams.

Bending Stresses in beams: Introduction, Theory of Simple Bending, Moment of Inertia, Beams

Unit 3 with uniform bending Strength, Composite Beams, Unsymmetrical bending, Determination of **L-10, T-4**

principal axes, Ellipse of Inertia, combined direct and bending stresses.

Shear stresses in Beams: Introduction, Variation of shear stress, built up beams, Shear stress in thin sections, shear centre.

Unit 4 **Slope and Deflection:** Introduction, beam differential equation, slope and deflection at a point,

Double integration method, Macaulay's Method, Moment area method, Strain energy due to bending, Castigliano's Theorem, Impact loading on beams, Conjugate beam method, Deflection due to shear, Maxwell's reciprocal Deflection theorem, Betti's Theorem. **L-6, T-2 Fixed and Continuous Beams:** Introduction, Effect of Fixidity, Moment area method, Macaulay's Method, Clapeyron's Three-Moment Method, Moment distribution method, method of flexibility coefficients.

Unit 5 **Bending of Curved Beams:** Introduction, Bars of small Initial Curvature, Bars of Large Initial Curvature, Value of p^2 for various sections, Stresses in circular ring, Stresses in chain links, Deflection of curved beams, Castigliano's theorem.

L-6, T-2

Torsion: Introduction, Circular Shaft, Power transmission, Torsion of Tapered shaft, Shaft in Series and Parallel, Strain Energy in Torsion, Combined Bending and Torsion, Thin Tubular Section, Thin-walled section, Thin Rectangular members.

Readings:

1. S. S. Rattan, Strength of Materials Third Edition, Mc Graw Hill Education, Chennai 2017
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, TataMc. GrawHill Publishing Co. Ltd., New Delhi 2005.
5. Stephen Timoshenko, Strength of materials, CBS publishers and Distributers Pvt. Ltd..

Reference video Lectures from Swayam portal: *https://nptel.ac.in/courses/105/105/105105108/*

MEC 409	Instrumentation and Control	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Mechanical Workshop.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the accuracy, range, resolution and error of measurements by using instruments.
CO2	Understand the basics of signal processing and control systems.

CO3	Apply the techniques for controlling devices automatically.
CO4	Apply sensors for common engineering measurements.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1			1			2							1			
CO2	2											2	2	2		1
CO3		2		2		3		2	2				3	2		3
CO4	2	2				3		2			2	2	3			1
Average	**2**	**2**	**1**	**2**		**2.66**		**2**	**2**		**2**	**2**	**2.25**	**2**		**1.66**

Course Contents **Contact Hours**

Unit 1	***Measurement systems and performance:*** Accuracy, range, resolution, error sources.	**L-6**
Unit 2	***Instrumentation system elements:*** Sensors for common engineering measurements.	**L-6, T-2**
Unit 3	Signal processing and conditioning; correction elements- actuators: pneumatic, hydraulic, electric.	**L-7, T-2**
Unit 4	***Control Systems:*** Basic elements, open/closed loop, design of block diagram; control methodP, PI, PID, when to choose what, tuning of controllers.	**L-7, T-2**
Unit 5	System models, transfer function and system response, frequency response; Nyquist diagrams and their use.	**L-7, T-2**

Readings:

1. Bolton, W. (2000). Instrumentation and Control Systems (2nd Ed.). Newnes.
2. Beckwith, Thomas G., Marangoni, R. D., Lienhard, J. H. (2007). Mechanical Measurements (6th Ed.). Pearson Education India.
3. McMillan, Gregory K. (1999). Process/Industrial Instruments and Controls Handbook (5th Ed.) McGraw-Hill: New York.

Reference video Lectures from Swayam portal:

MEC 410	Internal Combustion Engines	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Mechanics, Thermodynamics and Applied Thermodynamics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand working and performance of IC Engines through thermodynamic cycles.
CO2	Understand combustion phenomena in SI and CI engines and factors influencing combustion chamber design.
CO3	Outline emission formation mechanism of IC engines, its effects and the legislation standards.

CO4	Understand working principles of instrumentation used for engine performance and emission parameters.
CO5	Evaluate methods for improving the IC engine performance.
CO6	Understand the latest developments in IC Engines and alternate fuels.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	1	1	1							1		1			1
CO2	2	2	1		1		1				1	1	2			1
CO3	2	3	2	2	1	1	1					1	2	1		
CO4	1	1	3		2	1		2	2			2	1			
CO5	1		2	3	2	1						1	3	2		
CO6	2	3	2	3	2	1	1	1				2	2			1
Average	**1.83**	**2**	**1.83**	**2.25**	**1.6**	**1**	**1**	**1.5**	**2**		**1**	**1.4**	**1.83**	**1.5**		**1**

Course Contents **Contact Hours**

Unit 1 Basic Concepts-Air standard cycles and fuel-air cycles Assumptions, Otto, Diesel &Dual cycles, comparison of cycles, fuel air cycle, Valve Timing diagram, Actual engine cycle. S.I. Engines- Theory of Carburetion, Types of carburetors, electronic fuel injection system, GDI, Combustion **L-10, T-4**

in spark Ignition engines, stages of combustion, flame propagation, rate of pressure rise, abnormal combustion. Phenomenon of Detonation in SI engines, effect of engine variables on Detonation, Combustion chambers, rating of fuels in SI engines, Additives

Unit 2 C.I. Engines- Fuel supply system, types of fuel pump, injector and distribution system, Combustion in compression ignition engines, stages of combustion, factors affecting **L-10, T-4**

combustion, Phenomenon of knocking in CI engine. Effect of knocking, Types of combustion chambers rating of fuels in CI engines, Additives; Comparison of knocking in SI & CI engines, Concepts of Supercharging and Turbo charging

Unit 3 Engine systems and components-Ignition system, (battery, magneto & electronic); Lubrication

system; Engine starting system; Engine cooling system; Governing system (quality and quantity

L-10, T-4

hit & miss governing); Intake and exhaust systems (two valves & four valves); Drive train (cam

shaft, valves etc.)

Performance characteristics & Testing of I.C. Engines-Introduction to Indian, Standards for

Unit 4

testing of I.C. Engine, mean effective pressure, indicated power, brake power, friction power,

Methods to determine power and efficiencies Variables affecting performance of engine, **L-6, T-2**

characteristic curves, heat balance sheet, Methods of improving engine performance; super &

turbocharged engines.

Unit 5 Fuels and Emissions- Chemical structure of the Petroleum, Refining process for petroleum,

important qualities of the Engine fuels - (SI & CI engines), Diesel, and Gasoline fuels-Indian

specifications. Alternate fuels (SI & CI engines)- Liquid fuels, gaseous fuels, hydrogen engines

(LPG, HC NG (15%, 20%, 25 % Blends Hydrogen and Biofuels), Air pollution due to IC

L-6, T-2

engine, Engine emissions, Hydrocarbon emissions, (HC) & PPM & Carbon monoxide

emissions (CO), oxides of Nitrogen (NOx) Euro norms , Bharat stage norms, Introduction to

EDC and IDC , Introduction to carbon credit, Emission control methods for SI and CI engines,

Electronic control module, Catalytic converters, EGR Concept of hybrid vehicles.

Readings:

1. Ganesan. V. Internal *combustion engines*: Tata Mc graw-Hill Publishing Company Limited.
2. Heywood, J. B. *Internal combustion engine fundamentals*: McGraw-Hill.
3. Pulkrabek, W. W. *Engineering* Macmillan.
4. Lumley, J. L; *Engines: an introduction*: Cambridge University Press

Reference video Lectures from Swayam portal:

MEC 411	Machine tools and Machining	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Engineering Workshop and Mechanics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting.
CO2	Understand tool materials, tool wear and controlling factors of tool wear.
CO3	Identify basic parts and operations of machine tools including lathe, shaper, planer, drilling, boring, milling and grinding machine.

CO4	Apply a machining operation, machining conditions and corresponding machine tool and tool geometry for a specific purpose in real time.
CO5	Apply a measuring instrument to inspect the dimensional and geometric features of a given component.
CO6	Apply the fundamental knowledge and practical experience of traditional machining process in industrial application where conventional machining is required.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1						1						1				
CO2									2			1				
CO3						2			2			1				
CO4		2				3			3			1				
CO5						3						1				
CO6		2				3			3		2	1				
Average		**2**				**2.4**			**2.5**		**2**	**1**				

Course Contents **Contact Hours**

Unit 1 ***Introduction:*** Classifications of manufacturing processes, characteristics of material removal processes, need and purpose of conventional material removal processes. Basic description of conventional machining processes, identification of process parameters and concept of machinability. General Constructional Configuration of Basic Machine Tools: Constructional configuration and specifications of basic machine tools like lathe, drilling machine, shaping machine, milling machine, grinding machine. Concept of generatrix and directrix. **L-6, P-8, T-4**

Unit 2 ***Basic Kinematic Structure of Centre Lathe:*** Kinematic analysis of Speed Gear Box, Feed Gear Box, Apron Mechanism, Thread Cutting. **Tool Geometry:** Detailed discussions restricted to ASA, ORS and MRS and for single point cutting tool as well as WRS, Introduction to NRS. Introduction to tool geometry of milling cutters and drills. **L-6, T-2**

Unit 3 ***Mechanism of Chip Formation:*** Detailing on chip formation mechanism of brittle and ductile work material. Chip reduction coefficient, shear angle, Kroonenberg's relation, Build-up edge (BUE). Cutting strain, cutting strain rate, orthogonal machining, causes and modeling of chip deviation concept of effective rake, concept of oblique machining. Introduction to characteristics of chip formation in milling. **L-6, P-2**

Unit 4 ***Mechanics of Machining:*** Identification of cutting forces on orthogonal plane. Merchant's circle diagram, interrelations between cutting forces, angle relationships. Merchant's 1st solution, 2nd solution and Lee and Shaffer's solution. Cutting forces in turning, milling, shaping and drilling. Effect of process parameters and tool geometry on mechanics of chip formation,

	Measurement of cutting forces, effect of tool geometry. Mechanism of chip formation of surface roughness. Effect of cutting forces on product quality. Cutting temperature: Identification of heat sources in machining. Effect of cutting temperature on product quality and cutting tool life. Estimation, measurement and control of cutting temperature. Effect of process parameters and tool geometry on cutting temperature.	**L-10**
Unit 5	Tool Wear, Tool Life and Tool Material: Different mechanism of tool wear. Types of tool wear (crater, flank etc), Measurement and control of tool wear, Concept of tool life, Taylor's tool life equation (including modified version). Different tool materials and applications including effect of tool coating. Machining Time: Estimation of machining time in different machining operations, Introduction to economics of machining, Revisit to the concept of machinability.	**L-8**

Readings:

1. Sen, G. C., and Bhattacharyya, A. (2009). Principles of Machine Tools. (2nd Edition). New Central Book Agency.
2. Bhattacharyya, A. (2012). Theory and Practice of Metal Cutting. New Central Book Agency.
3. Boothroyd, G., and Knight, W. A. Fundamentals of machining and machine tools. Taylor and Francis.

Reference video Lectures from Swayam portal:

MEC 418	**Flexible Manufacturing System**	**L-3 T-0 P-0**	**3 credits**

Pre-requisites: Knowledge of Engineering Workshop and Material Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand FMS and job-shop and mass production manufacturing systems.
CO2	Understand processing stations and material handling systems used in FMS environments.
CO3	Design and analyze FMS using simulation and analytical techniques.
CO4	Understand tool management in FMS.
CO5	Analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.

Mapping of course outcomes with program outcomes

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PEO 1**	**PEO 2**	**PEO 3**	**PEO 4**
CO1	2	2	2		2	1					2	1				
CO2	3	2	1	2	2	1					2	1				
CO3	2	3	3		2	1					1	1				
CO4	2	2	1	2	3	1					1	1				
CO5	2	2	1		2	1					1	1				

Average	**2.2**	**2.2**	**1.8**	**2**	**2.2**	**1**					**1.4**	**1**				

Course Contents **Contact Hours**

Unit 1 *Understanding of FMS: Evolution of Manufacturing Systems, Definition, objective and Need,*

L-6

Components, Merits, Demerits and Applications of FMS

Unit 2 *Processing stations: Machining Centers, turning centers, CMM, Washing/ Deburring station,*

L-6

etc. Different Layouts and their Salient features.

Unit 3 *Material Handling System: An introduction, Conveyor, AGV, ASRS, Robots, etc. and their*

L-6

salient features.

Management technology: Tool Management, Configuration planning and routing, Production

Unit 4 **L-6**

Planning and Control, Scheduling and control

Unit 5 Computer networks and control: Hardware, Software and database of FMS, Design of FMS:

Performance Evaluation, Analytical model and Simulation model of FMS, Case studies: **L-6, T-4**

Typical FMS problems from researches papers

Readings:

1. Groover,M.P "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt.Ltd. New Delhi 2009
2. Tempelmeier. H and Kuhn. H. "Flexible Manufacturing system: Decision support for design and operation", John Wiley and Sons 2003.
3. Maleki A. "Flexible Manufacturing Systems: the technology and management". Prentice Hall International –2009.

Reference video Lectures from Swayam portal:

MEC 432	Advanced Thermodynamics	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of basic Thermodynamics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand Maxwell's and thermodynamic relations of gas mixtures.
CO2	Estimate thermodynamic properties of gas mixtures.
CO3	Identify the models to estimate the properties of real gases.
CO4	Analyze reactive and non-reactive gas mixtures using the concepts of statistical thermodynamics and kinetic theory of gases.
CO5	Analyze chemical reaction and combustion of gas-mixtures.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2	2	3	2	1	1				1				
CO2	3	3	2	2	2	3	1	1				1				
CO3	3	2	2	2	2	3	2	2				1				
CO4	3	3	2	2	3	3	3	3				1				
CO5	3	2	3	3	3	3	2	2	3	3		1				
Average	**3**	**2.4**	**2.2**	**2.2**	**2.6**	**2.8**	**2.8**	**2.8**	**3**	**3**		**1**				

Course Contents **Contact Hours**

Unit 1 Revision of Thermodynamics: I Law of Thermodynamics, II Law of Thermodynamics, Entropy, Availability

Properties of Gases and Gas Mixtures: Equations of State, changes in internal energy, enthalpy and entropy for an ideal gas, Equations of state for a real gas, Virial Expansions, Law of Corresponding States, Generalized Compressibility Chart, Reduced coordinates, Other Equations of state, Dalton's Law of Partial Pressures, Internal Energy, Enthalpy and Entropy and Specific Heats of Gas Mixtures, Gibbs Function of a Mixture. **L-6**

Unit 2

Thermodynamic Relations: Some Mathematical Theorems, Maxwell's Relations, T-ds Equations, Difference in Heat Capacities, Ratio of Heat Capacities, Energy Equation, Claussius-Clapeyron Equation, Joule-Thomson Coefficient, Evaluation of Thermodynamic Properties from Equation of State, Mixtures of Variable Composition, Conditions of Equilibrium for a Heterogeneous System, Gibbs Phase Rule, Types of Equilibrium, Conditions of Stability, Third Law of Thermodynamics. **L-6**

Unit 3 Reactive Mixtures: Degree of Reaction, Reaction Equilibrium, Equilibrium Constant, Law of Mass Action, Thermal Ionization of Monatomic Gas, Gibbs Function Change, Fugacity and Activity, Enthalpy of Formation, Enthalpy of Combustion, Heating Values, Adiabatic Flame Temperature, Second Law Analysis of reactive Systems, Chemical Exergy, Second Law Efficiency. **L-6**

Unit 4 Statistical Thermodynamics: Quantum Hypothesis, Quantum Principle Applied to a System of Particles, Wave-Particle Duality, De Broglie Equation, Heisenberg's Uncertainty Principle, Schrodinger's Wave Equation, Probability Function, Particle in a Box, Rigid Rotator, Harmonic Oscillator, Phase Space, Maxwell-Boltzmann Statistics, Stirling's Approximation, BoseEinstein Statistics, Fermi-Dirac Statistics, Partition Function, Entropy and Probability, Monatomic Ideal Gas, Principle of Equi-partition of Energy, Statistics of a photon gas, Electron Gas, Thermodynamic Properties. **L-6**

Unit 5 Kinetic Theory of Gases: Molecular Model, Distribution of Molecular Velocities, Molecular Collisions with a Stationary Wall, Maxwell-Boltzmann Velocity Distribution, Average, RootMean Square and Most Probable Speeds, Molecules in a Certain Speed Range, Energy Distribution Function, Specific Heat of a Gas, Specific Heat of a Solid. **L-6, T-4**

Transport Processes in Gases: Mean Free Path and Collision Cross-section, Distribution of Free Paths, Transport Properties.

Readings:

1. Cengel, Y.A & Boles, M.A., Thermodynamics-An Engineering Approach, TMH, 2011.
2. Borgnakke, C & Sonntag, R.E., Fundamentals of Thermodynamics, Wiley, 2009.
3. Nag, P.K., Basic and Applied Thermodynamics, TMH, 2009.
4. Smith, J.M. etal, Introduction to Chemical Engineering Thermodynamics, TMH, 2005.
5. Mcquarrie, D.A., and Simon, J.D., Molecular Thermodynamics, Viva Books, 2004..

Reference video Lectures from Swayam portal:

MEC 433	Finite Element Method	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Mechanics of Solids

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply finite element method to solve problems in solid mechanics, fluid mechanics and heat transfer.
CO2	Formulate and solve problems in one dimensional structure including trusses, beams and frames.
CO3	Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axi-symmetric and plate bending problems.
CO4	Implement and solve the finite element formulations using software

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2			3				1	1		1				

CO2	3	3	1	1	3											
CO3	3	3	1	1	3											
CO4	1	2			3		2					2				
Average	**2.25**	**2.5**	**1**	**1**	**3**		**2**		**1**	**1**		**1.5**				

Course Contents **Contact Hours**

Unit 1 Basic concepts- The standard discrete system, Finite elements of an elastic continuumdisplacement approach, Generalization of the finite element concepts **L-12**

Unit 2 Element Types- Triangular, rectangular, quadrilateral, sector, curved, iso-parametric elements and numerical integration, Automatic mesh generation schemes **L-8**

Unit 3 Direct Stiffness approach, Variational approach, Elements of variational calculus - Euler Lagrange equation, Rayliegh Ritz method, Weighted Residual methods, Point Collocation method, Galerkin's method - Steps involved in FEM **L-8**

Unit 4 Application to structural mechanics problems- Plane stress and plane strains, Axisymmetric stress analysis, three-dimensional stress analyses, bending of plates **L-8**

Unit 5 FEM in Steady State Field Problems- Introduction, heat conduction, fluid flow and non-linear material problems, plasticity, creep etc., Computer procedures and software applications for Finite element analysis **L-8**

Readings:

1. Seshu P, Textbook of Finite Element Analysis, PHI. 2004
2. Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2007.
3. Singiresu S.Rao, Finite element Method in Engineering, 5ed, Elsevier, 2012
4. Zeincowicz, The Finite Element Method for Solid and Structural Mechanics, 4th Edition, Elsevier 2007.

Reference video Lectures from Swayam portal:

MEC 434	Advanced Welding Technology	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Engineering Workshop.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand solid state welding processes and applications.
CO2	Identify suitable reinforcement and matrix materials for preparation of composites using friction stir processing.
CO3	Understand basic principle of electron beam and laser beam processes and its application.
CO4	Understand weldability of cast iron and high carbon steel.
CO5	Select welding power sources.
CO6	Understand the importance of grain growth mechanism and related properties.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2	2	1							1				
CO2	3	2	2	2	1							1				
CO3	2	3	2	1	1	1						1				
CO4	2	3	2	1	1	1	1					1				
CO5	3	3	2	1	1	1	1					1				
CO6	3	2	2	2	1							1				
Average	**2.66**	**2.5**	**2**	**1.5**	**1**	**1**	**1**					**1**				

Course Contents **Contact Hours**

Unit 1 Solid state welding: classification of solid-state welding processes, Adhesive bonding, advantages and applications. **L-6**

Unit 2 Friction welding: Friction welding process variables, welding of similar and dissimilar materials, Defective analysis of friction welded components, Friction welding of materials with inter layer. **L-10**

Friction stir welding: Processes parameters, tool geometry, welding of Aluminium alloys,

Friction stir welding of Aluminum alloys and Magnesium alloys.

Unit 3 Electron Beam welding (EBW): Electron Beam welding process parameters, atmospheric affect

L-6

Defective analysis of Electron beam welds and Electron Beam welding dissimilar materials.

Laser Beam welding (LBW): Laser Beam welding process parameters, atmospheric affect and

Unit 4 **L-6**

Laser Beam welding of steels.

Unit 5 Selection power source: Constant voltage and constant current power sources.

L-6

Weldability of cast iron and steel: weldability studies of cast iron and steel,

Readings:

1. Nadkarni S.V., Modern Welding Technology, Oxford IBH Publishers, 1996.
2. Parmar R. S., Welding Engineering and Technology, Khanna Publishers, 2005.
3. D. L. Olson, T. A. Siewert, Metal Hand Book, Vol 06, Welding, Brazing and Soldering, ASM International Hand book Metals Park, Ohio USA, 2008.

Reference video Lectures from Swayam portal:

MEC 512	Heat Transfer	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Thermodynamics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the basic modes of heat transfer.
CO2	Compute temperature distribution in steady-state and unsteady-state heat conduction.
CO3	Understand and analyze heat transfer through extended surfaces.
CO4	Interpret and analyze forced and free convection heat transfer.
CO5	Understand the principles of radiation heat transfer
CO6	Design heat exchangers using LMTD and NTU methods.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2	2	2	1						1	1			
CO2	3	2	2	2	1	1						1	3			2
CO3	2	3	2	2	1	1	1					1	2	1		
CO4	2	3	2	2	1	1	1					1	1	3		3
CO5	3	2	2	1	1	1	1					1	1	1		
CO6	3	2	2	2	1	1						1	3			3
Average	**2.66**	**2.33**	**2**	**1.83**	**1.16**	**1**						**1**	**1.83**	**1.66**		**2.66**

Course Contents **Contact Hours**

Unit 1 Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heisler's charts. **L-12**

Unit 2 Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- **L-12**

Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit 3 Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using **L-8** radiative properties, view factors and the radiosity method.

Unit 4 Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods. **L-8**

Unit 5 Boiling and Condensation heat transfer, Pool boiling curve. Introduction mass transfer, **L-6** Similarity between heat and mass transfer.

Readings:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P. Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley.
4. Massoud Kaviany, Principles of Heat Transfer, John Wiley, 2002
5. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002.

Reference video Lectures from Swayam portal:

MEC 513	Solid Mechanics	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Mechanics and Strength of Materials

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the deformation behavior of solids under loading
CO2	Solve problems for stresses induced in rotating components
CO3	Analyze component's suitability for required task.
CO4	Design new components suitable for required tasks.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2	1			2					1	2			
CO2	3	3	2	2			2					1	3	3		
CO3	3	3	2	1			2					1	2	3		3
CO4	3	3	3	1			2					1	3	1		2
Average	**3**	**3**	**2.25**	**1.25**			**2**					**1**	**2.5**	**2.33**		**2.5**

Course Contents **Contact Hours**

Unit 1 **Column and Struts:** Introduction, Euler's Theory, Equivalent Length, Limitations of Euler's Formula, Rankin's Formula, Other Formulae, Strut with Eccentric Load, Strut with Initial Curvature, Strut and Tie with Lateral Loading, Strut of Varying Cross-sections. **L-6, T-2**

Unit 2 **Cylinders and spheres:** Introduction, Thin cylinder, Thin spherical Shell, Thin cylinder with spherical Ends, Volumetric strain, thick cylinders, Thick spherical shells.

Rotating Discs and Cylinders: Introduction, Thin rotating ring, Disc of Uniform thickness, Disc of uniform strength**.** **L-6, T-2**

Unit 3 **Theories of Failures:** Introduction, Main theories of Failure, Design of thick cylindrical shell, Graphical representation of theories of Failure. **L-6, T-2**

Unit 4 **Plastic Bending and Torsion:** Introduction, Plastic theory of bending, moment of resistance at plastic hinge, Symmetrical and Unsymmetrical Bending, Collapse load, Torsion of circular shaft, combined direct and bending stress. **L-6, T-2**

Unit 5 **Properties and Testing of Materials:** Mechanical Properties, Factor of Safety, Tensile Testing, Compression Testing, Torsion Testing, Hardness testing, Impact Testing, Column Testing, Creep testing, Fatigue Testing. **L-6, T-2**

Readings:

1. S. S. Rattan, Strength of Materials Third Edition, Mc Graw Hill Education, Chennai 2017
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, TataMc. GrawHill Publishing Co. Ltd., New Delhi 2005.
5. Stephen Timoshenko, Strength of materials, CBS publishers and Distributers Pvt. Ltd.

Reference video Lectures from Swayam portal: *https://nptel.ac.in/courses/105/105/105105108/*

MEC 514	Manufacturing Processes	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Basic Mechanical Engineering and Engineering Graphics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the principles and process parameters of both conventional and nonconventional manufacturing processes.
CO2	Categorize and select the suitable conventional and nonconventional manufacturing processes as per requirements of the end products and with the aim of reducing cost, manpower, material wastage and machining time.
CO3	Identify the process parameters affecting the quality of end product in different conventional and nonconventional manufacturing processes.
CO4	Apply a suitable conventional/nonconventional manufacturing process, process parameters and corresponding machine tool for a specific purpose in real time.
CO5	Apply the fundamental knowledge and practical experience of manufacturing process in industrial applications where conventional/nonconventional machining is required.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2	2					3			1	1			1
CO2	3	2	2	2					3			1	2		1	
CO3	2	2	2	2					3			1	2	2		
CO4	2	2	2	2		1			3			1	1	3	2	2
CO5	3	2	2	1		1			3			1	1	3		2
Average	**2.6**	**2**	**2**	**1.8**		**1**			**3**			**1**	**1.4**	**2.66**	**1.5**	**1.66**

Course Contents **Contact Hours**

Unit 1 ***Conventional Manufacturing Processes:*** **Casting and molding:** Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. **Forming and Shearing:** Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending). **L-8, T-4**

Unit 2 ***Metal Cutting:*** Single and multi-point cutting tool; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, cutting tool materials, cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining. **L-8, T-2**

Additive Manufacturing: Rapid prototyping and rapid tooling. **Joining/fastening processes:** Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.

Unit 4	***Non-conventional Machining Processes:*** Principles and process parameters of Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining and Ultrasonic Machining.	**L-7, T-4**
Unit 5	***Non-conventional Machining Processes:*** Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant & maskant, process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining.	**L-8, T-4**

Readings:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
3. Kaushik, J. P., Manufacturing Processes, Second Edition, 2010
4. Degarmo, Black & Kohser, Materials and Processes in Manufacturing.

Reference video Lectures from Swayam portal:

Unit 3		**L-6, T-2**

MEC 515	Kinematics and Theory of Machines	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Engineering Mechanics and Strength of Materials.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms.
CO2	Analyze the planar mechanisms for position, velocity and acceleration.
CO3	Synthesize planar four bar and slider crank mechanisms for specified kinematic conditions.
CO4	Evaluate gear tooth geometry and select appropriate gears for the required applications.
CO5	Design cams and followers for specified motion profiles.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	1	1		1							1	2	1		
CO2	2	3	2	3						1		1		3	1	3
CO3	2	1	3	3	2					1		2	1	3	2	2
CO4	2	1	3	1								2	3	1		
CO5	1	2	1		2							1	3	1		
Average	**2**	**1.6**	**2**	**2.33**	**1.66**					**1**		**1.4**	**2.25**	**1.8**	**1.5**	**2.5**

Course Contents **Contact Hours**

Unit 1 Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashoff's law, Kinematic inversions of four bar chain and slider crank chains-Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms. **L-8, T-4**

Unit 2 Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure

equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics Coincident points- Coriolis component of acceleration- introduction to linkage synthesis-three position graphical synthesis for motion and path generation**.**

L-8, T-2

Classification of cams and followers- Terminology and definitions- Displacement DiagramsUniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting,

Unit 3

L-6, T-2

Unit 4

sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion **L-6, T-2** gears, epicyclic and regular gear train kinematics.

Unit 5 Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication-friction **L-6, T-2** clutches- belt and rope drives- friction in brakes.

Readings:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005
2. Cleghorn W. L., Mechanisms of Machines, Oxford University Press, 2005
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988.

Reference video Lectures from Swayam portal:

MEC 516	Automotive Chassis	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Engineering Mechanics, Strength of Materials and Kinematics of machines.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the functioning of the machine components of Engine and vehicle body/Chases.
CO2	Identify mechanisms in real applications.
CO3	Ability to know the steering geometry.
CO4	Recognize what should be the tyre pressure for different vehicle.
CO5	Identify which type of brakes is best for vehicle and recognize which safety systems are best for vehicle and also for safety consideration.

Unit 1 ***Front Axle and Steering System:*** Functions of front axle, Types of front axle, Construction, Stub axle and Wheel bearing, Front wheel steering Geometry – castor, Camber, King pin inclination, toe-in, toe-out, Centre point Steering, Self-returning property, Adjusting and checking of front wheel geometry, Ackerman and Davis steering linkages, Steering system layout, Steering gear boxes. **L-8, T-4**

Unit 2 ***Vehicle Suspension Systems:*** Road irregularities and need of suspension system, Types of suspension system, Sprung and unsprung mass, Suspension springs – requirements, types and

Unit 3

L-6, T-2

Unit 4

characteristics of leaf spring, coils spring, rubber spring, air and torsion bar springs, independent suspension for front and rear, Types, Hydro-elastic suspension, roll centre, Use of anti-roll bar and stabilizer bar, Shock absorbers – need, operating principles and types, Active suspension. **L-8, T-2**

Braking Systems: Function and requirements of braking system, Types of brakes, Elementary theory of shoe brake, drum brake arrangement, disc brake arrangement, self-energizing, brake friction material. brake linkages, hydraulic brake system and components, hydraulic brake fluids, air brakes, vacuum servo assisted brake, engine exhaust brake, parking brakes, dual

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1		3	3										1	1		
CO2	2	3						2				2	2			
CO3				2	3								1			
CO4					3	2						1	2	1		2
CO5			2			3			3					1		3
Average	**2**	**3**	**2.5**	**2**	**3**	**2.5**		**2**	**3**			**1.5**	**1.5**	**1**		**2.5**

Course Contents **Contact Hours** power brake system, regenerative brake system, fail-safe brake, anti – lock brakes, anti-skid brakes, brake efficiency and testing, weight transfer, braking ratio.

Vehicle Safety Systems: Introduction, Electronic stability program system operation, overview, rollover mitigation system overview, active safety and passive safety, latest trends in traffic **L-6, T-2**

system for improved road safety, head restraints, introduction to the type of safety glass and their requirements, types of different mirrors and their location.

Unit 5 ***Vehicle Chassis:*** Introduction To chassis, chassis operating condition, chassis frame, vehicle component's location. Manufacturing processes for chassis, causes of chassis failure. **L-6, T-2**

Readings:

1. "Automobile Engineering" R. B. Gupta Satya Prakashan New Delhi
2. "Basic Automobile Engineering" C. P. Nakra Dhanpat Rai Publishing Company (P) Ltd-New Delhi
3. "Automotive Mechanics" N.K. Giri 8th Edition Khanna Publishers New Delhi.

Reference video Lectures from Swayam portal:

MEC 517	Computer Integrated Manufacturing	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Manufacturing processes and Engineering graphics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand geometric transformation techniques in CAD.
CO2	Develop mathematical models to represent curves and surfaces.
CO3	Model engineering components using solid modeling techniques.
CO4	Develop CNC programs to manufacture industrial components.
CO5	Understand the elements of an automated manufacturing environment.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	1	2	3	1						1				
CO2	3	2	1	2	3	1						1				
CO3	2	2	1	2	3	1						1				
CO4	2	2	1	2	3	2						1				
CO5	2	2	1	2	3	2						1				
Average	**2.4**	**2**	**1**	**2**	**3**	**1.4**						**1**				

Course Contents **Contact Hours**

Unit 1 **Introduction to CAD/CAM**: Introduction to CAD/CAM/CIM, CAD/CAM input devices, CAD/CAM output devices, CAD/CAM Software, **Transformations of geometry**: Translation, Scaling, Reflection, Rotation, Homogeneous representation of transformation, Concatenation of transformations. **L-10**

Unit 2 **Geometric Modelling of Curves**: 3-D Wire frame modelling, modelling of cubic spline, Bezier and B-spline curves, **Geometric Modelling of Surfaces**: Basic surfaces entities, Surface of revolution, blends, intersections, Modelling of analytical & sculptured surfaces, **Geometric Modelling of Solids:** Solid entities, Boolean operations, B-rep of Solid Modelling, CSG approach of solid modelling. **L-10**

Unit 3 **Data Exchange Formats and Applications**: Data exchange formats, Finite element analysis,

Unit 4	Rapid prototyping, **Computer Aided Manufacturing (CAM)**: Introduction to Computer Numerical Control (CNC), Structure of NC machine tools, Designation of axes, Drives & actuation systems, Feedback devices, CNC tooling, Automatic tool changers & Work holding devices.	**L-10**
	CNC Programming: Part programming fundamentals, Manual Part Programming, APT Programming, Geometric & motion commands, Post processor commands, **Robotics:** Anatomy & configuration of robot, Characteristics of robots, Grippers, Application of robots in manufacturing, Robot programming, **Group Technology:** Introduction to Group technology, Part classification & coding systems.	**L-10**
Unit 5	**Computer Aided Process Planning (CAPP):** Introduction to CAPP, Variant & Generative methods of CAPP, advantages of CAPP, **Flexible Manufacturing System (FMS):** Components of FMS, FMS equipment & control, FMS case studies, **Computer Integrated Manufacturing (CIM):** Elements of CIM, CIM case studies.	**L-10**

Readings:

1. "Automobile Engineering" R. B. Gupta Satya Prakashan New Delhi
2. "Basic Automobile Engineering" C. P. Nakra Dhanpat Rai Publishing Company (P) Ltd-New Delhi
3. "Automotive Mechanics" N.K. Giri 8th Edition Khanna Publishers New Delhi.

Reference video Lectures from Swayam portal:

MEC 535	Computational Fluid Dynamics	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Fluid Mechanics, Thermodynamics and Fluid Machines.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Develop mathematical models for flow phenomena.
CO2	Analyze mathematical and computational methods for fluid flow and heat transfer simulations.
CO3	Solve computational problems related to fluid flows and heat transfer.
CO4	Evaluate the grid sensitivity and analyze the accuracy of a numerical solution.
CO5	Evaluate flow parameters in internal and external flows.
CO6	Develop flow simulation code for fluid flow and heat transfer problems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2	1	2	2	2		1			1				
CO2	3	3	3	1	2	2	2		2			1				
CO3	2	3	2	3	3	3	3		3			1				
CO4	3	1	2	3	3	3	1		2			1				
CO5	3	3	3	2	3	3	3		1			1				
CO6	2	3	3	3	3	3	3	3	3			1				
Average	**2.66**	**2.66**	**2.5**	**2.16**	**2.66**	**2.66**	**2.33**	**3**	**2**			**1**				

Course Contents **Contact Hours**

Unit 1 Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods

Governing Equations of Fluid Dynamics: Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, **L-12**

Unit 4

Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching.

Unit 2 Mathematical Behavior of Partial Differential Equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations.

Basic Aspects of Discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and **L-12** unequally spaced grid points.

Grids With Appropriate Transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.

Unit 3 Parabolic Partial Differential Equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization.

Stability Analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, **L-12** Error analysis, Modified equations, Artificial dissipation and dispersion.

Elliptic Equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods.

Hyperbolic Equations: Explicit and implicit finite difference formulations, splitting methods,

Unit 4

multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order tvd schemes.

Scalar Representation of Navier-Stokes Equations: Equations of fluid motion, numerical **L-12** algorithms: ftcs explicit, ftbcs explicit, DuFort-Frankel explicit, McCormack explicit and implicit, btcs and btbcs implicit algorithms, applications.

Grid Generation: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation

Unit 5 Finite Volume Method For Unstructured Grids: Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetra hedral Elements, 2-D Heat conduction with Triangular Elements

Numerical Solution of Quasi One Dimensional Nozzle Flow: Subsonic-Supersonic isentropic **L-10** flow, Governing equations for Quasi 1-D flow, Non-dimensionalizing the equations, McCormack technique of discretization, Stability condition, Boundary conditions, Solution for shock flows.

Readings:

1. Anderson, J.D.(Jr), Computational Fluid Dynamics, McGraw-Hill Book Company, 1995.
2. Hoffman, K.A., and Chiang, S.T., Computational Fluid Dynamics, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.
3. Chung, T.J., Computational Fluid Dynamics, Cambridge University Press, 2003.
4. Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, McGraw Hill Book Company, 2002.

Reference video Lectures from Swayam portal:

MEC 536	**Mechanical Vibrations**	**L-3 T-0 P-0**	**3 credits**

Pre-requisites: Knowledge of Kinematics and theory of machines.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the causes and effects of vibration in mechanical systems.
CO2	Develop schematic models for physical systems and formulate governing equations of motion.
CO3	Understand the role of damping, stiffness and inertia in mechanical systems
CO4	Analyze rotating and reciprocating systems and compute critical speeds.
CO5	Analyze and design machine supporting structures, vibration isolators and absorbers.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	1	1	2	1	1					2				
CO2	3	3	3	1	1							2				
CO3	3	2	2	1	1							2				
CO4	3	3	2	2	2							2				
CO5	3	3	2	3	2		3					3				
Average	**3**	**2.8**	**2**	**1**	**1.6**	**1**	**2**					**2.8**				

Course Contents **Contact Hours**

Unit 1 Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models. SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert's method, Energy method **L-8**

Unit 2 Free Vibration: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation.

Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration **L-10**

Unit 3 Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium

method, Lagrangian method, Case studies on formulation of equations of motion

Free vibration response, Eigen values and Eigen vectors, Normal modes and mode **L-10**

superposition, coordinate coupling, decoupling of equations of motion, Natural coordinates,

Response to initial conditions, free vibration response case studies, Forced vibration response,

undamped vibration absorbers, Case studies on undamped vibration absorbers.

Multi degree of freedom systems: Introduction, Formulation of equations of motion, Free

Unit 4

vibration response, Natural modes and mode shapes, orthogonally of model vectors,

normalization of model vectors, decoupling of modes, model analysis, mode superposition

L-8

technique, Free vibration response through model analysis, forced vibration analysis through

model analysis, Model damping, Rayleigh's damping, Introduction to experimental model

analysis.

Unit 5 Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free

vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems

L-6

Case studies, Approximate methods for continuous systems and introduction to Finite element

method.

Readings:

1. L. Meirovich, Elements of Vibration analysis, 2nd Ed. Tata Mc-Grawhill 2007
2. Singiresu S Rao, Mechanical Vibrations. 4th Ed., Pearson education 2011
3. W.T., Thompson, Theory of Vibration. CBS Publishers
4. Clarence W. de Silva , Vibration: Fundamentals and Practice, CRC Press LLC, 2000.

Reference video Lectures from Swayam portal:

MEC 537	Design of Mechanisms	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Kinematics of Machinery.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Perform kinematic and dynamic analysis of planar mechanisms with rigid-bodies.
CO2	Evaluate the suitability of existing designs for a given task.
CO3	Simulate the kinematic parameters generated by planar mechanisms.
CO4	Design a mechanism for practical implementation in the machinery.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2		2											
CO2	3	3	2		2		2									
CO3	3	3	2	2	3	2										
CO4	3	3	2		2											
Average	**3**	**3**	**2**	**2**	**2.25**	**2**	**2**									

Course Contents **Contact Hours**

Unit 1 Introduction: Reviewing basic concepts of mechanisms and machine theory. Plane and space mechanisms, with practical examples. Kinematic pairs, kinematic inversions, degrees of freedom. Deferent methods of generation quick return motion with practical examples. Velocity and acceleration analyses. **L-6**

Unit 2 Mobility of Mechanisms: Grashoff's criterion for four bar mechanisms and slider crank mechanism. Derivation of the criterion. Linkages with more than four links, geared five bar linkages. Six bar linkages. Grashoff's type rotatability criteria for higher order linkages. Mechanisms with springs as links, practical examples. Practical considerations for creating good quality designs. Linkages versus cams. **L-10**

Synthesis of Mechanisms: Type synthesis, quantitative synthesis, dimensional synthesis. Function, path, motion generation. Two position and three position synthesis with practical examples.

Unit 3 Position analysis: Function generation and accuracy points. Structural error and Chebyschev spacing of points. Freudenstin's equation for three-point synthesis of four bar mechanism and also slider crank mechanism. Synthesizing four bar and slider crank mechanisms for three instantaneous conditions using Freudenstin's equation. Hirschhorn's method of components for **L-8**

synthesizing four bar mechanism instantaneous conditions. Synthesis of four bar mechanism for four accuracy points and five accuracy points.

Unit 4 Straight line Mechanisms: Approximate straight-line mechanism, Watt mechanism, Robert mechanism, Chebyschev mechanism, Hoeken mechanism. Practical examples. **L-6**

Exact straight-line mechanism: Derivation of general conditions to be satisfied. Analysis of Peaucellier mechanism, Hart's mechanism.

Unit 5 Coupler Curves: Coupler curves of four bar mechanism. Cusp and Crunode. Hornes and Nelson Atlas of four bar coupler curves and use of the same for designing a four-bar mechanism for a practical application. Symmetrical curves and non-symmetrical four bar linkages. Single dwell mechanism with revolute pairs. Double dwell mechanisms. Practical examples. Geared five bar coupler curves. Cognates. Robert- Chebyschev theorem for identical coupler curves. **L-6**

Readings:

1. Robert L. Nortan, Design of Machinery, McGraw Hill Internation Edition, New York, 2006.
2. Shigley, J.E and Joseph Uicker, J. Theory of Machines and Mechanisms, McGraw Hill International Editions, 2nd edition, 2003.
3. Hamilton H. Mabie and Fred L. Ocvirk, Mechanisms and Dynamics of Machinery, John Wiley & Sons, New York, Delhi, 2000.

Reference video Lectures from Swayam portal:

MEC 538	Advanced Metal Forming	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Manufacturing.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve for strain rates, temperatures and metallurgical states in forming problems using constitutive relations.
CO2	Develop process maps for metal forming processes using plasticity principles.
CO3	Estimate formability limits for sheets and bulk metals.
CO4	Evaluate high energy rate deformation process parameters.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	3								1	1				
CO2	3	3	3	2	2	2	2				1	1				
CO3	3	3	3	2	2	2	2				1	1				
CO4	3	3	3								1	1				
Average	**3**	**3**	**3**	**2**	**2**	**2**	**2**				**1**	**1**				

Course Contents **Contact Hours**

Unit 1 Introduction: Introduction of metal forming as a manufacturing process and its relation with other processes, Metal Forming from systems point of view, Advantages of metal forming as a manufacturing process, Classifications of metal forming processes, Forming equipment, Presses (mechanical, hydraulic). **L-8**

Unit 2 Theoretical analysis: Theory of plasticity, Stress-strain relationship, Strain hardening, Material incompressibility, Work of plastic deformation, Work hardening, Yield criteria, Flow rule, Yield criterion and flow rule for Anisotropic material, Initiation and extent of plastic flow-Problems. **L-8**

Unit 3 HERF: Overview of various metal forming operations: Conventional Vs High velocity forming methods – Material behaviour - stress waves and deformation in solids – Stress wave induced fractures. **L-8**

Unit 4 Bulk Forming Processes: Forging; open-die forging, closed-die forging, coining, nosing, upsetting, heading, extrusion and tooling, Rod, wire and tube drawing, rolling; flat rolling, shape rolling and tooling, spinning, hydro forming, rubber-pad forming, explosive forming, problems. **L-8**

Unit 5 Sheet Forming Processes: Blanking, piercing, press bending, deep drawing, stretch forming, formability tests, forming limit diagrams, process simulation for deep drawing and numerical

approaches, Case studies. **L-6, T4**

Problems & Case Studies: Case studies on the manufacturing aspects of products using the lessons learnt.

Readings:

1. Surender Kumar, Technology of Metal Forming Processes, Prentice- Hall, Inc., 2008.
2. Henry S. Valberg, Applied Metal Forming - Including FEM Analysis, Cambridge University Press, 2010.

Reference video Lectures from Swayam portal:

MEC 553	Thermal Engineering Laboratory	L-0 T-0 P-2	1 credit

Pre-requisites: Theoretical knowledge of Fluid Mechanics Thermodynamics and Heat Transfer.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Develop skills to impart practical knowledge in real time solutions.
CO2	Measure various properties of fluids and Thermal Systems.
CO3	Characterize the performance of fluid and thermal machinery.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	1	2	3	2		1	1	2			1	3		2	
CO2	2	2	1	3	2		1		1			1	3	2	1	2
CO3	2	2	1	3	2		1	1	1			1	2		2	2
Average	**2**	**1.66**	**1.33**	**3**	**2**		**1**	**1**	**1.33**			**1**	**2.66**	**2**	**1.66**	**2**

Course Contents **Contact Hours**

Complete atleast 10 experiments from the following:

Experiment 1	Calibration of Venturimeter & Orifice meter	**P-2**
Experiment 2	Determination: Coefficient of discharge for small orifice/mouthpiece by constant head method.	**P-2**
Experiment 3	Determination of friction factor of a pipe.	**P-2**
Experiment 4	Determination of Coefficient for minor losses.	**P-2**
Experiment 5	Calculation of Reynold's Number using Reynold's Apparatus.	**P-2**
Experiment 6	Study of boilers- Locomotive, Lancashire, Babcock Wilcox boiler	**P-2**
Experiment 7	Conduction - Composite wall experiment	**P-2**
Experiment 8	Convection - Experiment on heat transfer from tube-natural convection	**P-2**
Experiment 9	Convection - Heat transfer through fin-natural convection	**P-2**
Experiment 10	Any experiment on Stefan's Law, on radiation determination of emissivity, etc.	**P-2**

Experiment 11	Heat exchanger - Parallel flow experiment	**P-2**
Experiment 12	Experiment on refrigeration test rig and calculation of various performance parameters.	**P-2**
Experiment 13	To study different types of expansion devices used in refrigeration system.	**P-2**
Experiment 14	To study different types of evaporators used in refrigeration systems.	**P-2**
Experiment 15	To study basic components of refrigeration system.	**P-2**
Experiment 16	Experiment on air-conditioning test rig & calculation of various performance parameters.	**P-2**
Experiment 17	To study air washers	**P-2**
Experiment 18	Study & determination of volumetric efficiency of compressor.	**P-2**

Readings:

1. Printed manual provided to students.

Reference video Lectures from Swayam portal:

MEC 619	Manufacturing Technology	L-4 T-0 P-0	4 credits

Pre-requisites: Knowledge of Basic Mechanical Engineering and Engineering Graphics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the tooling needed for manufacturing.
CO2	Measure the dimensions with dimensional accuracy and tolerances of products.
CO3	Assemble different components using advanced material handling techniques.
CO4	Apply optimization methods in manufacturing.
CO5	Apply forecasting and scheduling techniques to production systems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	1	3	1	2	1								1			1
CO2	3	3	2	3	3	2				1		1	2	2		
CO3	3	2	2	2						1		1	2		1	
CO4	2	2	2		1	3	1		1		1	1		3	2	
CO5		2	2		1	3	1		1		1		1	3		2
Average	**2.25**	**2.4**	**1.8**	**2.33**	**1.5**	**2.66**	**1**		**1**	**1**	**1**	**1**	**1.5**	**2.66**	**1.5**	**1.5**

Unit 1 Tooling for conventional Machining Processes: Mold and die design, Press tools, cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design. **L-6, T-2**

Unit 2 Metrology and Inspection: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality. **L-8, T-2**

Unit 3 Assembly and Material Handling Devices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices. **L-6, T-2**

Unit 4 Automation of Manufacturing Processes: Introduction to automation and numerical control, adaptive control, industrial robots, sensor technology, flexible fixturing, Assembly systems; **L-8, T**

Course Contents **Contact Hours** Design Considerations for Fixturing, Assembly, Disassembly, and Servicing; Economic Considerations.

Unit 5 Production Planning and Control (PPC) and Forecasting Methods: Introduction, Objectives of PPC, Functions of PPC, – Elements of PPC, Factors determining the PPC processes, Rules and Scope of PPC; Forecasting: Importance of forecasting, Types of forecasting and their uses, **L-6, T-2** General principles of forecasting, Forecasting techniques, qualitative and quantitive methods of forecasting.

Readings:

1. Kalpak Jian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014.
2. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.
3. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.

Reference video Lectures from Swayam portal:

MEC 620	Design of Machine Elements	L-3 T-1 P-0	4 credits

Pre-requisites: Knowledge of Manufacturing Technology.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the failure criteria using component behavior subjected to loads.
CO2	Understand the concepts of principal stresses, theories of failure, stress concentration and fatigue loading.
CO3	Design shafts, couplings and gears.
CO4	Analyze the pressure distribution and design journal bearings.
CO5	Design belts, springs, brakes, clutches and engine parts.

Unit 1 Definition, Design requirements of machine elements, Design procedure, Standards in design, Selection of preferred sizes, Indian Standards designation of carbon & alloy steels, Selection of materials for static and fatigue loads, Design against Static Load Modes of failure, Factor of safety, Principal stresses, Stresses due to bending and torsion, Theory of failure **L-6, T-2**

Unit 2 Design against Fluctuating Loads, Cyclic stresses, Fatigue and endurance limit, Stress concentration factor, Stress concentration factor for various machine parts, Notch sensitivity, Design for finite and infinite life, Soderberg, Goodman & Gerber criteria Riveted JointsRiveting methods, materials, Types of rivet heads, Types of riveted joints, Caulking and Fullering, Failure of riveted joint, Efficiency of riveted joint, Design of boiler joints, Eccentric loaded riveted joint **L-6, T-2**

Unit 3 Shafts Cause of failure in shafts, Materials for shaft, Stresses in shafts, Design of shafts

subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads, Design for rigidity Keys and Couplings Types of keys, splines, **L-6, T**

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	1	1						1		1		1	2			
CO2	3	3	2	2	1			2				2	1		1	
CO3	3	3	2	2	2							2	3	2		3
CO4	3	3	2	3	2							2	1	3		3
CO5	3	3	3	2	2							2	3	1		3
Average	**2.6**	**2.6**	**2.25**	**2.25**	**1.45**			**1.5**		**1**		**1.8**	**2**	**2**	**1**	**3**

Course Contents **Contact Hours** Selection of square & flat keys, Strength of sunk key, Couplings-Design of rigid and flexible couplings.

Unit 4 Mechanical Springs, Material for helical springs, End connections for compression and tension helical springs, Stresses and deflection of helical springs of circular wire, Design of helical springs subjected to static and fatigue loading Power Screws, Forms of threads, multiple threads, Efficiency of square threads, Trapezoidal threads, Stresses in screws, Design of screw jack. **L-6, T-2**

Unit 5 Design procedure and applications of Dynamically Loaded Machine Elements. Shafts, Spur, helical, bevel and worm gears, Journal and rolling contact bearings, Belts and chains. Assemblies of various machine elements like those of a screw jack and a gear box. **L-6, T-2**

Readings:

1. Bhandari, V B., Design of Machine Elements, 3/e, Tata McGraw Hill Book Company, New Delhi, 2009.
2. Norton, R. L., Machine Design: An Integrated Approach, 3/e, Pearson, 2004.
3. Shigley, J.E and Mischke, C. R. Mechanical Engineering Design, 6/e, Tata McGraw Hill, 2005.
4. Paul H Black and O. E. Adams, P., Machine Design, 3/e, Mc Graw Hill Book Company, Inc., New York, USA., 2007.
5. Kannaiah, P., Machine Design, 2/e, Scitech Publication Pvt. Ltd., 2009.

Reference video Lectures from Swayam portal:

MEC 621	Non-Destructive Evaluation and Testing	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Manufacturing Technology.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand non-destructive tests.
CO2	Apply non-destructive tests on components.
CO3	Evaluate suitable NDT method for requires components.
CO4	Develop new non-destructive testing methods for components.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2	2	1							1	1			1
CO2	3	2	2	2	1							1		3		3
CO3	2	3	2	1	1	1	1					3	3	1		
CO4	3	3	2	1	1	1	1					3	3	1		1
Average	**2.75**	**2.5**	**2**	**1.5**	**1**	**1**	**1**					**2**	**2.33**	**1.66**		**1.66**

Course Contents **Contact Hours**

Unit 1 Introduction and Visual Methods- Optical aids, In-situ Metallography, Optical holographic methods, Dynamic inspection; Penetrant Flaw Detection- Principles: Process: Penetrant systems: Liquid penetrant materials: Emulsifiers: cleaners, developers: sensitivity: Advantages: Limitations: Applications **L-4, T-2**

Unit 2 Radiographic Methods- Limitations: Principles of radiography: sources of radiation, Ionizing radiation - X-rays sources, gamma-rays sources Recording of radiation: Radiographic sensitivity: Fluoroscopic methods: special techniques: Radiation safety; Ultrasonic Testing of Materials- Advantages, disadvantages, Applications, Generation of. Ultrasonic waves, general characteristics of ultrasonic waves: methods and instruments for ultrasonic materials testing: special techniques **L-4, T-2**

Unit 3 Magnetic Methods- Advantages, Limitations, and Methods of generating field: magnetic particles and suspending liquids Magnetography, field sensitive probes: applications. Measurement of metal properties; Electrical Methods- Eddy current methods: potential-drop methods, applications. **L-4, T-2**

Unit 4 Electromagnetic Testing- Magnetism: Magnetic domains: Magnetization curves: Magnetic Hysteresis: Hysteresis loop tests: comparator - bridge tests Absolute single-coil system: applications. **L-4, T**

Unit 5 Other Methods- Acoustic Emission methods, Acoustic methods: Leak detection: Thermal inspection.

L-4, T-2

Readings:

1. P. Halmshaw; Non-Destructive Testing
2. Metals Handbook Vol. II, Non-destructive inspection and quality control
3. B. Ram Prakash, ISO9000 and NDE Vol.2, interline publishing, 1993 4. NDT-Hand book.

Reference video Lectures from Swayam portal:

MEC 622	Mechatronics Systems	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Basic Electronics Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Model, analyze and control engineering systems.
CO2	Identify sensors, transducers and actuators to monitor and control the behaviour of a process or product.
CO3	Evaluate the performance of mechatronic systems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	3	1	2				2			1				
CO2	1	1	1	3	1				2		1					
CO3	3	2	2	2	3		1	2	2			1				
Average	**2.33**	**2**	**2**	**2**	**2**		**1**	**2**	**2**		**1**	**1**				

Course Contents **Contact Hours**

Unit 1 Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface; Sensors and transducers: classification, Development in Transducer technology, Opto-electronics-Shaft encoders, CD Sensors, Vision System, etc. **L-4, T-2**

Unit 2 Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems **L-4, T-2**

Unit 3 Smart materials: Shape Memory Alloy, Piezoelectric and Magneto-Strictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc. **L-4, T-2**

Unit 4 Micro-mechatronic systems: Microsensors, Micro-Actuators; Micro-Fabrication techniques **L-4, T-2**

Unit 5 LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology. **L-4, T-2**

Readings:

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3. A Textbook of Mechatronics, R.K.Rajput, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

Reference video Lectures from Swayam portal:

MEC 623	Vehicle Dynamics	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Internal combustion engines and Automobiles.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the various forces and loads
CO2	Identify performance under acceleration, ride and braking.
CO3	Understand acceleration and braking characteristics, effect on vehicle due to various forces
CO4	Understand what is ride and handling in vehicle design.
CO5	Balance machine at the time of design by considering all forces.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2		2	3	3	3	1		1	2	2	1	1			
CO2	3	3	2	3	3	3	3	1			2	1	2		2	
CO3	3	2	3	2	3	1	3	1	1			1	2			1
CO4	2	3	3	3	3	1	3		1	1	1		2		2	2
CO5	2	3	3	3	3	3	3			1	1	2		3		2
Average	**2.4**	**2.75**	**2.6**	**2.8**	**3**	**2.2**	**2.6**	**1**	**1**	**1.33**	**1.5**	**1.25**	**1.75**	**3**	**2**	**1.66**

Course Contents **Contact Hours**

Unit 1 ***Introduction of Vehicle Dynamics***: Vehicle coordinate system, earth fixed coordinate system, longitudinal, lateral and vertical vehicle dynamics, vehicle springing system - requirements, sprung mass and unsprung mass. Performance characteristics of road vehicles **L-6**

Unit 2 ***Steady State Operation:*** Various external forces acting on vehicle, Nature of the forces and factors affecting the forces, Tractive effort and Power available from the engine, equation of motion, maximum tractive effort, weight distribution, stability of vehicle on slope, road performance curves, acceleration, gradeability and drawbar pull. **L-6**

Unit 3 ***Transient Operation:*** Inertia effect, Equivalent mass, Equivalent moment of inertia, Equivalent

ungeared system, Time to produce synchronizing during gear change, Effect of engine flywheel

L-6

on acceleration, Dynamics of vehicles on Banked tracks, Gyroscopic Effects, Net driving

power.

Acceleration and Braking Characteristics: Acceleration - Power limited acceleration: Engines,

Unit 4 **L-6**

Power Train, And Automatic Transmission. Traction Limited Acceleration: Transverse Weight

Shift, Traction Limit, Numerical Treatment. Braking – Constant Deceleration, Braking Force, Brake Factor, Braking Efficiency And Stopping Distance, Reaction Time And Stopping Time, Braking Applied To Rear Wheels, Front Wheels And All Four Wheels, On Straight And Curved Path, Mass Transfer And Its Effect.

Unit 5 ***Handling mode or Riding mode:*** Fundamental condition for true Rolling Steady State Handling: Slip angle, cornering power, Neutral steer, under steer and over steer, Steady state **L-4, T-2** response, Yaw velocity, Lateral Acceleration, Curvature response and Directional stability.

Readings:

1. "Mechanical Vibrations", Singh V.P., Dhanpat Rai and Sons, New Delhi
2. "Mechanical Vibrations", Grover, G. K. and Nigam, S. P., Nemchand and Brothers, Roorkee, U.K, India.

Reference video Lectures from Swayam portal:

MEC 639	Rotor Dynamics	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Mechanical Vibrations and Finite Element Methods.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand principles of rotor bearing systems.
CO2	Analyze dynamic behavior of rotor bearing system.
CO3	Predict the response of a rotor bearing system through analytical and computational models.
CO4	Identify the malfunctions in rotating machinery using vibration measurements.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2	1	3	1	2					1				
CO2	3	3	2	2	3	1	2					2				
CO3	3	3	1	2	3	1	2					3				
CO4	2	2	1	3	3	1	1					3				
Average	**2.75**	**2.75**	**1.5**	**2**	**3**	**1**	**1.75**					**2.25**				

Course Contents **Contact Hours**

Unit 1 Introduction: Introduction to rotor dynamics, Review of Vibration of single and multi-degree of

L-6

freedom systems. Rotating and reciprocating unbalances in mechanical systems.

Unit 2 Linear Rotor dynamics: Equation of motion for Rotating systems, Undamped Jeffcott Rotor,

Free whirling, Unbalance response, Shaft Bow, Jeffcott Rotor with viscous damping – Free

L-8

whirling, Unbalance response, Shaft Bow, Jeffcott Rotor with structural damping – Free

whirling, Unbalance response, frequency dependent loss factors.

Unit 3 Discrete multi-degree of freedom rotors: Introduction, Transfer matrix approach for rotor

systems, The finite element method for rotors, Beam elements, spring elements, Mass elements,

L-8

Assembly and constraints Computation of critical speeds, Computation of unbalance response,

Campbell and root locus diagrams.

Transmission Shafts: Euler-Bernoulli and Timoshenko beam models. Dynamic stiffness, Free

Unit 4

Torsional and axial vibrations and critical speeds

Rotor Bearing Interaction: Rigid body and flexural modes, Isotropic rotors on Anisotropic

L-12

supports, non-isotropic rotors on isotropic supports, Linearization of bearing Characteristics,

rolling element bearings, Fluid film bearings, Magnetic bearings, Bearing alignment in multi

rotor bearings

Unit 5 Malfunctioning of Rotors: Measurement of vibration data in rotor systems, Data processing,
L-6 Signature analysis, Identification of malfunctioning using measured data.

Readings:

1. Giancarlo Genta, Dynamics of Rotating Systems, Springer, 2009
2. Rao, J.S., Rotor Dynamics, 3 Ed. New Age International, 2003

Reference video Lectures from Swayam portal:

MEC 640	Mechanics of Composite Materials	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Material science.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concepts of composite materials.
CO2	Analyze macro and micro mechanical behavior of a lamina.
CO3	Develop governing equations for bending, buckling and vibrations in laminated plates.
CO4	Analyze and design composite structures used in automobile and aerospace applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	2	2	1	2	3	3	1	1	2	2				
CO2	2	3	2	2	1	3	2	2	1	1	2	3				
CO3	1	2	2	2	1	1	2	2	1	2	1	2				
CO4	2	2	3	3	1	1	1	1	1	1	2	2				
Average	**1.75**	**2.25**	**2.25**	**2.25**	**1**	**1.75**	**2**	**2**	**1**	**1.25**	**1.75**	**2.25**				

Course Contents **Contact Hours**

Unit 1 Introduction to composite materials: Introduction, what is a composite material, Current and potential advantages of fibre reinforced composites, Applications of composite materials, Military, civil, space, automotive and commercial applications **L-6**

Unit 2 Macro and micro mechanical behaviour of a lamina: Stress strain relations for anisotropic materials, Restrictions on engineering constants, Strengths of an orthotropic lamina, Biaxial strength criteria for orthotropic lamina **L-8**

Unit 3 Micro mechanical behaviour of lamina and laminates: Mechanical of material approach to stiffness, Elasticity approach to stiffness, Classification lamination theory, Special cases, strength of laminates **L-8**

Unit 4 Bending, Buckling and Vibration of laminated plates: Governing equations for bending buckling and vibration of laminated plates, Deflection of simply supported laminated plates, Vibration of simply supported laminated plates **L-8**

Unit 5 Design of composite structures: Introduction, design philosophy, Anisotropic analysis, bending extension coupling, Micromechanics, Nonlinear behaviour, Interlaminar stresses, transverse shearing, Laminate optimization **L-8**

Readings:

1. Ronald F. Gibson, Principles of composite material mechanics, CRC Press, 2011.
2. Robert M Jones, Mechanics of Composite Materials, Taylor & Francis, 2000.
3. Lawrence E. Nielsen, Nielson, Paul Nielsen, Mechanical Properties of Polymers and Composites, Second Edition, CRC press, 2000.

Reference video Lectures from Swayam portal:

MEC 641	Advanced Manufacturing Processes	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Manufacturing Processes and Manufacturing Technology.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand abrasive and electrical discharge machining processes.
CO2	Understand principles and applications of electron beam, ion beam and laser hybrid welding processes.
CO3	Understand the relation between the process parameters and mechanical properties.
CO4	Understand forming process for thin sections
CO5	Understand the principles and applications of friction stir welding processes

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	2	2	1							1				
CO2	3	2	2	2	1							1				
CO3	2	3	2	1	1	1						1				
CO4	2	3	2	1	1	1	1					1				
CO5	3	3	2	1	1	1	1					1				
Average	**2.6**	**2.6**	**2**	**1.4**	**1**	**1**	**1**					**1**				

Course Contents **Contact Hours**

Unit 1	Advanced manufacturing processes: Abrasive machining and advantages and applications, Electrical discharge Machining: process parameters, applications advantages and limitations.	**L-6**
Unit 2	Stir casting, organic processes, Magnetic moulding, high pressure moulding, metal injection moulding, centrifugal casting.	**L-6**
Unit 3	Electron beam welding and Laser beam welding: Principle, application and advantages of EBW and LBW, process parameters.	**L-6**
Unit 4	Hybrid welding process and advantages and applications and surfacing	**L-6**
Unit 5	Introduction forming processes, advantages, limitations and applications, Hydro, Magnetic and High velocity forming, design for forming, welding and injection moulding, and forming of thin sections	**L-6**

Readings:

1. R. S. Mishra, Friction Stir Welding and Processing, ASM International, 2007.
2. 2. Heine, Loper and Rosenthal, “Principles of Metal Casting”, Tata McGraw-Hill, New Delhi, 2008.
3. 3. Jain, Vijay K., Advanced Machining Process, Chapter-7 (A) Electric Discharge Machining (EDM), Allied Publishers Pvt. Ltd., New Delhi, 2004, 126-129

Reference video Lectures from Swayam portal:

MEC 642	Micro and Nano Manufacturing	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Manufacturing Processes and Manufacturing Technology.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand manufacturing considerations at the micro and nano scale.
CO2	Understand design-and-analysis methods and tools used for micro and nano manufacturing
CO3	Select manufacturing methods, techniques and process parameters for material processing quality
CO4	Design and select industrially-viable processes, equipment and manufacturing tools for specific industrial products

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2	1	3	2			2			1				
CO2	1	2	2	3	1				2		1	1				
CO3	3	1	1	1	3		2	2	2							
CO4	3	3	3	2	3		1	2	2			1				
Average	**2.5**	**2.25**	**2**	**1.75**	**2.5**	**2**	**1.5**	**2**	**2**		**1**	**1**				

Course Contents **Contact Hours**

Unit 1 Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology.

Nanomaterials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials- sol-gel process, Liquid solid reactions; Gas Phase synthesis of nanomaterials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing(GPC), Chemical Vapour Condensation(CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing(GPC). **L-12**

Unit 2 Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe **L-8**

Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM)..

Unit 3 Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass **L-8** Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS).

Unit 4 Microfabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding. MEMS Fabrication Techniques, Bulk Micromachining, **L-8** Surface Micromachining, High- Aspect-Ratio Micromachining.

Unit 5 Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.

L-8

ME

MS devices and applications: Pressure sensor, Inertial sensor, Optical MEMS and RFMEMS, Micro-actuators for dual-stage servo systems.

Readings:

1. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.
2. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009.
3. Ray F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Springer, 2005.
4. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc, New York, 1994. 5. B.D. Cullity - Elements of X-Ray Diffraction, 3rd edition, Prentice Hall, 2002.
5. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture,” McGraw- Hill, 2008.

Reference video Lectures from Swayam portal:

MEC 643	Refrigeration and Air Conditioning	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Thermodynamics and Heat transfer.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the principles and applications of refrigeration systems.
CO2	Understand vapour compression refrigeration system and identify methods for performance improvement.
CO3	Study the working principles of air, vapour absorption, thermoelectric and steam-jet refrigeration systems.
CO4	Analyze air-conditioning processes using the principles of psychrometry.
CO5	Evaluate cooling and heating loads in an air-conditioning system.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	1	3	3	1		1	2	1	1			2				
CO2	2	3	1	1	2				2			2				
CO3	1	3	1	2	2				3			2				
CO4	2	3		1	2				2			2				
CO5		2	1	1	2	1		1	1			1				
Average	**1.5**	**2.8**	**1.5**	**1.2**	**2**	**1**	**2**	**1**	**1.8**			**1.8**				

Course Contents **Contact Hours**

Unit 1 Introduction: Introduction to Refrigeration –Basic Definition, ASHRAE Nomenclature

Air Refrigeration: Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits, analysis.

Vapour Compression Refrigeration System (VCRS): Vapour Compression Refrigeration system – Carnot Vapour compression refrigeration cycle, Working and analysis, Limitations, Standard Vapour Compression Refrigeration system, Working and analysis, Effects of sub cooling and super heating, Multi-Pressure or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and water inter cooling. **L-12**

Unit 2 Refrigerants: Classification, Selection of Refrigerants and Nomenclature of refrigerants, Desirable Properties of an ideal refrigerant, A discussion on Ozone layer Depletion and Global Warming **L-12**

Refrigeration systems Equipment: Refrigeration System Equipment – Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

Unit 3 Vapour Absorption systems: Other types of Refrigeration systems – Vapour Absorption Refrigeration Systems, Absorbent – Refrigerant combinations, Water-Ammonia Systems, Water-Lithium Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly **L-10**

Other systems: Brief Discussion on (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration system

Unit 4 Psychrometry: Introduction to Air-Conditioning, Basic Definition, Classification, ASHRAE Nomenclature pertaining to Air-Conditioning, Applications of Air-Conditioning, Psychrometry – Air-water vapour mixtures, Psychrometric Properties, Psychrometric or Air-Conditioning processes, Psychrometric Chart. **L-8**

Unit 5 Air-Conditioning: Mathematical Analysis of Air-Conditioning Loads, Related Aspects,

Numerical Problems, Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged AirConditioner, Components related to Air-Conditioning Systems. **L-8**

Readings:

1. Roy J. Dossat, Principles of Refrigeration, Wiley Limited
2. Arora C.P., Refrigeration and Air-conditioning, Tata Mc Graw –Hill, New Delhi
3. Stoecker W.F., and Jones J.W., Refrigeration and Air-conditioning, Mc Graw - Hill, New Delhi

Data Book:

1. Refrigerant and Psychrometric Properties (Tables & Charts) SI Units, Mathur M.L. & Mehta F.S., Jain Brothers.

Reference video Lectures from Swayam portal:

MEC 644	Cryogenics	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Thermodynamics and Heat transfer.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand principles of cryogenic systems.
CO2	Understand air and helium liquefaction processes.
CO3	Classify cascade refrigeration systems.
CO4	Understand principles of ultra-low temperature systems and their applications.
CO5	Evaluate storage systems used in cryogenic applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4

CO1	2	1	2	2	2	1	1					1				
CO2	3	1	2	2	1	1	1					1				
CO3	2	3	2	1	1	1	1					1				
CO4	2	3	2	1	1	1	1					1				
CO5	3	2	2	2	1	1	1					1				
Average	**2.4**	**2**	**2**	**1.6**	**1.2**	**1**	**1**					**1**				

Course Contents **Contact Hours**

Unit 1 Introduction: Definition and Engineering Applications of Cryogenics, Properties of solids for **L-6**

cryogenic systems

Unit 2 Refrigeration and Liquefaction: Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual- **L-6**

pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle

Unit 3 Ultra-low-temperature refrigerators: Definition and Fundamentals regarding ultra-low-

temperature refrigerators, Equipment associated with low-temperature systems, Various **L-8**

Advantages and Disadvantages

Storage and Handling of Cryogenic Refrigerants: Storage and Transfer systems, Insulation,

Unit 4

Various Types of Insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene **L-8**

Foams (PSFs), Vacuum Insulation, and so on

Unit 5 Applications: Broad Applications of Cryogenic Refrigerants in various engineering systems **L-6**

Readings:

1. Traugott H.K. Frederking and S.W.K. Yuan, Cryogenics - Low Temperature Engineering and Applied Sciences, Yutopian Enterprises, 2005.
2. Arora, C.P., Refrigeration and Air-conditioning, Tata-McGraw Hill, 2008

Reference video Lectures from Swayam portal:

MEC 645	Energy Systems and Management	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Thermodynamics and Heat transfer.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand principles of energy management and its influence on environment.
CO2	Comprehend methods of energy production for improved utilization.
CO3	Improve the performance of thermal systems using of energy management principles
CO4	Analyze the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems.
CO5	Evaluate energy projects on the basis of economic and financial criteria.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	3		1		2	1				2				
CO2	2	3	2		1		2									
CO3	3	2	2		2		3					1				
CO4	3	2	1		1		2					2				
CO5	1			1					1		2	1				
Average	**2.4**	**2.25**	**2**	**1**	**1.25**				**1**		**2**	**1.5**				

Course Contents **Contact Hours**

Unit 1 Introduction to Thermodynamics, Fluid Flow and Heat Transfer, Heat transfer media: Water, steam, Thermal fluids, Air-water vapour mixtures, Heat transfer equipment: Heat exchangers, Steam plant **L-8**

Unit 2 Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems **L-6**

Unit 3 Energy conversion systems: Furnaces, turbines, Heat recovery systems: Incinerators, regenerators and boilers **L-6**

Energy Management: Principles of Energy Management, Energy demand estimation, Organizing

Unit 4 **L-8**

and Managing Energy Management Programs, Energy pricing

Unit 5 Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries, Economic Analysis: Scope, Characterization **L-8**

of an Investment Project case studies.

Readings:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Murphy, W. R., Energy Management, Elsevier, 2007.
4. Smith, C. B., Energy Management Principles, Pergamon Press, 2007.

Reference video Lectures from Swayam portal:

MEC 654	Design Engineering Laboratory	L-0 T-0 P-2	1 credit

Pre-requisites: Theoretical knowledge of Mechanics, Strength of Materials, Theory of Machines and Design of Machine Elements.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the deformation behavior of materials.
CO2	Understand the kinematic and dynamic characteristics of mechanical devices.
CO3	Draw complex geometries of machine components in sketcher mode.
CO4	Generate freeform shapes in part mode to visualize components.
CO5	Create complex engineering assemblies using appropriate assembly constraints.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	1	2	1				1			1	2			
CO2	2	2	1	2	1				1			2	2			
CO3	2	2	2	1	3	2	1		1	1		3	3	2	1	
CO4	2	2	3	1	3	2	1		1	1		3		2		2
CO5	2	2	3	2	3	2	1		1	1		3	1	3	1	3
Average	**2**	**2**	**2**	**1.6**	**2.2**	**2**	**1**	**1**	**1**	**1**		**2.4**	**2**	**2.33**	**1**	**2.5**

Course Contents **Contact Hours**

Complete atleast 10 experiments from the following:

Experiment 1	Uniaxial tension test on mild steel rod	**P-2**
Experiment 2	Torsion test on mild steel rod	**P-2**
Experiment 3	Impact test on a metallic specimen	**P-2**
Experiment 4	Brinell and Rockwell hardness tests on metallic specimen	**P-2**
Experiment 5	Bending deflection test on beams	**P-2**
Experiment 6	Strain measurement using Rosette strain gauge	**P-2**

Experiment 7	Microscopic examination of heat-treated and untreated metallic samples	**P-2**
Experiment 8	Velocity ratios of simple, compound, epicyclic and differential gear trains	**P-2**
Experiment 9	Kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms	**P-2**
Experiment 10	Cam & follower and motion studies	**P-2**
Experiment 11	Single degree of freedom Spring-mass-damper system, determination of natural frequency and damping coefficient	**P-2**
Experiment 12	Determination of torsional natural frequency of single and double rotor systems-undamped and damped natural frequencies	**P-2**
Experiment 13	Introduction to Software and working with sketch mode	**P-2**
Experiment 14	Working with creating features (Extrude & Revolve), Working Datum Planes	**P-2**
Experiment 15	Working with the tools like Hole, Round, Chamfer and Rib	**P-2**
Experiment 16	Working with the tools like Pattern, Copy, Rotate, Move and Mirror	**P-2**
Experiment 17	Working with advanced modeling tools (Sweep, Blend, Variable section Sweep, Swept Blend & Helical Sweep)	**P-2**
Experiment 18	Assembly modelling in Software, Generating, editing and modifying drawings in Software	**P-2**

Readings:

1. Printed manual provided to students.
2. *Software Manual provided to students in pdf format*

Reference video Lectures from Swayam portal:

MEC 724	Operations Research	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of general engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand game, queuing and decision theories
CO2	Solve linear programming problems
CO3	Determine optimum solution to transportation problem
CO4	Determine average queue length and waiting times of queuing models.
CO5	Determine optimum inventory and cost in inventory models.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	2		2		2		1	1	2	1	2	1	1	3
CO2	3	2	2		2		2		1	1	2	1	3	2		3
CO3	3	2	1		2		2		1	1	2	1	3	2		3
CO4	3	2	1		2		2		1	1	1	1	3	1	1	
CO5	3	2	1		2		2		1	1	1	1	3			3
Average	**3**	**2.2**	**1.4**		**2**		**2**		**1**	**1**	**1.6**	**1**	**2.8**	**1.5**	**1**	**3**

Course Contents **Contact Hours**

Unit 1 Linear Programming: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems. **L-8**

Unit 2 Transportation Problems: Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal solutions. Degeneracy in Transportation problems. **L-8**

Unit 3 Queueing Theory: Basic structure of queuing models, birth-and-death process, basic queuing models, blocking models, priority-discipline models, queuing networks. **L-8**

Elements of Inventory Control: Economic lot size problems - Fundamental problems of EOQ.

Unit 4 **L-8**

The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only)

Unit 5 Game Theory: Formulation of two-person zero-sum games, games with mixed strategies, graphical solution procedure, solving by linear programming.

Decision Analysis: Decision making with and without experimentation, decision trees, utility theory.

Readings:

1. Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand & Co., 2006
2. J.C.Pant, Introduction to Operatins Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo : Mathematical Programming Techniques, East-West Pub., Delhi, 1991.
4. Taha, H.A., Operations Research, 9th Edition, Prentice Hall of India, New Delhi, 2010.
5. Hillier, F.S., and Lieberman, G.J., Introduction to Operations Research, 7th Edition, TMH, 2009.
6. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, John Wiley & sons, 2001.

Reference video Lectures from Swayam portal:

MEC 725	Industrial Automation	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of general engineering and manufacturing processes.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Enumerate principles, strategies and advantages of industrial automation.
CO2	Select level of automation and calculate manpower requirement.
CO3	Design material handling and material storage systems for an automated factory.
CO4	Automate shop floor controls and part/device identification methods.
CO5	Study the effect of automation by simulation and experimentation.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	2	1	2	1	1	1	1	1	1	1	2		1	3
CO2	2	1	1	1	2	1	1	2	2	1	1	1	2		1	1
CO3	2	2	2	2	2	1	1	1	1	1	1	1	3			1
CO4	1	1	1	2	2	1	1	1	1		1	1	1	3		
CO5	2	2	1	1	2		1			1	1	1		3		2
Average	**1.8**	**1.6**	**1.4**	**1.4**	**2**	**1**	**1**	**1.25**	**1.25**	**1**	**1**	**1**	**2**	**3**	**1**	**1.75**

Course Contents **Contact Hours**

Unit 1 Principles and Strategies of Automation-Power to Accomplish the Automated Process, program of Instruction, Control System, Advanced automation Functions-safety Monitoring,

L-8

maintenance and repair Diagnostics, error Detection and Recovery, levels of automations-Five levels of automation and control in manufacturing.

Unit 2 Material Handling systems and Design-Introduction to Material Handling, Material Transport Equipment, analysis of Material Transport Systems, Storage Systems-Storage System

L-8

Performance and Location Strategies, Conventional Storage Methods and Equipment,

Automation Storage Systems, Engineering Analysis of Storage Systems.

Unit 3 Automatic identification methods-Overview of Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies, Industrial control systems-Process Industries Vs Discrete Manufacturing Industries, Levels of Automation in the two industries, Variables and Parameters in the two industries. Continuous Vs Discrete control- Continuous Control System, Discrete Control System, **L-8**

Unit 4

Computer process control and its forms- Control Requirements, Capabilities of Computer Control, and Forms of Computer process Control. **L-8**

Unit 5 Control system components-Sensors, Actuators, Analog-to-Digital Convertors, Digital-to-Analog Convertors, Input/output Devices for Discrete Data. **L-6**

Readings:

1. Groover, M.P., Automation production Systems and Computer Integrated Manufacturing, Pearson Education, 2003.
2. Krishna Kant, Computer Based Industrial Control, Prentice Hall of India, New Delhi, 2000.
3. Tiess Chiu Chang and Richard A.W., An Introduction to Automated Process planning Systems, Tata McGraw-Hill Publishing company, New Delhi, 2000.

Reference video Lectures from Swayam portal:

MEC 726	Automobile Engineering	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Basic Mechanical engineering, Thermodynamics and Internal Combustion engines.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the basic lay-out of an automobile.
CO2	Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
CO3	Understand the principles of transmission, suspension, steering and braking systems.
CO4	Understand automotive electronics.
CO5	Study latest developments in automobiles.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2		2	3	3	3	1		1	2	2	1	2	1		1
CO2	3	3	2	3	3	3	3	1			2	1	2	1		
CO3	3	2	3	2	3	1	3	1	1			2	3	1		3
CO4	2	3	3	3	3	1	3		1	1	1		3	2		2
CO5	2	3	3	3	3	3	3			1	1	1	3	1	1	3
Average	**2.4**	**2.75**	**2.6**	**2.8**	**3**	**2.2**	**2.6**	**1**	**1**	**1.33**	**1.5**	**1.25**	**2.6**	**1.2**	**1**	**2.25**

Course Contents **Contact Hours**

Unit 1 Introduction: Overview of the course, Examination and Evaluation patterns, History of Automobiles, Classification of Automobiles. **L-6**

Unit 2 Engine: Classification, Engine Terminology, Types of Cycles, working principle of an IC engine, advanced classification of Engines- Multi cylinder engines, Engine balance, firing order. **L-8**

Unit 3 Fuel System and Ignition System and Electrical system: spark Ignition engines- Fuel tank, fuel filter, fuel pump, air cleaner/filter, carburetor, direct injection of petrol engines. Compression Ignition engines, Fuel Injection System- air & solid injection system, Pressure charging of engines, super charging and turbo charging, Components of Ignition systems, battery ignition system, magneto ignition system, electronic ignition and ignition timing. Main electrical circuits, generating & stating circuit, lighting system, indicating devices, warning lights, speedometer. **L-12**

Transmission, axles, clutches, propeller shafts and differential: Types of gear boxes, automatic

Unit 4

transmission, electronic transmission control, functions and types of front and rear axles, types and functions of the clutches, design considerations of Hotchkiss drive torque tube drive, function and parts of differential and traction control. **L-10**

Unit 5 Steering System: functions of steering mechanism, steering gear box types, wheel geometry, Automotive air conditioning: ventilation, heating, air condition, refrigerant, compressor and evaporator. **L-8**

Readings:

1. Crouse, W.H., and Anglin, D.L., Automotive Mechanics, Tata McGraw Hill, New Delhi, 2005.
2. Heitner, J., Automotive Mechanics, Affiliated South West Press, New Delhi, 2000.
3. Narang, G.B., Automobile Engineering, Khanna Publishers, New Delhi, 2001.
4. Kamaraju Ramakrishna, Automobile Engineering, PHI Learning pvt. Ltd., New delhi-2012.

Reference video Lectures from Swayam portal:

MEC 727	Tool Design	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Design of Machine Elements and Manufacturing Technology.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Interpret the geometrical and dimensional details of a production drawing.
CO2	Understand principles of locating and clamping systems.
CO3	Design jigs and fixtures for conventional and NC machining
CO4	Select and design progressive, compound or combination dies for press working operations
CO5	Design single point and multipoint cutting tools

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2		1					1			1				
CO2	3	3		3	1				1			1				
CO3	3	3		3	1				1			1				
CO4	2	1	1	1	2				1			1				
CO5	2	1		1	2				1			1				
Average	**2.6**	**2**	**1**	**1.8**	**1.5**				**1**			**1**				

Course Contents **Contact Hours**

Unit 1 Basic principles of tool design: Tool design – An overview, Introduction to Jigs and fixtures, Work holding devices: Basic principle of six-point location, Locating methods and devices, Principle of clamping and Types of clamps. **L-8**

Unit 2 Design of jigs: Type of Drill bushes, Classification of drill jigs, Design of drill jigs, Design of fixtures: Design of milling fixtures, Design of turning fixtures. **L-8**

Unit 3 Introduction of press tool design: Introduction to Die cutting operations, Introduction to press and classifications, die set assembly with components, Introduction to Centre of pressure, Examples of centre of pressure, Design of piercing die, Design of blanking die, Progressive, Compound and Combination dies. **L-10**

Unit 4 Design of cutting tools: Introduction to cutting tools, Design of single point tool, Design of drill bit, Design of milling cutter. **L-8**

Unit 5 Brief introduction of NC machines work holding devices: Tool design for NC machines- An introduction, Fixture design for NC Machine, cutting tools for NC Machine, Tool holding **L-10** methods for NC Machine, ATC and APC for NC Machine, Tool presetting for NC Machine.

Readings:

1. F.W.Wilson.F.W. "Fundamentals of Tool Design", ASME, PHI, New Delhi, 2010
2. 2. Donaldson.C, G.H.Lecain and V.C.Goold "Tool Design", TMH, New Delhi, 2010.

Reference video Lectures from Swayam portal:

MEC 728	New Venture Creation	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of general Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
CO2	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.
CO3	Understand entrepreneurship and entrepreneurial process and its significance in economic development.
CO4	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO5	Develop a framework for technical, economic and financial feasibility.
CO6	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1						2	3	2	2	2	1	2				
CO2								2	2	2	2	3				
CO3						1			3			3				
CO4						3		2		3	1	2				
CO5				1			2			1	2	2				
CO6							1	2		1		1				
Average				**1**		**2**	**2**	**2**	**2.33**	**1.8**	**1.5**	**2.16**				

Course Contents **Contact Hours**

Unit 1 Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; **L-8**

Institutional Interface for Small Scale Industry/Enterprises.

Unit 2 Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and **L-8**

selection of site.

Unit 3 Planning a Small-Scale Enterprises: Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business **L-8**

organization/ownership.

Operational Issues in SSE: Financial management issues; Operational/project management

Unit 4 **L-8**

issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.

Unit 5 Performance appraisal and growth strategies: Management performance assessment and

L-10

control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Readings:

1. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.
2. D.F. Kuratko and T.V. Rao, Entrepreneurship: A South-Asian Perspective, Cengage Learning, 2013 3. Dr. S.S. Khanka, Entrepreneurial Development (4th ed.), S Chand & Company Ltd., 2012.
4. Dr. Vasant Desai, Management of Small-Scale Enterprises, Himalaya Publishing House, 2004.

Reference video Lectures from Swayam portal:

MEC 729	Industrial Robotics	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of general Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Model forward and inverse kinematics of robot manipulators.
CO2	Analyze forces in links and joints of a robot.
CO3	Programme a robot to perform tasks in industrial applications.
CO4	Design intelligent robots using sensors.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	1	2	2				2	1		1				
CO2	3	1	2	2	3					2		2				
CO3	3	3	3	2	3	2	1	1	2	2		2				
CO4	3	3	3	3	2	1	1	1	3	1		1				
Average	**3**	**2.5**	**2.25**	**2.25**	**2.5**	**1.5**	**1**	**1**	**2.33**	**1.5**		**1.5**				

Course Contents **Contact Hours**

Unit 1 Robotics-classification, Sensors-Position sensors, Velocity sensors, Proximity sensors, Touch and Slip Sensors, Force and Torque sensors. **L-6**

Unit 2 Grippers and Manipulators-Gripper joints, Gripper force, Serial manipulator, Parallel Manipulator, selection of Robot based on the Application, Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation. **L-10**

Unit 3 Differential Kinematics and static- Dynamics-Lagrangian Formulation, Newton-Euler Formulation for RR & RP Manipulators. **L-6**

Unit 4 Trajectory planning-Motion Control- Interaction control, Rigid Body mechanics, Control architecture- position, path velocity and force control systems, computed torque control, adaptive control, and Servo system for robot control **L-10**

Unit 5 Programming of Robots and Vision System- overview of various programming languages, Application of Robots in production systems- Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection. **L-8**

Readings:

1. Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., Robotics control, Sensing, Vision and Intelligence, McGraw-Hill Publishing company, New Delhi, 2003.
2. Klafter, R.D., Chmielewski, T.A., and Negin. M, Robot Engineering-An Integrated Approach, Prentice Hall of India, New Delhi, 2002.
3. Craig, J.J., Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.

Reference video Lectures from Swayam portal:

MEC 730	Supply Chain Management	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of general Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the decision phases and apply competitive & supply chain strategies.
CO2	Understand drivers of supply chain performance.
CO3	Understand the role of aggregate planning, inventory, IT and coordination in a supply chain.
CO4	Analyze factors influencing network design.
CO5	Analyze the influence of forecasting in a supply chain.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1			1		1	2	1	1	2	1	2	1				
CO2		1	1		2	1	1				1					
CO3	2	2	2		2	2	2	1	2	2	2	1				
CO4		1	2		2	1	2	1			3					
CO5	1	2	1		1	1		1			1					
Average	**1.5**	**1.5**	**1.4**		**1.6**	**1.4**	**1.5**	**1**	**2**	**1.5**	**1.8**	**1**				

Course Contents **Contact Hours**

Unit 1 Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope. **L-8**

Unit 2 Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit. **L-6**

Unit 3 Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation. **L-8**

Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and

Unit 4 **L-8**

forecasting methods, Risk management in forecasting.

Unit 5 Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory. **L-12**

Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect.

Readings:

1. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
2. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

Reference video Lectures from Swayam portal:

MEC 731	Rapid Prototyping	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of general Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify suitable time compression techniques for rapid product development and minimize errors during generation of STL files.
CO2	Model complex engineering products and develop process plans for rapid production
CO3	Analyze and select a rapid manufacturing technology for a given component.
CO4	Optimize FDM process parameters to improve the quality of the parts.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	3	1	3	3	2	1					1				
CO2	2	2	1	3	3	2	2					1				
CO3	1	2	1	3	3	2	3					1				
CO4	1	2	1	3	3	2	1					1				
Average	**1.5**	**2.25**	**1**	**3**	**3**	**2**	**1.75**					**1**				

Course Contents **Contact Hours**

Unit 1 Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP. **L-8**

Unit 2 RP Software: Need for RP software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, Solid View, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP. **L-8**

Unit 3 Rapid Prototyping Processes: Photopolymerization RP Processes, Powder Bed Fusion RP Processes, Extrusion-Based RP Systems, Printing RP Processes, Sheet Lamination RP Processes, Beam Deposition RP Processes, Application of Rapid Prototyping Processes. **L-12**

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct

Unit 4

and Indirect Tooling Methods, Soft and Hard Tooling methods, Reverse Engineering: Reverse

L-8

Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE

hardware, RE in product development.

Unit 5 Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS, etc., RP Applications: Design, Engineering Analysis and planning applications, **L-8** Rapid Tooling, Reverse Engineering, Medical Applications of RP.

Readings:

1. Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.
2. Ian Gibson., David W Rosen., Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
3. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

Reference video Lectures from Swayam portal:

MEC 746	Power Plant Engineering	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Thermodynamics, Heat transfer and Engines.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand functions of the components of power plant.
CO2	Understand the working of nuclear, thermal and oil-based power plants.
CO3	Evaluate the design layout and working of hydroelectric power plants.
CO4	Evaluate economic feasibility and its implications on power generating units.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	3	1	1	3				2			2				
CO2	1	3	1	1	2	1			2			2				
CO3	2	3	1	2	3				3			2				
CO4	3	3		1	2				2			2				
Average	**2**	**3**	**1**	**1.25**	**2.5**	**1**			**2.25**			**2**				

Course Contents **Contact Hours**

Unit 1 Introduction-Analysis of steam cycles, optimization of reheat pressure and degree of regeneration, coupled cycles and combined plants, process heat and power, Fuels and their properties, stoichiometric and actual air requirements, flue gas analysis. **L-8**

Unit 2 Boilers- Different types of boilers, boiler mountings, feed water treatment, boiler loading and manner of operation, boiler energy balance, draft system. Different types of furnaces for burning coal, fuel oil and gas, Circulation theory, down-comers and risers, economizers and super-heaters, air pre-heater, drum and its internals. **L-10**

Unit 3 Steam Turbines- Convergent and convergent-divergent nozzles - theory and design, Impulse and reaction turbines, compounding of turbines, optimum velocity ratio, reheat factor and condition line, parallel exhaust, losses in steam turbines, steam turbine governing. **L-12**

Plant Components- Theory and design of condensers, air ejector and cooling towers, Types and

Unit 4 **L-8**

applications, Power Plant, Economics & Environmental, Considerations, Economic analysis.

Unit 5 Plant energy studies, Energy accounting, various thermal systems and energy management.

Electrical load management, Waste heat recovery, Multi objective energy management-

L-10

conservation, pollution control and evaluation of alternative energy sources. Cost of energy

management and payback.

Readings:

1. Power plant engineering by 'Arrora & Domkundwar', Dhanpat Rai & Sons, New Delhi, 2008.
2. Power plant Technology by 'M.M.Ei-Wakil', McGraw Hill Com., 1985.
3. Power plant engineering by 'P C Sharma', S.K. Kataria & Sons, New Delhi, 2010.

Reference video Lectures from Swayam portal:

MEC 747	Gas Dynamics	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Fluid mechanics and Machines.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the flow through constant area ducts with friction and heat transfer.
CO2	Analyze flows with normal and oblique shocks.
CO3	Solve flow problems with supersonic velocities using shock-expansion theory.
CO4	Solve linearized velocity potential equation for multi-dimensional flows.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	3	1	2	2	2		2	1		1				
CO2	3	3	2	3	3	3	3		3	1		1				
CO3	3	1	2	3	3	3	1		2	1		1				
CO4	3	3	3	2	3	3	3		1	1		1				
Average	**3**	**2.5**	**2.5**	**2.25**	**2.75**	**2.75**	**2.25**		**2**	**1**		**1**				

Course Contents **Contact Hours**

Unit 1 Introduction: Review of basic fluid dynamic and thermodynamic principles, Conservation

L-6

equations for inviscid lows.

Unit 2 One Dimensional flow: One-dimensional wave motion, normal shock waves, Oblique shock

L-6

waves, Prandtl-Meyer expansions and applications, Generalized one-dimensional flow.

Unit 3 Nozzle Flow: Isentropic flow with area change, Flow with friction (Fanno flow), Flow with heat

L-6

addition (Rayleigh flow).

Nozzle Flow application, Method of characteristics (application to one-dimensional unsteady

Unit 4 **L-6**

isentropic flow)

Unit 5 Supersonic Flow: Velocity Potential Equation, Numerical Techniques for Steady Supersonic

L-6

Flow, Time Marching Technique for Supersonic Blunt Bodies and Nozzles.

Readings:

1. Anderson, J.D Jr., Modern Compressible Flows, Tata McGraw Hill, 2012.
2. Yahya, S.M., Fundamentals of Compressible Flow, New age International Pub., 2013.
3. Zucrow, M., Gas Dynamics, Wiley India, 2013.

Reference video Lectures from Swayam portal:

MEC 748	Innovative Design	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Design engineering and CAD.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the conceptual development techniques to find solution for a critical design issue.
CO2	Apply embodiment principles to translate the conceptual ideas to engineering design.
CO3	Apply environmental, ethical and social issues during innovative design process.
CO4	Design and develop innovative engineering products for industrial needs using robust design philosophy.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	1	2	1		2		2		2		1	1				
CO2	2	2			1						1	1				
CO3		2	3			2	3				1	1				
CO4		2	3			2		3			1	1				
Average	**1.5**	**2**	**2.33**		**1.5**	**2**	**2.5**	**3**	**2**		**1**	**1**				

Course Contents **Contact Hours**

Unit 1 Introduction: Innovations in Design, Engineering Design Process, Prescriptive and integrative

L-6

models of design, Design Review and societal considerations.

Unit 2 Identification of Customer Need: Evaluating Customer requirements and survey on customer

L-6

needs, Conversion of customer needs into technical Specifications, Information sources.

Unit 3 Concept Generation and Evaluation: Creativity and Problem solving, Brainstorming, Theory of Inventive Problem solving (TRIZ), Functional Decomposition of the problem for innovative

L-10

concept development, Morphological design, Introduction to Axiomatic Design, Concept evaluation and decision making.

Embodiment Design: Introduction, Product Architecture, Configuration and Parametric design

Unit 4 **L-6**

Concepts, Industrial Design.

Unit 5 Design for X: Design for Manufacturing, Design for Assembly, Design for Environment,

L-8

Design for Reliability and Robustness, Introduction to FMEA.

Readings:

1. Nigel Cross, Engineering Design Methods, John Wiley, 2009.
2. George E. Dieter, Engineering Design, McGraw-Hill, 2009.
3. Genrich Altshuller, The Innovation Algorithm, Technical Innovation Centre, 2011.

Reference video Lectures from Swayam portal:

MEC 749	Theory of Constraints	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of general engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand TOC thinking process tools including CRT, EC, FRT and PRT
CO2	Assess the system performance using throughput accounting.
CO3	Apply DBR and OPT methodologies for manufacturing scheduling.
CO4	Implement critical chain methodology for project scheduling

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	2		1	1	2	2	2	1	3	3				
CO2	2				1	1	1			1	3	2				
CO3	2				1	1	1		1		3	1				
CO4	2				1	1	1		2		3	1				
Average	**2**				**1**	**1**	**1.25**		**1.66**	**1**	**3**	**1.75**				

Course Contents **Contact Hours**

Unit 1 Introduction: Basic philosophy, local and global optima, five focusing steps of TOC, **L-8**

comparison with TQM & JIT philosophies.

Unit 2 Throughput Accounting: Financial and operating measures, local and global performance measures, throughput, inventory, operating expenses, linking concepts of throughput accounting **L-8**

with financial accounting.

Unit 3 Manufacturing Scheduling: Line and job shop processes, make-to-stock and make-to-order environments, scheduling rules, DBR methodology for scheduling line processes, OPT **L-10**

methodology for scheduling job shops, buffering and types of buffers, buffer management.

Project Scheduling: Critical chain methodology, developing single-project critical chain plan,

Unit 4

developing multi-project critical chain plan, buffer and threshold sizing, project risk **L-8**

management.

Unit 5 TOC Thinking Process: Current reality tree, evaporating clouds, future reality tree, prerequisite

L-8

tree, transition tree.

Readings:

1. Dettmer H. W., Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement. ASQ Quality Press, Wiscousin, 1997.
2. Leach, L.P, Critical Chain Project Management, 2nd Edition, Artech House Inc, London, 2005.

Reference video Lectures from Swayam portal:

MEC 755	Automobile Engineering Laboratory	L-0 T-0 P-2	1 credit

Pre-requisites: Theoretical knowledge of Mechanics, Strength of Materials, Theory of Machines and Design of Machine Elements.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the Construction, working and other details about Internal Combustion Engines used in automobiles
CO2	Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems.
CO3	Understand importance and features of different systems like axle, brakes, steering, suspension, and balancing etc.
CO4	Identify Modern technology and safety measures used in Automotive Vehicles

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2		2	3	3	3	1		1	2	2	1	1			1
CO2	3	3	2	3	3	3	3	1			2	1	1	3		3
CO3	3	2	3	2	3	1	3	1	1			2	2	3		3
CO4	2	3	3	3	3	1	3		1	1	1		3	3		3
Average	**2.5**	**2.66**	**2.5**	**2.75**	**3**	**2**	**2.5**	**1**	**1**	**1.5**	**1.66**	**1.33**	**1.75**	**3**		**2.5**

Course Contents **Contact Hours**

Complete at least 10 experiments from the following:

Experiment 1 Design of automotive clutch assembly and component drawing using any drafting software. (Two full imperial sheets along with design calculations report) consists of: **P-4**

- Functional design of clutch
- Design of clutch shaft, hub and flange
- Design of damper springs
- Design of sectors, rivets etc.
- Design of pressure plate assembly
- Design for linkage mechanism
- Details and assembly drawing
- Details and assembly drawing

Experiment 2 Design of automotive gear box along with reverse gear (Two full imperial sheets along with design calculations report) consists of: **P-4**

- Calculation of gear ratios
- Determination of number of teeth on gear pair

- Determination of gear reductions
- Design of gear pairs
- Design of shafts
- Selection of bearings
- Details and assembly drawing

Experiment 3	Study of lubricating system.	**P-2**
Experiment 4	Study of fuel supply systems of automobile	**P-2**
Experiment 5	Study of various electrical and starting systems in automobile	**P-2**
Experiment 6	Study of braking systems of automobile with brake efficiency measurement	**P-2**
Experiment 7	Fault finding of ignition system.	
Experiment 8	Study of various suspension systems of automobile.	**P-2**
Experiment 9	Disassembly & assembly of two types of gear boxes in the automobile	**P-2**
Experiment 10	Laboratory testing of vehicle on chassis dynamometer for performance and emission.	**P-2**
Experiment 11	Study of steering system & its adjustment	**P-2**
Experiment 12	Disassembly & assembly of two stroke engine	**P-2**
Experiment 13	Report based on visit to vehicle testing and research organization.	**P-2**

Readings:

1. Printed manual provided to students.
2. Software Manual provided to students in pdf format

Reference video Lectures from Swayam portal:

MEC 756	**Production Engineering Laboratory**	**L-0 T-0 P-2**	**1 credit**

Pre-requisites: Theoretical knowledge of Mechanics, Strength of Materials, Theory of Machines and Design of Machine Elements.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Fabricate joints using gas welding and arc welding.
CO2	Evaluate the quality of welded joints using non-destructive testing methods.
CO3	Test the properties of moulding sands.
CO4	Perform injection moulding studies on plastics.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	1	2	1	1	1	1			3	3	1	1				
CO2	1	2	1	1	1	1			3	3	1	1				
CO3	1	2	2	2	1	1			3	3	1	1				
CO4	1	2	2	2	2	2			3	3	1	1				
Average	**1**	**2**	**1.5**	**1.5**	**1.25**	**1.25**			**3**	**3**	**1**	**1**				

Course Contents **Contact Hours**

Complete at least 10 experiments from the following:

Fabricate the butt joint in the given samples by using shielded metal arc welding in the given

Experiment 1 **P-2**

samples

Experiment 2 Fabricate the butt joint in the given samples by using shielded metal submerged arc welding **P-2**

Experiment 3 Fabrication of circumferential butt joint in the given samples by using shielded metal arc **P-2**

welding

Experiment 4 Fabricate the butt joint in the given samples by using gas welding **P-2**

Experiment 5 Fabricate the butt joint in the given samples by using tungsten inert gas welding **P-2**

Experiment 6 Fabricate the similar metal plates in the given samples using resistance spot welding **P-2**

Experiment 7 Joint the rectangular cross section plates in the given samples by flash butt welding

Experiment 8 Identification welding defects by liquid penetration test in the welded sample **P-2**

Experiment 9 Identification of welding defects by implant testing. In the welded sample **P-2**

Experiment 10 Demonstration on sweep pattern and core making in mould preparation **P-2**

Experiment 11 Calculate the amount of the clay content in the given moulding sand **P-2**

Experiment 12 Find out the grain fineness number of the given moulding sand **P-2**

Experiment 13 Find out the green shear and green compression strength of the given moulding sand **P-2**

Experiment 14 Calculate the permeability of the given moulding sand **P-2**

Experiment 15 Find out the dry shear and dry compression strength of the given moulding sand **P-2**

Experiment 16 Find out shatter index of the given moulding sand **P-2**

Experiment 17 Demonstration casting of at least two products. **P-2**

Readings:

1. Printed manual provided to students.

Reference video Lectures from Swayam portal:

MEC 771	Project	L-0 T-0 P-4	2 credits

Pre-requisites: Knowledge of Mechanical Engineering for practical exposure and project preparation.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work.
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	1		2	2	1	1	2	2	1	2	2			
CO2	1	1	2	2			2	2	1	2	1	2	2			
CO3	2	2		3					2	2		1	1	3	1	
CO4				2				2	2	3		1	3	2	1	3
CO5		1		2	2			2	2	3		1	2	1		3
Average	**1.66**	**1.5**	**1.5**	**2.25**	**2**	**2**	**1.5**	**1.75**	**1.8**	**2.4**	**1**	**1.4**	**2**	**2**	**1**	**3**

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design, fabrication and demonstration are expected to be completed in the seventh semester. The detailed Report along with the published research papers (if any) is required to be submitted in the department before commencement of End semester Examinations for seventh semester.

MEC 881	Internship	L-0 T-0 P-0	15 credits

Pre-requisites: Knowledge of Mechanical Engineering for practical exposure in industry.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Demonstrate the application of knowledge and skill sets acquired from the course and workplace in the assigned job functions
CO2	Solve real life challenges in the workplace by analyzing work environment and conditions, and selecting appropriate skill sets acquired from the course

CO3	Articulate career options by considering opportunities in company, sector, industry, professional and educational advancement
CO4	Communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means
CO5	Recommend ideas to improve work effectiveness and efficiency by analyzing challenges and considering viable options
CO6	Exhibit professional ethics by displaying positive disposition during internship

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	1		1	1	1		1			2	2	2	3	
CO2	3	2	2	2	1	2	2	2	1			2	1			3
CO3	3	2	2	2	1	2	2		1	2	3	2			2	2
CO4	3	2						1	1	3	2	2	1		3	2
CO5	3	2	3	2		2	2	2	1	2	3	2		3	3	
CO6	1	2	1					3	1	2	2	2				3
Average	**2.66**	**2**	**1.8**	**2**	**1**	**1.75**	**1.75**	**2**	**1**	**2.25**	**2.5**	**2**	**1.33**	**2.5**	**2.75**	**2.5**

The objective of Internship (Industrial Training & Presentation) is to enable the student to go to industry or R&D laboratory for training for 3 to 6 months and extend theoretical and practical work, under the guidance of a supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

- In depth study of the work assigned.
- Review and finalization of the Approach to the Problem relating to the assigned work;
- Detailed Analysis of Problem; Solving or Experiment as needed;
- Final development of process, testing, results, conclusions and future directions; • Preparing a Report in the standard format for being evaluated by the Department;
- Final Seminar Presentation before a Departmental Committee.

OME 601	Industrial Safety	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Basic Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the effects of release of toxic substances.

CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and preventive measures.
CO4	Assess the risks using fault tree diagram.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	2	2	3	1	1	2	3	2		2		1		3		
CO2			3			2	3	2		2	2	1	2			
CO3			3	1	1	2	3	2		1	2	1	2			1
CO4	1	1	3	1	1	1	3	1		2		1	2	2		2
Average	**1.5**	**1.5**	**3**	**1**	**1**	**1.75**	**3**	**1.75**		**1.75**	**2**	**1**	**2**	**2.5**		**1.5**

Course Contents **Contact Hours**

Unit 1 General Industrial work environment, safety concepts, safety as essential parameter in the design of industrial of industrial production system **L-6**

Unit 2 Hazards, their nature, consequences and classifications, analysis techniques, prevention strategies and measures, accident cost and the assessment **L-6**

Unit 3 Types of fire, fire prevention and strategies, Safety measures, Standards and programs **L-6**

Unit 4 Measuring safety performance, contribution of ergonomics to operator and plant safety **L-6**

Unit 5 Contribution of safety engineering to plant productivity industrial safety acts **L-6**

Readings:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall,2011.
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Vol. 6, Elsevier India, 2006.

Reference video Lectures from Swayam portal:

OME 602	Total Quality Management	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Basic Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Develop an understanding on quality management philosophies and frameworks.
CO2	Adopt TQM methodologies for continuous improvement of quality.

CO3	Measure the cost of poor quality, process effectiveness and efficiency to identify areas for improvement.
CO4	Apply benchmarking and business process reengineering to improve management processes.
CO5	Determine the set of indicators to evaluate performance excellence of an organization

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	1		2			1		3	2	1	1	1	3		3	
CO2	1		1	1		2		2	2	1	1	1	2		3	3
CO3	1		1	1	1	3		3	1	2	2	1	2	2		2
CO4	1	1			1	1		2	2	3	3	1	1	3	3	2
CO5	1	1			1	2		3	2	2	2	1	3	1		
Average	**1**	**1**	**1.33**	**1**	**1**	**1.8**		**2.6**	**1.8**	**1.8**	**1.8**	**1**	**2.2**	**2**	**3**	**2.33**

Course Contents **Contact Hours**

Unit 1 Evolution of Quality - Historical Perspective, Basic Concepts of Quality, Vision, Mission and Objectives of an Organization, Corporate Structure in an Organization and Role of Quality,

L-8

Quality Planning, Quality by Design, Quality Costs and Cost of Failure, Waste Control, How Quality Benefits Business.

Unit 2 Quality and Competitiveness in Business, Zero Defects and Continuous Improvement, Role of Leadership and Commitment in Quality Deployment, Team Building, Motivation and Rewards,

L-8

Total Employee Empowerment, Quality Functions - Measurement, Inspection, Testing, Calibration and Assurance.

Unit 3 Design Control and Conformity, Tolerance and Variability, PDCA Cycle, Juran Trilogy, Crosby's 10 points and Deming's 14 Points Customers Requirements, Customer-Supplier and

L-8

Chain Links, Establishing Customer Focus-Customer, Satisfaction, Measurement and Customer

Retention.

Product Liability, Total Quality Concepts and CWQC, Difference in Western and Japanese

Unit 4

Approach of TQM, Basic Philosophy and Fundamental Models of TQM, Total Quality and

L-8

Ethics, Internal Politics and Total Quality Management, Quality Culture, Education and

Training, Implementing Total Quality Management - An Integrated System Approach.

Unit 5 Total Preventive Maintenance: Self-Assessment, International/National Quality Awards:

Malcolm Baldridge Award, Deming Prize, European Award, Rajeev Gandhi Award, CII Exim **L-8**

Award, Jamna Lal Bajaj Award, Golden Peacock Award

Readings:

1. Total Quality Management by N.V.R Naidu, G. Rajendra New Age international, First Edition, Jan 2006.
2. Total Quality Management by R.S Naagarazan , New Age international,3e, 2015.
3. Quality Control & Application by B. L. Hanson & P. M. Ghare, Prentice Hall of India, 2004.
4. Total Quality Management by V.S Bagad Technical Publications, First Edition, Jan 2008.
5. Total Quality Management by S. Rajaram Dreamtech Press, First Edition, Jan 2008.

Reference video Lectures from Swayam portal:

OME 603	Maintenance and Reliability	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Basic Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concepts of reliability, availability and maintainability
CO2	Develop hazard-rate models to know the behavior of components
CO3	Build system maintenance and reliability models for different configurations
CO4	Asses reliability of components and systems using field and test data
CO5	Implement strategies for improving reliability of repairable and non-repairable systems

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	2	1				2					1	2		1	
CO2	3	2	1	1	1		2					1	3	2		2
CO3	3	2	2	1	2		2			1		1	3	2	1	
CO4	3	2	1	3	1		2			1	1	1	1			2
CO5	3	3	1		2	1	2			1	1	1		3		
Average	**3**	**2.2**	**1.2**	**1.33**	**1.5**	**1**	**2**			**1**	**1**	**1**	**2.25**	**2.33**	**1**	**2**

Course Contents **Contact Hours**

Unit 1 Introduction, operating life cycle, reliability, Failure data analysis, failure rate curve, hazard models, elements in series, parallel, mix, logic diagrams, improving reliability, redundancy- element, unit, standby, maintainability, availability, reliability and maintainability trade off. **L-8**

Unit 2 Maintenance Strategies: Break down maintenance, planned maintenance, strategies, preventive maintenance, design out maintenance, planned lubrication, total productive maintenance, zero break down, preventive inspection of equipment used in emergency. **L-8**

Unit 3 Maintenance Management, production maintenance system, objectives and functions, forms, policy, planning, organization, economics of maintenance, manpower planning, materials planning, spare parts planning and control, evaluation of maintenance management. **L-8**

Reliability: Definition of reliability, types of failures, definition and factors influencing system

Unit 4

effectiveness, various parameters of system effectiveness. Methods of reliability improvement,

L-8

component redundancy, system redundancy, types of redundancies-series, parallel, series -

parallel, stand by and hybrid, effect of maintenance

Reliability Testing: Life testing, requirements, methods, test planning, data reporting system, data reduction and analysis, reliability test standards. **L-8**

Readings:

1. R.Billintan & R.N. Allan, "Reliability Evaluation of Engineering and Systems", Plenum Press.
2. K.C. Kapoor & L.R. Lamberson,"Reliability in Engineering and Design", John Wiely and Sons.
3. S.K. Sinha & B.K. Kale,"Life Testing and Reliability Estimation", Wiely Eastern Ltd.
4. M.L. Shooman, "Probabilistic Reliability, An Engineering Approach", McGraw Hill.
5. G.H.Sandler,"System Reliability Engineering", Prentice Hall.
6. Management of systems – R.N. Nauhria & R. Prakash.

Reference video Lectures from Swayam portal:

Unit 5

OME 704	Engineering Acoustics	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Basic Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand wave propagation, absorption, transmission, reflection and radiation.
CO2	Formulate acoustic problems for reduction of sound levels.
CO3	Analyze and design resonant systems including pipes, mufflers, Helmholtz resonators.
CO4	Evaluate architectural acoustics reverberation time, direct echoes and acoustical amplification.
CO5	Analyze the acoustic levels and analytical predictions.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	3	3	3		2		1	1					2			2
CO2	3	3	2		1			1				1	2	3		
CO3	3	3	3		1	3						1	1	3		3
CO4	1	2	1		1	2	2		1	1		1	3	2		
CO5	1	2	1	2	2	1	1		1			1	1	3		3
Average	**2.2**	**2.6**	**2**	**2**	**1.4**	**2**	**1.33**	**1**	**1**	**1**		**1**	**1.8**	**2.75**		**2.66**

Course Contents **Contact Hours**

Unit 1 Introduction: Review of vibrations, resonance and frequency, Transverse wave equation, Spherical and cylindrical wave equation, Acoustic intensity, decibel scales,
Acoustic wave propagation: Transmission through different media, reflection from solid surfaces, radiation and reception of acoustic waves, absorption and attenuation of sound, Cavities and wave guides. **L-10**

Unit 2 Pipes, Resonators, and Filters: Resonance in pipes, standing waves, Absorption of sound, Helmholtz resonator, acoustic impudence, acoustic filters. **L-8**

Unit 3 Damping Attenuation and Absorption: Viscous attenuation of sound, absorption by atmosphere, attenuation in water, absorption in fluid filled pipes, damping in solids. **L-8**

Unit 4 Architectural Acoustics: Sound in enclosures, direct and reverberant sounds, sound absorption materials, acoustic factors in architectural design, standing waves and normal modes in enclosures. **L-8**

Noise Control: The auditory system, Effects of noise on humans, noise measurement and criterion, treatment at source and treatment of transmission path, Analysis and design of **L-8** mufflers for automotive applications.

Readings:

3. Robert D Finch. Introduction to acoustics, PHI 2008
4. Michael Moser, Michael Maser, S. Zimmermann, Engineering Acoustics: An introduction to Noise Control, 2/e, Springer, 2009.
5. Frank J Fahy, Foundations of Engineering Acoustics, Academic Press, 2000.
6. Michael Moeser, Michael Maser, Engineering Acoustics: An Introduction to Noise Control, Springer, 2004.

Reference video Lectures from Swayam portal:

Unit 5

OME 705	Project Management	L-3 T-0 P-0	3 credits

Pre-requisites: Knowledge of Basic Engineering.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the importance of projects and its phases.
CO2	Analyze projects from marketing, operational and financial perspectives.
CO3	Evaluate projects based on discount and non-discount methods.
CO4	Develop network diagrams for planning and execution of a given project.
CO5	Apply crashing procedures for time and cost optimization.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PEO 1	PEO 2	PEO 3	PEO 4
CO1	1	1	1			2	2	2	2	1	3	1	3			2
CO2		1	1			2	2	2	2	1	3			3	2	
CO3						1		1		1	2		3		3	2
CO4			1		1						1		2		3	
CO5			3		2	3		3	2	1	3	1	2	3	2	2
Average	**1**	**1**	**1.5**		**1.5**	**2**	**2**	**2**	**2**	**1**	**2.4**	**1**	**2.5**	**3**	**2.5**	**2**

Course Contents **Contact Hours**

Unit 1 Introduction: Introduction to Project Management, History of Project Management, Project Life Cycle.

L-8

Project Analysis: Facets of Project Analysis, Strategy and Resource Allocation, Market and Demand Analysis, Technical Analysis, Economic and Ecological Analysis.

Unit 2 Financial Analysis: Financial Estimates and Projections, Investment Criteria, Financing of Projects.

L-6

Unit 3 Network Methods in PM: Origin of Network Techniques, AON and AOA differentiation, CPM network, PERT network, other network models. **L-6**

Optimization in PM: Time and Cost trade-off in CPM, crashing procedure, scheduling when resources are limited. **L-6**

Unit 4

Project Risk Management: Scope Management, Work Breakdown Structure, Earned Value Management, Project Risk Management. **L-6**

Readings:

1. Prasanna Chandra, Project: A Planning Analysis, Tata McGraw Hill Book Company, New Delhi, 4th Edition, 2009.
2. 2. Cleland, Gray and Laudon, Project Management, Tata McGraw Hill Book Company, New Delhi, 3rd Edition, 2007.
3. 3. Jack R. Meredith., Samuel J. Jr. Mantel., Project Management - A Managerial Approach, John Wiley, 6th Edition, 2011.

Reference video Lectures from Swayam portal:

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