INSTITUTE OF ENGINEERING & TECHNOLOGY

(Dr. Bhimrao Ambedkar University, Agra (Formerly- Agra University, Agra)

(B++ Grade, NAAC Accredited; AICTE Approved Institution)

Minutes of the meeting of Academic Committee held on 17.06.2019 at the Institute of Engineering & Technology, Agra

The following members of the Academic Committee for Department of Mechanical Engineering & Civil Engineering were present as per approval of the Hon'ble Vice-Chancellor dated 12.06.2019.

The members of Academic Committee are as follows:

1.	Prof. Sunder Lal	Subject Expert, Mathematics (EX - Vice Chancellor)
2.	Prof. Jai Prakash	Academic Mentor, NPIU, New Delhi
3.	Prof. D. Singhal	Subject Expert, Civil Engineering (DCRUST, Murthal)
4.	Prof. Suresh Verma	Subject Expert, Mechanical Engineering (DCRUST, Murthal)
5.	Prof. P.K. Tripathi	Subject Expert, Civil Engineering (HBTU, Kanpur)
6.	Prof. P.N. Asthana	Subject Expert, Management
7.	Dr. M.K. Upadhyay	Head, Deptt. of Mechanical Engineering
8.	Prof. D.K. Singh	Dean (Academics)
9.	Dr. V.K. Saraswat	Director/Convener

The committee has taken the following decisions unanimously:

1. The minutes of the previous Academic Committee held on 15.09.2018 were confirmed without any change.
2. The members of the Academic Committee (Subject Experts) approved the CBCS (Choice Based Credit System) a per AICTE Model Curriculum for the II, III & IV Year Bachelor of Engineering Degree Programme in All Branche running in the Institute w.e.f. Academic Year 2019-20.
3. The revised Syllabi to be effective from Academic Year 2019-20 of all the subjects for the I & II Year and Scheme for I, II, III & IV Year for B.E. (Mechanical Engineering & Civil Engineering) Degree Programme as per new curriculum were reviewed and approved after incorporating necessary changes.

Prof. P.N. Asthana
Subject Expert, Management

Prof. Sunder Lal
Subject Expert, Mathematics
(EX - Vice Chancellor)

Prof. D. Singhal
Expert, Civil Engineering
(DCRUST, Murthal) 17/6/19

Prof. P.K. Tripathi
Subject Expert, Civil Engineering
(HBTU, Kanpur)

17/6/19
Prof. Suresh Verma
Subject Expert, Mechanical Engineering
(DCRUST, Murthal)

17/6/19
Dr. M.K. Upadhyay
Head, Deptt. of
Mechanical Engineering, IET

Prof. Jai Prakash 17/6/19
Academic Mentor, TEQIP III
NPIU, New Delhi

17.06.2019
Prof. D.K. Singh
Dean (Academics)

17.6.2019
Dr. V.K. Saraswat
Director/Convener

INSTITUTE OF ENGINEERING & TECHNOLOGY

DR. BHIMRAO AMBEDKAR UNIVERSITY, KHANDARI CAMPUS, AGRA

Minutes of the Academic Committee held on 26.09.2018 in the Conference Hall, Institute of Engineering & Technology, Agra

The following members of the Academic Committee were present as per order dated 15.09.18 of the Hon'ble Vice-Chancellor.

1.	Dr. V. K. Saraswat	Director/Convener
2.	Prof. D. K. Singh	Dean (Academics)
3.	Dr. M. K. Upadhyay	Head, Deptt. of Mechanical Engineering
4.	Dr. M. P. Singh	Head, Deptt. of Electronics & Communication Engineering
5.	Dr. S. K. Jain	Incharge, Deptt. of Computer Science & Engineering
6.	Prof. Anand Kumar	Subject Expert, Mechanical Engineering (HBTU, Kanpur)
7.	Dr. Anurag Singh	Subject Expert, Computer Science Engineering (NIT, Delhi)
8.	Prof. Vikram Singh	Subject Expert, Physics (BIT, Jhansi)
9.	Prof. Ram Naresh Tripathi	Subject Expert, Mathematics (HBTU, Kanpur)
10.	Dr. N. K. Gosh	Subject Expert, English (Agra College, Agra)
11.	Prof. C. L. Gahlot	Subject Expert, Chemistry (HBTU, Kanpur)
12.	Er. Sandeep Sharma	Alumni of Institute of Engineering & Technology, Agra
13.	Prof. Ajay Taneja	Special Invitee for CBCS System
14.	Er. Naman Garg	Special Invitee for EE & ECE

The committee has taken the following decisions unanimously:

1. The minutes of the previous Academic Committee held on 21 June 2017 were confirmed without any change.

2. The members of the Academic Committee (Subject Experts) approved the CBCS (Choice based Credit System) as per AICTE Model Curriculum for the I year Bachelor of Engineering Degree Programme in Civil Engineering, Computer Science Engineering, Electronics & Communication Engineering, Electrical Engineering and Mechanical Engineering w.e.f. Academic Year 2018-19.

26.9.18

3. The revised Syllabi to be effective from Academic Year 2018-19 of all the subjects for the I year Bachelor of Engineering Degree Programme as per new curriculum were reviewed and approved after incorporating necessary changes.

4. The revised ordinances for all the branches of Bachelor of Engineering Courses was approved, w.e.f. Academic Year 2018-19.

Er. Naman Garg
Special Invitee for EE & ECE

Prof. Ajay Taneja
Special Invitee for CBCS System

Er. Sandeep Sharma
Alumni of Institute of Engineering & Technology, Agra

Prof. C. L. Gahlot
Subject Expert, Chemistry
(HBTU, Kanpur)

Dr. N. K. Gosh
Subject Expert, English
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Prof. Ram Naresh Tripathi
Subject Expert, Mathematics
(HBTU, Kanpur)

Prof. Vikram Singh
Subject Expert, Physics
(BIT, Jhansi)

Dr. Anurag Singh
Subject Expert, Computer Science Engineering (NIT, Delhi)

Prof. Anand Kumar
Subject Expert, Mechanical Engineering (HBTU, Kanpur)

Dr. S. K. Jain
Incharge, Deptt. of Computer Science & Engineering

Dr. M. P. Singh
Head, Deptt. of Electronics & Communication Engineering

Dr. M. K. Upadhyay
Head, Deptt. of Mechanical Engineering

Prof. D. K. Singh
Dean (Academics)

Dr. V. K. Saraswat
Director/Convener

Undergraduate Degree Courses in Engineering & Technology

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)

General, Course Structure & Scheme

&

Semester-Wise Credit Distribution

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week 2 Hours Practical (Lab)/week	0.5 credits 1 credit

B. **Structure of Undergraduate Engineering program:**

S. No.	Category	Suggested Breakup of Credits (Total 160)
1.	Basic Science Courses (BSC)	20
2.	Engineering Science Courses (ESC)	30
3.	Humanities, Social Science and Management Courses (HSMC)	10
4.	Professional Core Courses (PCC)	60
5.	Professional Elective Courses (PEC)	18
6.	Open Elective Courses (OEC)	14
7.	Seminar	2
8.	Project	10
9.	Internships in industry	8
10.	Mandatory Courses (MC)	NC
	Total Credits	172

C. Course code and definition:

Course code	Definitions
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
LC	Laboratory course
MC	Mandatory courses

**Minor variation is allowed as per need of the respective disciplines.*

Mechanical Engineering

Table: Structure of B.E. Program
Calculation Table of Credits as per AICTE Norms

S. No.	Courses		Credits							Actual Credits
		Total Credits	I&II	III	IV	V	VI	VII	VIII	
1.	Basic Science Courses (BSC)	20	17	4						21
2.	Engineering Science Courses (ESC)	30	19	8	4					31
3.	Humanities, Social Science and Management Courses (HSMC)	10	4			3	3			10
4.	Professional Core Courses (PCC)	60		8	18	10	13	6	7	62
5.	Professional Elective Courses (PEC)	18				4	3	4	4	15
6.	Open Elective Courses (OEC)	14				3	3	4	4	14
7.	Seminar	2						2		2
8.	Project	10						3	7	10
9.	Internships in industry	8		2		2		3		7
10	Mandatory Courses (MC)	NC								
	Total Credits	172	40	22	22	22	22	22	22	172

Institute of Engineering & Technology, Dr. Bhimrao Ambedkar University, Khandari Campus, Agra

B.E. II Year (Mechanical Engineering) Third Semester

Course Structure & Evaluation Scheme

S. No.	Course Category	Course Code	Course Title	Contact hrs/Week			Sessional Marks			End Semester Marks		Total	Credit
				L	T	P	CT	TA	Total	TE	PE		
1	BSC	BSC301	MATH III	3	1	0	30	10	40	60	-	100	4
2	PCC	BME301	STRENGTH OF MATERIAL	3	1	0	30	10	40	60	-	100	4
3	ESC	BME302	MATERIAL SCIENCE	3	0	0	30	10	40	60	-	100	3
4	PCC	BME303	ENGINEERING THERMODYNAMICS	3	1	0	30	10	40	60	-	100	4
5	ESC	BME304	MACHINE DRAWING	2	0	0	30	10	40	60	-	100	2
6	MC	BMC301	ENVIRONMENTAL & ECOLOGY	2	0	0	30	10	40	60	-	100	0
7	ESC	BME352	MATERIAL SCIENCE LAB	0	0	2	20	20	40	-	60	100	1
8	ESC	BME354	MACHINE DRAWING LAB	0	0	4	20	20	40	-	60	100	2
9	Project (Internship)	BME355	MINI PROJECT/ INTERNSHIP ASSESMENT*	0	0	2	-	-	100	-		100	2
			Total	16	3	8	220	100	420	360	120	900	22

* The Mini Project or Internship (3-4 weeks) conducted during summer break after II semester & will be assessed during III semester.

Institute of Engineering & Technology, Dr. Bhimrao Ambedkar University, Khandari Campus, Agra

B.E. II Year (Mechanical Engineering) Fourth Semester

Course Structure & Evaluation Scheme

S. No.	Course Category	Course Code	Course Title	Contact hrs/Week			Sessional Marks			End Semester Marks		Total	Credit
				L	T	P	CT	TA	Total	TE	PE		
1	ESC	BME401	MEASUREMENT & METROLOGY	3	0	0	30	10	40	60	-	100	3
2	PCC	BME402	ENGINEERING FLUID MECHANICS	3	1	0	30	10	40	60	-	100	4
3	PCC	BME403	MANUFACTURING SCIENCE-I	3	0	0	30	10	40	60	-	100	3
4	PCC	BME404	THEORY OF MACHINES-I	3	1	0	30	10	40	60	-	100	4
5	PCC	BME405	APPLIED THERMODYNAMICS	3	1	0	30	10	40	60	-	100	4
6	MC	BMC402	HUMAN VALUES AND PROFESSIONAL ETHICS	2	0	0	30	10	40	60	-	100	0
7	ESC	BME451	MEASUREMENT & METROLOGY LAB	0	0	2	20	20	40	-	60	100	1
8	PCC	BME452	ENGINEERING FLUID MECHANICS LAB	0	0	2	20	20	40	-	60	100	1
9	PCC	BME453	MANUFACTURING SCIENCE I LAB	0	0	2	20	20	40	-	60	100	1
10	PCC	BME455	APPLIED THERMODYNAMICS LAB	0	0	2	20	20	40	-	60	100	1
			Total	17	3	8	260	140	400	360	240	1000	22

Institute of Engineering & Technology, Dr. Bhimrao Ambedkar University, Khandari Campus, Agra

B.E. III Year (Mechanical Engineering) Fifth Semester

Course Structure & Evaluation Scheme

S. No.	Course Category	Course Code	Course Title	Contact hrs/Week			Sessional Marks			End Semester Marks		Total	Credit
				L	T	P	CT	TA	Total	TE	PE		
1	PCC	BME501	INTERNAL COMBUSTION ENGINE	3	1	0	30	10	40	60	-	100	4
2	PCC	BME502	THEORY OF MACHINES-II	3	1	0	30	10	40	60	-	100	4
3	DE-ME	DE-ME501	DEPARTMENTAL ELECTIVE I	3	1	0	30	10	40	60	-	100	4
4	OE-ME	OE-ME501	OPEN ELECTIVE I	3	0	0	30	10	40	60	-	100	3
5	HS	BHSM-501	INDUSTRIAL MANAGEMENT	3	0	0	30	10	40	60	-	100	3
6	MC	BMC501	Occupational Health and Safety	3	0	0	30	10	40	60	-	100	0
6	PCC	BME551	INTERNAL COMBUSTION ENGINE LAB	0	0	2	20	20	40	-	60	100	1
7	PCC	BME552	THEORY OF MACHINES LAB	0	0	2	20	20	40	-	60	100	1
8	Project (Internship)	BME553	INTERNSHIP	0	0	4	-	-	100	-	-	100	2
			Total	18	3	8	220	100	420	36	120	800	22

B.E. III Year (Mechanical Engineering) Sixth Semester

Course Structure & Evaluation Scheme

S. No.	Course Category	Course Code	Course Title	Contact hrs/Week			Sessional Marks			End Semester Marks		Total	Credit
				L	T	P	CT	TA	Total	TE	PE		
1	PCC	BME601	DESIGN OF MACHINE ELEMENTS	3	1	0	30	10	40	60	-	100	4
2	PCC	BME602	HEAT AND MASS TRANSFER	3	1	0	30	10	40	60	-	100	4
3	PCC	BME603	AUTOMOBILE ENGINEERING	3	0	0	30	10	40	60	-	100	3
4	DE-ME	DE-ME 601	DEPARTMENTAL ELECTIVE II	3	0	0	30	10	40	60	-	100	3
5	OE-ME	OE-ME-601	OPEN ELECTIVE II	3	0	0	30	10	40	60	-	100	3
6	HSMC	BHSM-601	ECONOMICS FOR INDUSTRY	3	0	0	30	10	40	60	-	100	3
7	PCC	BME652	HEAT AND MASS TRANSFER LAB	0	0	2	20	20	40	-	60	100	1
8	PCC	BME653	AUTOMOBILE ENGINEERING LAB	0	0	2	20	20	40	-	60	100	1
			Total	18	2	4	220	100	320	360	120	800	22

Institute of Engineering & Technology, Dr. Bhimrao Ambedkar University, Khandari Campus, Agra

B.E. IV Year (Mechanical Engineering) Seventh Semester

Course Structure & Evaluation Scheme

S. No.	Course Category	Course Code	Course Title	Contact hrs/Week			Sessional Marks			End Semester Marks		Total	Credit
				L	T	P	CT	TA	Total	TE	PE		
1	PCC	BME 701	MECHANICAL VIBRATION	3	0	0	30	10	40	60	-	100	3
2	PCC	BME 702	ADVANCED WELDING TECHNOLOGY	2	0	0	30	10	40	60	-	100	2
3	DE-ME	DE-ME 701	DEPARTMENTAL ELECTIVE III	3	0	0	30	10	40	60	-	100	3
4	OE-ME	OE-ME701	OPEN ELECTIVE III	3	1	0	30	10	40	60	-	100	4
5	PCC	BME 751	MECHANICAL VIBRATION LAB	0	0	2	20	20	40	-	60	100	1
6	DE-ME	DE-ME 751	DEPARTMENTAL ELECTIVE III LAB	0	0	2	20	20	40	-	60	100	1
8	Project (Internship)	BME752	INTERNSHIP	0	0	4	20	20	40	-	60	100	3
9	SEMINAR	BME753	SEMINAR	0	0	4	20	20	40	-	60	100	2
10	Project (Internship)	BME754*	MINOR PROJECT	0	0	6	-	150	150	-	150	300	3
			Total	11	1	18	200	270	470	240	390	1100	22

***Internal evaluation**

Institute of Engineering & Technology, Dr. Bhimrao Ambedkar University, Khandari Campus, Agra

B.E. IV Year (Mechanical Engineering) Eight Semester

Course Structure & Evaluation Scheme

S. No.	Course Category	Course Code	Course Title	Contact hrs/Week			Sessional Marks			End Semester Marks		Total	Credit
				L	T	P	CT	TA	Total	TE	PE		
1	PCC	BME801	Computer Aided Design and Manufacturing	3	0	0	30	10	40	60	-	100	3
2	PCC	BME802	THERMAL TURBO MACHINES	3	0	0	30	10	40	60	-	100	3
3	DE-ME	DE-ME 801	DEPARTMENTAL ELECTIVE IV	3	1	0	30	10	40	60	-	100	4
4	OE-ME	OE-ME 801	OPEN ELECTIVE IV	3	1	0	30	10	40	60	-	100	4
5	PCC	BME851	Computer Aided Design and Manufacturing Lab	0	0	2	20	20	40	-	60	100	1
6	Project (Internship)	BME852*	INDUSTRIAL BASED PROJECT	0	0	20	-	150	150	-	150	300	7
			Total	12	2	22	140	210	350	240	210	800	22

*External evaluation

DEPARTMENTAL ELECTIVE ME I **4[3-0-2]**

Sr. No.	Subject Code	Course Title	L	T	P	Credits
1.	DE-ME-501	Manufacturing Science –II	3	1	0	4
2.	DE-ME-502	Rapid Prototyping & Rapid Tooling	3	1	0	4
3.	DE-ME-503	Tribology	3	1	0	4

OPEN ELECTIVE ME I **3[3-0-0]**

Sr. No.	Subject Code	Course Title	L	T	P	Credits
1.	OE-ME-501	Industrial engineering & Automation	3	0	0	3
2.	OE-ME-502	Total Quality Management	3	0	0	3
3.	OE-ME-503	Production Planning and Control	3	0	0	3
4.	OE-ME-504	Value Engineering	3	0	0	3

DEPARTMENTAL ELECTIVE ME II **3[3-0-0]**

Sr. No.	Subject Code	Course Title	L	T	P	Credits
1.	DE-ME-601	Un Conventional Manufacturing	3	0	0	3
2.	DE-ME-602	Experimental Stress Analysis	3	0	0	3
3.	DE-ME-603	Reliability and Maintenance Engineering	3	0	0	3
4.	DE-ME-604	Additive Manufacturing	3	0	0	3

OPEN ELECTIVE ME II **3[3-0-0]**

Sr. No.	Subject Code	Course Title	L	T	P	Credits
1.	OE-ME-601	Composite Materials	3	0	0	3
2	OE-ME-602	Entrepreneurship	3	0	0	3
3	OE-ME-603	Mechanical System Design	3	0	0	3
4.	OE-ME-604	Product Design and Development	3	0	0	3

DEPARTMENTAL ELECTIVE ME III **4[3-0-2]**

Sr. No.	Subject Code	Course Title	L	T	P	Credits
1.	DE-ME-701	Refrigeration and Air Conditioning	3	0	2	4
2.	DE-ME-702	Design & Analysis of Heat Exchangers	3	0	2	4

OPEN ELECTIVE ME III **4[3-1-0]**

Sr. No.	Subject Code	Course Title	L	T	P	Credits
1.	OE-ME-701	Non-Conventional Energy Resources	3	1	0	4
2	OE-ME-702	Nanotechnology	3	1	0	4
3	OE-ME-703	Non-Destructive Evaluation	3	1	0	4
4.	OE-ME-704	Introduction to Mechanical Micro Machining	3	1	0	4

DEPARTMENTAL ELECTIVE ME IV **4[3-1-0]**

Sr. No.	Subject Code	Course Title	L	T	P	Credits
1.	DE-ME-801	Reverse Engineering	3	1	0	4
2.	DE-ME-802	Computational Fluid Dynamics	3	1	0	4

OPEN ELECTIVE ME IV **4[3-1-0]**

Sr. No.	Subject Code	Course Title	L	T	P	Credits
1.	OE-ME-801	Power Plant Engineering	3	1	0	4
2	OE-ME-802	Optimization Methods in Engineering	3	1	0	4
3.	OE-ME-803	Fracture Mechanics	3	1	0	4
4.	OE-ME-804	Machine Tool Design	3	1	0	4

Mathematics III (BSC-301)

III SEMESTER (ECE, CSE, EE, ME, CE)

L T P C

3 1 0 4

Prerequisite: Basic knowledge of elementary Mathematics.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Solve the Fourier Transform of function.
2. Compute poles & zeros.
3. Evaluate the real & complex integrals with the help of Cauchy's Residue Theorem.
4. Utilize curve fitting techniques for data representations and computation in engineering analysis.
5. Employee the principle of linear regression and correlation, translate real word problems into probability models, Use Binomial, Poisson & Normal Distribution to solve statistical problems.

Course Content:

Unit I

Fourier Transform: Fourier integral, conditions of convergence, Fourier sine and cosine integrals, complex form, applications, Inversion formula for Fourier transform, operational properties. Discrete and Fast Fourier transform. Applications of Fourier transform to solve boundary value problems.

Unit II

Functions of a Complex Variable and Conformal mapping: Limit, Continuity, Differentiability and Analyticity of functions of a complex variable, Cauchy-Riemann equations, Harmonic functions, Complex functions as mappings, Linear Transformation, Inverse transformation, Bilinear Transformations, Conformal Mapping & applications.

Unit III

Integration of Complex Functions: Contour integrals and evaluations, Cauchy's Theorem, Cauchy's Integral Formulae, Liouville's theorem, Convergence of power series, Taylor series, Laurent series, Zeros and Singularities of a complex function, Residues and Residue theorem, Evaluation of definite and improper integrals.

Unit IV

Curve- Fitting & Probability: Curve-fitting: method of least- squares, Normal equations, Normal equation in case of straight line, Fitting a straight line, Polynomial, non-linear and exponential

curves, Change of origin. Probability: Basics of probability, random variables, Expectation, Baye's theorem and probability distributions, Binomial, Poisson and Normal distributions.

Unit V

Statistical Methods: Sampling Theory, Parameters of Statistics, Tests of hypothesis and significance, z-test, t-test,$\chi 2$- test ,Goodness of fit test, Time series analysis, Index numbers, Quality control chart and acceptance sampling, Introduction to design of experiments, Forecasting models.

Text Books

1. R.K. Jain & S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002.
2. Erwin Kreyszig; Advanced Engineering Mathematics, John Wiley & Sons, 1962.
3. R.V. Churchill and J.L. Brown, Complex Variables and Applications, McGraw Hill, 1990.
4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.
5. J.H. Mathews and R.W. Howell, Complex analysis for Mathematics and Engineering, 3rd Ed. Narosa, 1998.

Strength of Materials (BME-301)

L T P C

3 1 0 4

Prerequisite: Students must have knowledge of engineering mechanics basic engineering applications.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Compute the fundamentals of stress and strain concepts in compound loading condition and demonstrate an understanding of the applied mechanics theory.
2. Calculate the stresses and strains associated with thin and thick cylinder.
3. Analyzing the problems of springs subjected to various actions and Evaluating stresses in columns.
4. Calculate stresses and deformations in beams subjected to different loading and Estimate the effect of torsion in shafts.
5. Demonstrate stress and deflection in unsymmetrical bending and Curved Beams, determination of shear center.

Course Content:

Unit I

Compound stress and strains: Introduction, normal stress and strain, shear stress and strain, stresses on inclines sections, strain energy, impact loads and stresses, state of plane stress, principal stress and strain, maximum shear stress, Mohr's stress circle, three dimensional states of stress & strain, equilibrium equations, generalized Hook's law, theories of failure.

Unit II

Thin cylinders & spheres: Introduction, difference between thin walled and thick walled pressure vessels, thin walled spheres and cylinders, hoop and axial stresses and strain, volumetric strain.

Thick cylinders: Radial, axial and circumferential stresses in thick cylinders subjected to internal or external pressures, compound cylinders, stresses in rotating shaft and cylinders, stresses due to interference fits.

Unit III

Helical and Leaf Springs: Deflection of springs by energy method, helical springs under axial load and under axial twist (respectively for circular and square cross sections) axial load and twisting moment acting simultaneously both for open and closed coiled springs, laminated springs.

Columns and Struts: Buckling and stability, slenderness ratio, combined bending and direct stress, middle third and middle quarter rules, struts with different end conditions, Euler's theory for pin

ended columns, effect of end conditions on column buckling, Ranking Gordon formulae, examples of columns in mechanical equipment and machines.

Unit IV

Stresses in Beams: Pure Bending**,** normal stresses in beams, shear stresses in beams due to transverse and axial loads, composite beams.

Deflection of Beams: Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams, Castigliano's Theorem

Torsion: Torsion combined bending & torsion of solid & hollow shafts, torsion of thin walled tubes.

Unit V

Unsymmetrical Bending: Properties of beam cross-section slope of neutral axis, stress and deflection in unsymmetrical bending, determination of shear center and flexural axis (for symmetry about both axis and about one axis) for I-section and channel section.

Curved Beams: Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression.

Textbooks:

1. Strength of Materials by R. K. Bansal.
2. Strength of Materials by R.K. Rajput

Reference books:

1. Engineering Mechanics by Irving H. Shames, Prentice-Hall.
2. Mechanics of Materials by E.P.Popov, PHI.
3. Strength of Materials by Ryder.
4. Mechanics of Material by Gere & Timoshenko.
5. Engineering Mechanics by A. Nelson.
6. Engineering Mechanics by U.C. Jindal.
7. Engineering Mechanics Statics by J.L. Meriam & L. G. Kraige.

Materials Science (BME-302)

L T P C

3 0 2 4

Prerequisite: Fundamental knowledge of Intermediate level physics and chemistry.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc.
2. Understand concept of mechanical behavior of materials and calculations of same using appropriate equations.
3. Explain the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions.
4. Understand and suggest the heat treatment process & types. Significance of properties Vs microstructure. Surface hardening & its types. Introduce the concept of hardenability & demonstrate the test used to find hardenability of steels.
5. Explain features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials, composite materials etc.

Course Content:

Unit I

Introduction: Historical perspective, importance of materials. Brief review of modern & atomic concepts in Physics and Chemistry. Atomic models, Periodic table, Chemical bondings.

Crystallography and Imperfections: Concept of unit cell space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density. Miller indices. X-ray crystallography techniques. Imperfections, Defects & Dislocations in solids.

Unit II

Mechanical properties and Testing: Stress strain diagram, Ductile & brittle material, Stress VS strength. Toughness, Hardness, Fracture, Fatigue and Creep. Testing's such as Strength testing's', Hardness testing, Impact testing's, Fatigue testing Creep testing, Nondestructive testing (NDT).

Microstructural Exam: Microscope principle and methods. Preparation of samples and Microstructure exam and grain size determination. Comparative study of microstructure of various metals & alloys such as Mild steel, CI, Brass.

Phase Diagram and Equilibrium Diagram: Unitary and Binary diagrams, Phase rules. Types of equilibrium diagrams: Solid solution type, eutectic type and combination type. Iron-carbon equilibrium diagram.

Unit III

Ferrous materials: Iron and steel manufacture, furnaces. Various types of carbon steels, alloy steels and cast irons, its properties and uses.

Heat Treatment: Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering and Case hardening. Time Temperature Transformation (TTT) diagrams.

Non-Ferrous metals and alloys: Non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc. and its applications. Various type Brass, Bronze, bearing materials, its properties and uses. Aluminum alloys such as Duralumin. Other advanced materials/alloys.

Unit IV

Magnetic properties: Concept of magnetism - Dia, para, ferro Hysteresis. Soft and hard magnetic materials, Magnetic storages.

Electric properties: Energy band concept of conductor, insulator and semi-conductor. Intrinsic & extrinsic semi-conductors. P-n junction and transistors. Basic devices and its application. Diffusion of Solid. Super conductivity and its applications. Messier effect. Type I & I superconductors. High temperature superconductors.

Unit V

Ceramics: Structure types and properties and applications of ceramics. Mechanical/Electrical behaviour and processing of Ceramics.

Plastics: Various types of polymers/plastics and its applications. Mechanical behaviors and processing of plastics. Future of plastics.

Other materials: Brief description of other material such as optical and thermal materials concrete, Composite Materials and its uses.

Performance of materials in service: Brief theoretical consideration of Fracture, Fatigue, and Corrosion and its control.

Text books:

1. Material Science & Engineering by W.D. Callister, Jr., Addison-Wesley Pub.Co.
2. Engineering Materials, Vol. I &II by Ashby &Jones, Pergemon Press.
3. Material Science by V Raghvan, Pretice Hall of India.
4. Material Science by K M Gupta.

Reference books:

1. Elements of Material Science & Engineering by Van Vlack, John Wiley & Sons.
2. Material Science by V. Raghvan, Prentice Hall of India.
3. Elements of Material Science & Engineering by Van Vlash John Wiley & Sons..
4. Science of Materials Engineering by Srivastava, Srinivasan Newage.

Materials Science Lab (BME-352)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Prepare formal laboratory reports describing the results of experiments;
2. Operate basic instruments in materials science and engineering;
3. Interpret the data from the experiments.
4. Relate properties to microstructure.
5. Understand various crystal structures and relationship to properties
6. Select metals and alloys for industrial applications
7. Understanding metals and their use in industries
8. Understanding heat treatment procedures and the change of properties
9. Improving material properties by different heat treatment processes.

Any 8 experiments out of following:

1. To identify different kind of materials by observation.
2. To prepare specimen for metallographic examination.
3. To perform Jominy End Quench Test to determine hardenability of steel.
4. Specimen preparation for micro structural examination-cutting, grinding, polishing, etching.
5. Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)
6. Heat treatment experiments such as annealing, normalizing, quenching, casehardening and comparison of hardness before and after.
7. Study of HCP FCC and BCC.
8. Study of microstructure of welded component and HAZ. Macro & Micro Examination.
9. To determine Rockwell Hardness and Brinell Hardness of given test specimen.
10. To perform tensile test on given specimen using UTM.
11. To perform Compression Test on given specimen using UTM.
12. To perform Izod & Charpy Impact test.
13. To perform Torsion test on given specimen.
14. To perform fatigue test on given specimen.

Engineering Thermodynamics (BME-303)

L T P C

3 1 0 4

Prerequisite: Physics of Class XII

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the role of the internal energy, enthalpy, entropy, temperature, pressure and specific volume thermodynamic properties and illustrate laws of thermodynamics state and apply the first law of thermodynamics for closed and open systems.
2. Understand second law of thermodynamics and concepts of entropy and apply the concept to solve entropy problems.
3. Distinguish between ideal gas and pure substance and calculate thermodynamics properties using tables of thermodynamics properties and ability to solve problems based on Rankine and Brayton cycle.
4. Understand concept of irreversibility and second law efficiency and establish thermodynamic relation among various equation.
5. Estimate Stoichiometric air required for combustion and exhaust gas analysis.

Course Content:

Unit I

Fundamental Concepts and Definitions: Introduction and definition of thermodynamics, Dimensions and units, Microscopic and Macroscopic approaches, Systems, surroundings and universe, Concept of continuum, Control system boundary, control volume and control surface, Properties and state, Thermodynamic properties, Pressure and its measurement, Thermodynamic path, process and cycle, Thermodynamic equilibrium, Reversibility and irreversibility, Quasistatic process, Energy and its forms, Work and heat, Gas laws, Ideal gas.

Zeroth law of thermodynamics: Zeroth law of thermodynamics, Temperature and its measurement, Temperature scales.

First law of thermodynamics: Thermodynamic definition of work, Thermodynamic processes, Calculation of work in various processes and sign convention, Non-flow work and flow work, Joules' experiment, First law of thermodynamics, Internal energy and enthalpy, First law of thermodynamics applied to open systems, Steady flow systems and their analysis, Steady flow energy equation, Boilers, Condensers, Turbine, Throttling process, Pumps etc. First law analysis for closed system (non flow processes), Analysis of unsteady processes such as filling and evacuation of vessels with and without heat transfer, Limitations of first law of thermodynamics, PMM-I.

Unit II

Second law of Thermodynamics: Devices converting heat to work, Thermal reservoir, Heat Source, Heat Sink, Heat engines, Efficiency, Devices converting work to heat, Heat pump, refrigerator, Coefficient of Performance, Reversed heat engine, Kelvin Planck statement of second law of thermodynamics, Clausius statement of second law of thermodynamics, Equivalence of two statements of second law of thermodynamics, Reversible and irreversible processes, Carnot cycle and Carnot engine, Carnot theorem and it's corollaries, thermodynamic temperature scale, PMM-II.

Entropy: Clausius inequality, Concept of Entropy, Entropy change in different thermodynamic processes, Tds equation, Principle of entropy increase, T-S diagram, Statement of the third law of thermodynamics.

Unit III

Properties of steam and thermodynamics cycles: Pure substance, Property of steam, Triple point, Critical point, Sub-cooled liquid, Saturation states, Superheated states, Phase transformation process of water, Graphical representation of pressure, volume and temperature, P-T & P-V diagrams, T-S and H-S diagrams, use of property diagram, Steam-Tables &Mollier charts, Dryness factor and it's measurement, processes involving steam in closed and open systems. Simple Rankine cycle, Brayton cycle.

Unit IV

Availability and Irreversibility: Available and unavailable energy, Availability and Irreversibility, Second law efficiency, Helmholtz & Gibb's function, Availability analysis.

Thermodynamic relations: Mathematical conditions for exact differentials. Maxwell Relations, Clapeyron Equation, Joule-Thompson coefficient and Inversion curve. Coefficient of volume expansion, Adiabatic & Isothermal compressibility; Real gas, Law of corresponding states, Dalton's law, Amagat's law, Property of mixture of gases.

Unit V

Fuels and Combustion: Combustion analysis, Heating Values and its measurement, Air requirement, Air/Fuel ratio, Standard heat of Reaction and effect of temperature on standard heat of reaction, heat of formation, Chemical Equilibrium, adiabatic flame temperature, Exhaust gas analysis.

Textbooks:

1. Basic and Applied Thermodynamics by PK Nag, MCGRAW HILL INDIA.
2. Fundamentals of Thermodynamics by Sonntag, Van Wylen, Borgnakke, JohnWiley& Sons
3. Thermodynamics : An engineering approach by Cengel& Boles, Mc Graw Hill

Reference books:

1. Engineering Thermodynamics by Jones and Dugans, PHI Learning Pvt. Ltd.
2. Thermodynamics by J.P. Holman, McGraw Hill.

Machine Drawing (BME-304)

L T P C

2 0 4 4

Prerequisite: Basic knowledge of Engineering Graphics and Design.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand principles of orthographic projections for machine drawing.
2. To draw the projections of machine elements including keys, couplings, cotters, riveted, bolted and welded joints.
3. To draw the assembled view using drawings of machine components and Engines.
4. To free hand sketches of machine elements.
5. Understand detailed Assembly drawings of Ball bearing, shaft, crane hook, Plummer block, tailstock, engine block assembly. Remembering the concepts Computer aided drawing of machine components.

Course Content:

Unit I

Review of engineering graphics, IS & ISO codes, fit and tolerance, Surface Finish , Design of Simple machine elements; (Threaded fasteners, locking arrangements, Guides) of some assemblies.

Unit II

Riveted Joints: Introduction, Rivets and Riveting, Rivet Heads, Classification of Riveted Joints and Welded Joint. **Keys and Cotters:** Keys, Cotter joints. Shaft and Couplings.

Unit III

Screwed (Threaded) fasteners: Introduction, Screw thread nomenclature, Forms of threads, Thread series, Thread designation. Representation of threads, Bolted joints, locking arrangements for nuts, Foundation bolts.

Unit IV

Free hand sketching: Introduction, Need for free hand sketching, Free hand of sketching of some threaded fasteners and simple machine components.

Unit V

Assembly drawing & part list; Ball bearing, shaft, crane hook, Plummer block, stop valve, tailstock, engine block assembly.

Computer aided drawing of machine components, Valves etc.'

A drawing Project on reverse engineering.

Textbooks:

1. A Text Book of Machine Drawing by Lakshmi narayanan .V. & Marhur, M. L Jain Brothers' N. Delhi.

2. Design of Machine Elements by V.B. Bhandari TMH N. Delhi.

Reference Books:

1. Machine Drawing by Siddheswar, N. Kannaiah. P. & Sastry V.V.S TMH N. Delhi.
2. Mechanical Engg. Design by Shigley & Mische Mc Graw Hill.

Machine Drawing (BME-354)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Prepare different types of line and dimensioning.
2. Understand of orthogonal projection and isometric projection.
3. Analyze the concept of different types of fasteners.
4. Understand and draw different types of machine elements.
5. Analyze the different types of Assembly.

List of Experiments:

1. Drawing sheet (1 sheet) – Scales, Types of Lines, Section Line, Dimensioning.
2. Drawing sheet (1 sheet) – Orthographic Projection in First and Third Angle, Isometric Projection.
3. Drawing sheet (2 sheet) –Screwed Fasteners.
4. Drawing sheet (1 sheet) – Keys and Cotters and Pin joints.
5. Drawing sheet (1 sheet) – Shaft Coupling.
6. Drawing sheet (1 sheet) – Riveted joint.
7. Drawing sheet (3 sheet) – Assembly Drawing.

Environment and Ecology (MC-301/MC-401)

L T P C

2 0 0 0

Prerequisite: Basic knowledge College Geography.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understanding of the importance of ecosystem and biodiversity and natural resources for maintaining ecological balance.
2. Analyze human impacts on various aspects of the environment and social issue related to sustainable development.
3. Identifying sources and effects of environmental pollution. Develop the methods for control of environmental pollution and hazards due to engineering/technological activities.
4. Aware of important acts and laws in respect of environment and EIA process.

Course Content:

Unit I

Nature of Environment Introduction to Environmental Science: Definition and scope and need for public awareness Ecosystems Concept, structure and functions, restoration of damaged ecosystems Biodiversity – Definition, description at national and global level, threats and conservation Natural Resources - Renewable and non-renewable and their equitable use for sustainability, Material cycles – carbon, nitrogen and sulphur cycle. Conventional and Non-conventional Energy Sources – fossil fuel-based, hydroelectric, wind, -nuclear and solar energy, biomass, biodiesel, hydrogen as an alternative fuel

Unit II

Impact of Human Activity on Environment Human Population and Environment: Population growth, population explosion and migration; Impact of farming, housing, mining, transportation and industrial growth Social Issues Related to Environment– Sustainable development, urban problems (related to water and energy conservation and waste management), resettlement and rehabilitation Environmental ethics

Unit III

Environmental Changes and Human Health Environmental Pollution: Definition, causes and effects, control measures for water, air, soil, marine, land, noise, thermal pollution, Climate change– Greenhouse effect and global warming, acid rain, ozone layer formation and depletion Impact on human health – water and air borne diseases, diseases induced by residual impurities in drinking water (fluoride and arsenic); Toxic wastes and carcinogens; Nuclear hazards

Unit IV

Environmental Protection through Assessment and Education Indicators and Impact Assessment: Bio-indicators, Natural disasters and disaster management, Impact assessment through inventorying and monitoring Environmental Protection– Role of individuals, organizations and government in pollution control Laws, Conventions and Treaties–National legislation, issues in the enforcement of environmental legislation, initiatives by non- governmental organizations, global efforts in environmental protection Environmental education–women and value education Recommended.

Text Books:

1. Environmental Studies, J Krishnawamy, R J Ranjit Daniels, Wiley India.
2. Environment and Ecology, R K Khandal, 978-81-265-4277-2, Wiley India.
3. Textbook of Environment Ecology, Singh, Acme Learning.
4. Environmental Studies, R Rajagopalan, 978-0195673937, Oxford University Press.

Reference Books:

1. Environmental Science, Bernard J. Nebel, Richard T. Right, 9780132854467, Prentice Hall Professional 1993.
2. Environmental Science, 8th Ed ISV, Botkin and Keller, 9788126534142, Wiley India.
3. Textbook of Environmental Science and Technology, M. Anjireddy, BS Publications.
4. Environmental Studies, Soli. J Arceivala, Shyam, R Asolekar, 9781259006050, McGrawHill India, 2012.
5. Environmental Studies, D.L. Manjunath, 9788131709122 Pearson Education India, 2007.
6. Perspective in Environmental Studies, Kaushik, New Age International.
7. Environmental Studies, B. Joseph, 2nd Ed, 978-0070648134, Tata McGraw Hill.

Measurement and Metrology (BME-401)

L T P C

3 0 2 4

Prerequisite: Basic knowledge of Engineering physics, Fundamental Concept of Workshop Practice, Engineering thermodynamics etc.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Ability to understand the basic concepts of measurement by learning about different measuring systems, different sensor and transducers and different signal transmission and processing devices.
2. Ability to understand the working principle of different measuring devices for time, pressure, force and temperature measurement.
3. Ability to understand the concept of limit, fit and tolerance for applying it for solving the numerical problems, and understand the concept of comparators.
4. Ability to understand the concept of geometric forms and use of different tools for measurement of geometric forms, measurement related to thread and surface texture.
5. Ability to understand the concept of control system and study of different types of controllers.

Course Content:

Unit I

Mechanical Measurements: Introduction to measurement and measuring instruments, Generalized measuring system and functional elements, units of measurement, static and dynamic performance characteristics of measurement devices, calibration, concept of error, sources of error, statistical analysis of errors. **Sensors and Transducers:** Types of sensors, types of transducers and their characteristics. **Signal transmission and processing:** Devices and systems, Signal Display & Recording Devices.

Unit II

Time related measurements: Counters, stroboscope, frequency measurement by direct comparison, Measurement of displacement. **Measurement of pressure:** Gravitational, directing acting, elastic and indirect type pressure transducers, Measurement of very low pressures. **Strain measurement:** Types of strain gauges and their working, strain gauge circuits, temperature compensation. Strain rosettes, calibration. **Measurements of force and torque:** Different types of load cells, elastic transducers, pneumatic & hydraulic systems. **Temperature measurement:** By thermometers, bimetallic, thermocouples, thermistors and pyrometers. **Vibration:** Seismic instruments, vibration pickups and decibel meters, vibrometers accelerometers.

Unit III

Metrology and Inspection: Standards of linear measurement, line and end standards. Limit, fits and tolerances. Interchangeability and standardization. Linear and angular measurements devices

and systems. **Comparators:** Sigma, Johansson's Microkrator. Limit gauges classification, Taylor's Principle of Gauge Design.

Unit IV

Measurement of geometric forms like straightness, flatness, roundness, Tool makers microscope, profile project autocollimator, **Interferometry:** principle and use of interferometry, optical flat. Measurement of screw threads and gears, **Surface texture:** quantitative evaluation of surface roughness and its measurement.

Unit V

Introduction: Concept of Automatic Controls–open loop & closed loop systems. Servomechanisms. Block diagrams, transfer functions. Applications of Laplace- Transform in control systems with simple examples / numerical. **Representation of control components & Systems:** Translation & rotational mechanical components, series & parallel combinations, cascade system, analogous system. **Controllers:** Brief introduction to Pneumatic, hydraulic and electric controllers.

Textbooks:

1. Engineering Metrology by R K Jain, Khanna Publishers.
2. Engineering Measurement by R K Jain, Khanna Publishers
3. Engineering Metrology by I C Gupta, Dhanpat Rai & Sons, New Delhi, 1994.

References Books:

1. Beckwith Thomas G., Mechanical Measurements, Narosa Publishing House, N. Delhi.
2. Doeblein E.O., "Measurement Systems, Application Design", McGraw Hill, 1990.
3. Kumar D.S., "Mechanical Measurements and Control", Metropolitan, N. Delhi.
4. Hume K.J., "Engineering Metrology", MacDonald and Co. 1963.
5. Sirohi, "Mechanical Measurement" New Age Publishers.

Measurement and Metrology Lab (BME-451)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the concept of vernier caliper and use it for measurement of gear tooth and learn to measure taper of a shaft.
2. Understand the concept of limit gauge and slip gauge and learn the use of micrometer.
3. Perform the test of roundness, concentricity and understand the concept and use of dial gauge.
4. Understand the concept of autocollimator and to perform test of thermocouple and stroboscope.

Any 7 experiments out of followings:

1. To measure the taper of a given shaft.
2. To measure the dimensions of a gear tooth using vernier calipers.
3. Study of slip gauges.
4. Study of limit gauges.
5. To measure out of roundness of a shaft.
6. To perform the concentricity test on a spur gear.
7. To calibrate a dial gage.
8. To study and use of autocollimator.
9. To determine the speed of pedestal fan using stroboscope.
10. To calibrate and measure temperature using Thermocouple.

Engineering Fluid Mechanics (BME-402)

L T P C

3 1 2 5

Prerequisite: Basic knowledge of engineering physics.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand property of fluid, measurement of pressure and broad principles of fluid statics.
2. Inculcate knowledge on description of fluid motion, stream and velocity potential, their properties and applications.
3. Understand the dynamics of fluid flow -energy equation and its applications and gain knowledge about dimensional and model analysis
4. Analyse the Flow through Pipes, Laminar and turbulent flows, major and minor losses in pipes.
5. Understand and solve the boundary layer problems and evaluate friction over surface.

Course Content:

Unit I

Introduction: Scope and importance of Fluid Mechanics, Physical properties of fluids ,viscosity Newton's law of viscosity, Newtonion and non-Newtonion fluids, Compressibility, Surface tension and Capillarity, vapours pressure), Rheological classification of fluids, Ideal fluid, Real Fluid.

Fluid Statics: Pressure, Pascal's Law, Hydrostatic Law, Pressure measurement devices – Piezometer, manometers, Mechanical gauges, Forces on plane and curved surfaces, Centre of pressure and pressure diagram, Buoyancy, Metacentre, Stability of Submerged and floating bodies, Fluid masses subjected to accelerations.

Unit II

Fluid Kinematics: Concept of control volume, Velocity and acceleration of fluid Particle, Lagrangian and Eulerian approach, Classification of fluid flow, Streamlines, Path lines and Streak lines, Equipotential lines, Stream Function and Velocity Potential, Flow Net, Continuity equation, Rotation, Vorticity and Circulation, Free and Forced vortex motion.

Unit III

Fluid Dynamics: Flow characteristics, the Reynolds Transport Theorem, application of continuity equation, energy equation and momentum equation. Forces acting on fluid in motion, Euler's equation, Bernoulli's Theorem and applications – Pitot Tube, Venturimeter, Orificemeter, Orifices and Mouthpieces.

Dimensional Analysis: Units and Dimensions, Dimensional analysis, Rayleigh's method, Buckingham's Π theorem, Non-dimensional numbers & their significance. Hydraulic Similitude

and Model Studies: Model and prototype; Similitude; Geometric, Kinematic and Dynamic similarity; Model Laws; Un-distorted model studies.

Unit IV

Viscous Flow: Laminar flow: Reynold's Experiment, Navier's Stokes' Equation, Coutte& Hagen Poisulle's Equation for viscous flow between parallel plates and circular pipes, Power absorbed in in viscous flow, Stokes law; Darcy's Law; Transition from laminar to turbulent flow. Introduction to Turbulant flow: Velocity distribution and Shear stresses in turbulent flow, Prandtl mixing length theory, Introduction to Moody's Chart.

Losses in pipes: Darcy - Wiesbach Equation, factors affecting friction, Minor Losses in pipes, Concept of HGL & TEL. Concept of equivalent length of pipe for different pipe fittings, Equivalent diameter of pipes, Hydraulic Power, transmission by pipe, Pipes in parallel, Series, Syphon, two reservoir problems, Water hammer in pipes, Surge tanks - function, location and uses, Pipe network.

Unit V

Laminar Boundary layer theory: Concept, Boundary layer along thin plate- Characteristics, Laminar, Turbulent Boundary Layer, laminar sub layer, Various Thicknesses- Nominal, displacement, Momentum, Energy, Hydraulically smooth and Rough boundaries, Separation of Boundary layer, control of Separation.

Forces on submerged bodies: Introduction to Drag and Lift on submerged bodies (like Flat plates, Sphere, Cylinder, aerofoil), stokes law, Drag and Lift coefficients. Introduction to Computational Fluid Dynamics (CFD)

Text Book:

1. Intro To Fluid Mechanics & Fluid Machines, Som and Biswas, Tata McGraw Hill Pvt Ltd.
2. Fluid Mechanics and hydraulics machines, Sukumar pati, Tata McGraw Hill Pvt Ltd.
3. A Textbook of Fluid Mechanics and Hydraulic Machines, R.K. Bansal, Laxmi Publications

Reference Book:

1. Fluid Mechanics, White, Tata McGraw Hill.
2. Fluid Mechanics, Cengel & Cimbala, Tata McGraw-Hill.
3. Introduction to Fluid Mechanics, Fox and Pritchard, Seventh Edition. Wiley India.
4. Fluid Mechanics and Hydraulic Machines: Problems and Solutions, K. Subramanya, McGraw Hill Education

Engineering Fluid Mechanics Lab (BME-452)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Verify the Bernoulli's Theorem.

2. Determine the friction factor for the pipes.
3. Determine the coefficient of discharge of Venturimeter and Orifice meter.
4. Determine the minor losses due to sudden enlargement, sudden contraction and bends.
5. Determine the coefficient of discharge of Notch (V and Rectangular types).

List of Experiments: (At least 8 of the following)

1. To determine the meta-centric height of a floating body.
2. To verify the Bernoulli's Theorem.
3. To determine coefficient of discharge of an orifice meter.
4. To determine the coefficient of discharge of venturi meter.
5. To determine the friction factor for the pipes.
6. To determine the coefficient of discharge, contraction & velocity of an orifice.
7. To determine the minor losses due to sudden enlargement, sudden contraction and bends.
8. To find critical Reynolds number for a pipe flow.
9. To determine the coefficient of impact for vanes.
10. To determine the coefficient of discharge of Notch (V and Rectangular types).
11. To show the velocity and pressure variation with radius in a forced vertex flow.

Manufacturing Science I (BME-403)

L T P C

3 0 2 4

Prerequisite: Course on Workshop Technology

Course Outcomes (COs):

After completing this course a student will be able to:

1. Define the term manufacturing and its importance towards technological and social economic development.
2. Classify the basic principles of casting processes and discuss its type's defects and remedies.
3. Design of gating/riser system needed for casting
4. Describe the various forming process like (rolling, forging, extrusion, drawing, sheet metal operation) and Implement a suitable forming process for a given component.
5. Compare the various types of joining processes and select the appropriate one according to the application.
6. Discuss the recent emerging areas in primary manufacturing process like powder metallurgy.

Course Content:

Unit I

Introduction: Importance of manufacturing towards technological and social economic development. Classification of manufacturing processes.

Casting: Basic principle of casting processes. Types of patterns and allowances. Types and properties of molding sand. Introduction and Design of Gating system. Risering design. Solidification of casting. Types of casting- Die Casting, Centrifugal casting. Investment casting, CO_2 casting, casting defects & remedies, Cupola furnace.

Unit II

Metal Forming Processes: Nature of plastic deformation-Hot working and cold working.

Rolling: Principle, types of rolling mills, rolling load calculation, rolling defects.

Forging: Types of forging operations-smith, drop, press and machine forging. Forging load estimation. Forging defects.

Extrusion: Principle, Hot extrusion, Cold extrusion processes. Extrusion defects. Tube drawing and wire drawing: Introduction and defects.

Unit III

Sheet Metal working: Introduction to shearing operations, Blanking, piercing, Drawing, Spinning, Bending, Embossing and coining processes Presses and their classification, die and punch assembly, sheet metal die- progressive, compound and combination dies.

Unit IV

Welding: Principle of welding, classification of welding, HAZ, Arc welding concept, Arc blow, **Arc welding operation:** Tungsten inert gas welding, gas metal arc welding, submerged arc welding. Resistance welding and its types, Gas welding- oxy acetylene welding, Soldering and Brazing. Residual stresses in welding and its remedies, welding defects.

Unit V

Powder Metallurgy:

Introduction, production of metallic powder, processing methods-mixing and blending, compacting, sintering, secondary operations, Advantages of powder metallurgy.

Text books:

1. Manufacturing Technology by P.N. Rao., TMH.
2. Manufacturing Science by Ghosh and Mallik.
3. Production Engg. Science by P.C. Pandey.

Reference books:

1. Production Technology by R.K. Jain.
2. Materials and Manufacturing by Paul Degarmo.
3. Manufacturing Engineering & Technology by Kalpakjian, Pearson Pub.

Manufacturing Science I Lab (BME-453)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Design the gating and riser system needed for casting and requirements to achieve defect free casting.
2. Understand the basic geometry of pattern making and their application.
3. To gain the knowledge of Forging technique and application in industrial domain.
4. Design the jigs and fixtures required for various mechanical works.
5. Understand the working of press working operation like blanking and piercing.

Any 8 experiments out of following:

1. Design of pattern for a desired casting (containing hole).
2. Pattern making.
3. Making a mould (with core) and casting.
4. Injection moulding with plastics.
5. Hand forging processes
6. Forging - power hammer study & operation.
7. Tube bending with the use of sand and on tube bending m/c.
8. Press work experiment such as blanking/piercing, washer, making etc.
9. Bending & spring back.
10. Jigs & Fixture experiment.

Theory of Machines I (BME-404)

L T P C

3 1 0 4

Prerequisite: A course on Engineering Thermodynamics and Engineering Drawing.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Define various components of mechanisms, Develop mechanisms to provide specific motion.
2. Draw velocity and acceleration diagrams of various mechanisms.
3. Basic ideas of kinematic synthesis
4. Understand the importance of Cams, Gain the basic ideas of kinematics of Cams,
5. Understand the basic ideas of gears and also Analyze speed and number of teeth in various gears, Select appropriate power transmission for specific application.

Course Content:

UNIT I

Introduction: Links-types, Kinematics pairs-classification, Constraints-types, Degree of Freedom, Grubler's equation, linkage mechanisms, inversions of four bar linkage, slider crank chain and double slider crank chain.

Velocity in Mechanisms: Velocity of point in mechanism, relative velocity method, instantaneous point in mechanism, Kennedy's theorem, instantaneous center method.

UNIT II

Acceleration in Mechanisms: Acceleration diagram, Coriolis component of acceleration, Klein's construction for Slider Crank and Four Bar mechanism, Analytic method for slider crank mechanism.

Mechanisms with Lower Pairs: Pantograph, Exact straight line motion mechanisms - Peaucellier's, Hart and Scott-Russell mechanisms, Approximate straight line motion mechanisms – Grass-Hopper, Watt and Tchebicheff mechanisms, Analysis of Hook's joint, Davis and Ackermann Steering gears.

UNIT III

Kinematics Synthesis of Planar Linkages: Movability of four bar linkages, Grashoff's law, Graphical methods of synthesis – Two and Three position synthesis of four bar and slider crank mechanisms, Analytical method-Freudenstein's equation for function generation (three position).

UNIT IV

CAMS: Cams and Followers - Classification & terminology, Cam profile by graphical methods for uniform velocity, simple harmonic motion and parabolic motion of followers, Analytical cam design – tangent and circular cams.

UNIT V

Gears: Classification & terminology, law of gearing, tooth forms, interference, under cutting, minimum number of teeth on gear and pinion to avoid interference, simple, compound and planetary gear trains.

Textbooks:

1. Theory of Machines by S. S. Rattan
2. Theory of Machines by J E Shingley
3. Theory of Machines by R. K. Bansal.
4. Theory of Machines by V. P. Singh.
5. Theory of Machines by Khurmi & Gupta.

References Books:

1. Theory of machines by Thomas Bevan.
2. Theory of machines and mechanisms by Ghosh & Mallik
3. Theory of machines and mechanisms by Rao &Dukkipati.
4. Theory of Machines by Malhotra & Gupta.
5. Mechanics of Machines by V. Ramamurti.
6. Kinematics by HN Tyson.

Applied Thermodynamics (BME-405)

L T P C

3 1 2 5

Prerequisite: A course on Engineering Thermodynamics and Engineering Drawing.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Analyze the cycle of internal combustion engine in order to perform heat, work and efficiency calculation.
2. Understand the vapour cycle in order to carry out the calculation on system performance.
3. Understand boilers and their performance, understand condenser and their performance.
4. Construct steam engine velocity diagram in order to determine the stage calculation mathematically and graphically.
5. Analyze the various gas turbine plant system arrangement in order to perform heat, work, efficiency calculation.

Course Content:

Unit I

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 use free energy. Introduction and Otto, Diesel and Dual cycles.

Unit II

Vapour Power cycles: Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Rankine cycle, effect of pressure and temperature on Rankine cycle, Reheat cycle, Regenerative cycle, Feed water heaters, Binary vapour cycle, Combined cycles, Cogeneration.

Fuels and Combustion: Combustion analysis, heating values, air requirement, Air/Fuel ratio, standard heat of reaction and effect of temperature on standard heat of reaction, heat of formation, Adiabatic flame temperature.

Unit III

Boilers: Classifications and working of boilers, boiler mountings and accessories, Draught and its calculations, air pre-heater, feed water heater, super heater. Boiler efficiency, Equivalent evaporation. Boiler trial and heat balance.

Condenser: Classification of condenser, air leakage, condenser performance parameters.

Unit IV

Steam and Gas Nozzles: Flow through Convergent and convergent-divergent nozzles, variation of velocity, area and specific volume, choked flow, throat area, Nozzle efficiency, Off design

operation of nozzle, Shock waves stationary normal shock waves, Effect of friction on nozzle, Super saturated flow.

Steam Turbines: Classification of steam turbine, Impulse and Reaction turbines, Staging, Stage and Overall efficiency, reheat factor, Bleeding, Velocity diagram of simple and compound multistage impulse and reaction turbines and related calculations, work done, efficiencies of reaction, Impulse reaction turbines, state point locus, Losses in steam turbines, Governing of turbines, Comparison with steam engine.

Unit V

Gas Turbine: Gas turbine classification, Brayton cycle, Principles of gas turbine, Gas turbine cycles with intercooling, reheat and regeneration and their combinations, Stage efficiency, Polytropic efficiency. Deviation of actual cycles from ideal cycles.

Jet Propulsion: Introduction to the principles of jet propulsion, Turbojet and turboprop engines and their processes, Principle of rocket propulsion, Introduction to Rocket Engine.

Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

Text Books:

1. Basic and Applied Thermodynamics by P.K. Nag, Mcgraw hill india.
2. Engineering Thermodynamics, by P.K. Nag, Mcgraw hill india.
3. Applied thermodynamics by Onkar Singh, New Age International.

Reference Books:

1. A Course in Thermal Engineering, Domkundwar and KothandaramanDhanpat Rai & Co. (P) Limited.
2. Applied Thermodynamics by Venkanna And Swati, PHI.
3. Thermodynamics: An Engineering Approach, Yunus A Cengel; Michael A Boles, McGraw-Hill Education.

Applied Thermodynamics (BME-455)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the working principles & knowledge of parts of boilers.
2. Understand the working principles & pats of two stroke I C Engines.
3. Understand the working principles & parts of four stroke I C Engines.
4. Demonstrate the performance of internal combustion engine.
5. Understand the working Principles & parts of steam & gas turbine.

List of Experiments: (At least 8 of the following)

1. Study of Fire Tube boiler.

2. Study of Water Tube boiler.
3. Study and working of Two stroke petrol Engine.
4. Study and working of Four stroke petrol Engine.
5. Determination of Indicated H.P. of I.C. Engine by Morse Test.
6. Prepare the heat balance sheet for Diesel Engine test rig.
7. Prepare the heat balance sheet for Petrol Engine test rig.
8. Study and working of two stroke Diesel Engine.
9. Study and working of four stroke Diesel Engine.
10. Study of Velocity compounded steam turbine.
11. Study of Pressure compounded steam turbine.
12. Study of Impulse & Reaction turbine.
13. Study of steam Engine model.
14. Study of Gas Turbine Model.

Human Value and Professional Ethics (MC402/MC-302)

L T P C

2 0 0 0

Prerequisite:

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society
2. Distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co-existence of Self and Body.
3. Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human-human relationships and explore their role in ensuring a harmonious society
4. Distinguish between ethical and unethical practices, and start working over the strategy to actualize a harmonious environment wherever they work.

Course Content:

UNIT I

Course Introduction: Need, Basic Guidelines, Content and Process for Value Education Understanding the need, basic guidelines, content and process for Value Education, Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfill the above human aspirations.

UNIT II

Understanding Harmony in the Human Being : Harmony in Myself Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

UNIT III

Understanding Harmony in the Family and Society: Harmony in Human-Human Relationship Understanding harmony in the Family- the basic unit of human interaction, Understanding values in

human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti (Mutual Happiness); Trust (Vishwas) and Respect (Samman) as the foundational values of relationship, Understanding the meaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman, Difference between respect and disrespect; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals, Visualizing a universal harmonious order in society.

UNIT IV

Understanding Harmony in the Nature and Existence: Whole existence as Co-existence Understanding the harmony in the Nature, Interconnectivity and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature, Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.

UNIT V

Implications of the Holistic Understanding of Harmony on Professional Ethics Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and ecofriendly production systems, technologies and management models. Improving quality of work life at work place.

Text Books:

1. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
2. R. Subramanian,2017, Professional Ethics,
3. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
4. 4. A N Tripathy, 2003, Human Values, New Age International Publishers.

Reference Books:

1. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
2. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &Engineers , Oxford University Press.
3. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
4. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
5. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted.

Internal Combustion Engines (BME-501)

L T P C

3 1 2 5

Prerequisite:

Course Outcomes (COs):

1. Understand various types of I.C. engines and cycles of operation.
2. Understand the normal and abnormal combustion phenomenon in SI and CI engines.
3. Identify fuel metering and fuel supply systems for different types of engines
4. Interpret different alternative fuels and its emissions, then the method to control these emissions and their effect on environment.
5. Understand supercharging and its effect on performance of SI and CI engine.

Course Content:

Unit I

Introduction to I.C Engines: Engine classification, Application, Constructions details, Working principle, Air standard cycles, Otto, Diesel, Stirling, Ericsson cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, Environment friendly engines.

Unit II

SI Engines: Carburetion, Mixture requirements, Carburetor types, Theory of carburetor, MPFI. Combustion in SI engine, Flame speed, Ignition delay, abnormal combustion and it's control, combustion chamber design for SI engines. Ignition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition.

Unit III

CI Engine: Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings. Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines. Scavenging in 2 Stroke engines, pollution and it's control.

Unit IV

Engine Cooling and Lubrication: Different cooling systems, Radiators and cooling fans. Engine friction, Lubrication principal, Type of lubrication, Lubrication oils, Crankcase ventilation.

Fuels: Fuels for SI and CI engine , important qualities of SI engine fuels, Rating of SI engine fuels, Important qualities of CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines.

Unit V

Supercharging: Effect of altitude on power output, Types of supercharging.

Testing and Performance: Performance parameters, Basic measurements, Blow by measurement, Testing of SI and CI engines.

Air Pollution and Control: Sources and classification, Effects of air pollution, Pollutants from I. C. engines, Mechanism of formation of pollutants, Particulate emissions, Exhaust gas treatmen

Text Books:

1. A Course in International Combustion Engines, by Mathur & Sharma, Dhanpat Rai & Sons.
2. I.C Engine, by Ganeshan, Tata McGraw Hill Publishers.
3. I.C Engine, by R. Yadav, Central Publishing House, Allahabad.

Reference Books:

1. Fundamentals of Internal Combustion Engine by Gill, Smith, Ziurs, Oxford & IBH Publishing COIC.
2. Engines, by Rogowsky, international Book Co.
3. Reciprocating and Rotary Compressors, by Chlumsky, SNTI Publications Czechoslovakia.
4. I.C Engine Analysis & Practice by E.F Obert.

Internal Combustion Engines Lab (BME-551)

Course outcome (COs):

1. Identify the various types of I.C. Engines and cycles of operation.
2. Express the effect of various operating variables on engine performance.
3. Demonstration of fuel metering and fuel supply systems for different types of engines.

List of Experiments:

Any 8 experiments out of following:

1. To study the cut models of I.C. Engines.
2. To study the actual valve timing diagram of 4-stroke petrol engine.
3. To study the actual valve timing diagram of 4-stroke diesel engine.
4. To determine the Morse test on a multi cylinder petrol engine.
5. To study the performance of single cylinder, 4 stroke, diesel engine connected to eddy current dynamometer in manual/computerized mode.
6. To study the performance of 3-cylinder, 4 stroke, petrol engine connected to dynamometer in manual mode.
7. To draw pressure-crank angle plot, pressure volume plot and calculate indicated power of the diesel engine.
8. Determination of volumetric efficiency and draw indicator (P-V) diagram of reciprocating compressor.
9. Dismantling and assembling of carburettor and its study.
10. Study of different types of fuel injection systems.
11. To study and determine the effect of A/F ratio on the performance of a Petrol engine.
12. Study of Fire Tube and Water Tube boiler models.

Theory of Machines II (BME-502)

L T P C

3 1 2 5

Prerequisite: A course on Engineering Mechanics and Thermodynamics.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand of force analysis of linkages and Demonstrate functioning of single slider crank mechanism and its inversions based systems.
2. To analyze the different types of governors and flywheels.
3. Understand the concept of gyroscopic couple for ships, aero planes and road vehicles.
4. To balancing of the reciprocation and rotatory systems.
5. Demonstrate functioning clutches and brakes.

Course Contents:

UNIT I

Force Analysis, Turning Moment & Fly wheel: Static force analysis of linkages, Equivalent offset inertia force, Dynamic analysis of slider crank & Bar mechanism. Piston and Crank effort, Inertia, Torque, Turning moment diagrams, Fluctuation of energy, Flywheel.

UNIT II

Governors: Introduction, types of governors, characteristics of centrifugal governors, gravity controlled and spring controlled centrifugal governors, hunting of centrifugal governors, Sensitivity, Stability, Hunting, Isochronism, inertia governors. Effort and Power of governor, Controlling force diagrams for Porter governor and spring controlled governors.

UNIT III

Gyroscopic Motion: Space motion of rigid bodies, angular momentum, gyroscopic couples, gyroscopic stabilization, ship stabilization, stability of four wheel and two wheel vehicles moving on curved paths.

UNIT IV

Balancing of machines: Static and dynamic balancing, Primary and secondary forces and couples. Balancing of rotating and reciprocating masses, methods of balancing the primary and secondary unbalanced forces, partial balancing, field balancing.

UNIT V

Friction: Pivot and collar friction, Friction circle, Single plate, Multi plate and Cone clutches.

Brakes and Dynamometers (Mechanical Type): External and internal shoe brakes, Band and Block brakes, Hydraulic brakes, Absorption and Transmission dynamometers.

Text Books:

1. Theory of Machine: S.S.Ratan (TMH).
2. Theory of Machine- R.K.Bansal (Laxmi publication)
3. Theory of Machines by R S Khurmi.

References Books:

1. Mechanisms & Dynamics of Machines-Mabie.
2. Theory of Machine & Mechanism-Shiglay.
3. Mechanisms and Machine Theory-A.K. Ambedkar (Jain Bros).
4. Theory of Machines- W.T.Green.
5. Mechanisms and Machine Theory- Rao & Dukhipati (New Age).
6. Theory of Machine & Mechanism- Ghosh & Mallik.
7. Theory of Machine S-P.L. Ballaney (Khanna pub.)

Theory of Machines II Lab (BME-552)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the profiles of cams and its effect on follower intermittent motion.
2. Understand the concept of gyroscopic couple for ships, aero planes and road vehicles.
3. To analyze the different types of governors.
4. Examine the balancing of rotating masses in dynamic balancing.
5. Demonstrate functioning of gears.

Min. 10 out of following (or such) experiments to be done:

1. Study of simple linkers/models/mechanisms.
2. Study of inversions of four bar linkage.
3. Study of inversions of single slider crank mechanisms.
4. Study of inversions of double slider crank mechanisms.
5. Study of peculiar mechanism.
6. Study of Hart Mechanism.
7. Study of Grass-Hopper Mechanism.
8. Study of Watt Mechanism.
9. Study of Tchebicheff Mechanism.
10. Experiment on cam.
11. Experiment on Gears (tooth profile, interference etc.).
12. Experiment on Gear trains.
13. To determine the Moment of Inertia of a plane disc by using a gyroscope.
14. To determine the forces on a spring in a Hartnell Governor to determine the spring stiffness.
15. To determine the speed ratio of a spur gear.

Departmental Elective I

Manufacturing Science II (DE-ME-501)

L T P C

3 1 0 4

Prerequisite: Course on Workshop Technology.

Course Outcomes (COs):

1. Detailed knowledge of cutting tool & their geometry, nomenclature, tool materials, their properties.
2. Identify the different machines on the basis of their operations- Lathe, shaper, slotter, planer, milling, drilling and boring.
3. Understand the use of Grinding machines.
4. Understanding the concept of limits, fits, tolerances and surface finish and their utility in the industrial context
5. Identify different non-conventional machining processes and the applications of non-conventional welding.

Course Contents:

Unit I

Metal Cutting- Mechanics of metal cutting. Geometry of tool and nomenclature, ASA system Orthogonal vs. oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required. Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Machinability. Brief introduction to machine tool vibration and surface finish. Economics of metal cutting.

Unit II

Machine Tool-Lathe: Principle, types, operations, Turret/capstan, semi/Automatic, Tool layout. **Shaper, slotter, planer:** operations & drives. **Milling:** Milling cutters, up & down milling. Dividing head & indexing. Max chip thickness & power required. **Drilling and boring:** Drilling, boring, reaming tools. Geometry of twist drills.

Unit III

Grinding: Grinding wheels, abrasive, cutting action. Grinding wheel specification. Grinding wheel wear - attritions wear, fracture wear. Dressing and Truing. Max chip thickness and Guest criteria. Surface and Cylindrical grinding. Centerless grinding.

Unit IV

Super finishing: Honing, lapping, and polishing.

Limits, Fits & Tolerance and Surface-roughness: Introduction to Limits, Fits, Tolerances and IS standards, and surface-roughness.

Unit V

Introduction to non-conventional Machining and Welding: Benefits, application and working principle of EDM, ECM, LBM, EBM, USM. AJM, WJM. Similarly, non-conventional welding application such as LBW, USW, EBW, Plasma arc welding, Explosive welding.

Textbooks:

1. Manufacturing science by Ghosh and Mallik.
2. Production Technology by R.K. Jain.
3. Advanced Machining Process - VK Jain

Reference books:

1. Fundamentals of Metal Cutting and Machine tools by Boothroyd.
2. Production Technology - H.M.T.
3. Production Engineering Science by P.C. Pandey.
4. Modern Machining Processes by P.C. Pandey & H.S. Shan.
5. Manufacturing science by Degarmo.
6. Fundamentals of metal cutting & machine tools - Juneja & Shekhon.
7. Process & materials of manufacturing - Lind burg.

Rapid Prototyping and Rapid Tools (DE-ME-502)

L T P C

3 1 0 4

Prerequisite: Course on Computer aided Design and Manufacturing and Basic course on manufacturing, numerical control and robotics

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand basics of rapid prototyping and modeling and steps of preparing prototypes.
2. Understand liquid, solid and powder based prototyping systems.
3. Understand practical applications of rapid prototyping and tooling in modern industries.
4. Become familiar with recent advances in rapid prototyping and tooling.
5. Apply the Process of Rapid Prototyping in Advanced techniques.

Course Contents:

Unit I

Introduction and fundamental to rapid Prototyping, Technology involved in Rapid Prototyping, Classifications of rapid Prototyping system. Rapid Prototyping Process chain, 3-D Modeling Data conversion and Trans mission Checking and Preparing, Building, Post Processing.

Rapid Prototyping Data formats: STL Format and its Problem, STL File Repair, Newly Proposed Formats

Unit II

Liquid Based Rapid prototyping Systems: Streolithography Apparatus (SLA), Solid Ground Curing (SGC), Solid Creation System (SCS), Rapid Freeze Prototyping, Microfabrication.

Unit III

Solid Based Rapid prototyping systems: Laminated Object Manufacturing (LOM), Fused Deposition modeling (FDM), Paper Lamination Technology (PLT),

Powder based rapid Prototyping Systems: Selective Laser Sintering Z-Corporation 3-D Printing (3DP), EOSINT Systems.

Unit IV

Applications and Advantages of Rapid prototyping: Manufacturing and Tooling. Aerospace Industry. Automotive Industry, Biomedical Industry, Design, Jewelry of Rapid Prototyping,

Unit V

Advance Topics in Rapid Prototyping: Optimum part deposition orientation and algorithms, Adaptive slicing and algorithms.

Text Books:

1. Rapid Prototyping: Principles and Applications by Chua C.K.,Leong K.F. and Lim C.S. World Scientific publications.
2. Rapid Prototyping : Principles and Applications by RafiqNoorani John Wiley

Reference books:

1. Laser-Induced Materials And Processes For Rapid Prototyping by Lu,L.,Fuh,J.Y. H.& Wong,Y.S.
2. Rapid Prototyping Laser-Based And Other Technologies by Venuvinod, PatriK & Ma, Weiyin.

Tribology (DE-ME-503)

L T P C

3 1 0 4

Prerequisite: Basic of Engineering mechanics and Design of machine elements.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand and explain different laws of friction and topology of surfaces.
2. Appreciate the various modes of wear and the wear mechanism maps.
3. Understand behavior of bearing in different lubrication regimes and able to develop mathematical model.
4. Differentiate between the types of lubricants and its respective application area.
5. Select the type of bearing for any given required engineering use and determine the load carrying capacity and other related parameters.

Course Contents:

Unit I

Introduction to Tribology: Definition, Scope, Applications, Friction, Definition, Scope, Laws of friction. Friction theories. Surface contaminants, Effect of sliding speed on friction.

Unit II

Wear: Definition, Scope, wear of metals, Types, Classification. Mechanism of wear, Quantitative laws. Hypothesis of Holm. Hypothesis of Burwell and Strang. Hypothesis of Archard, Rawe, Rabinowicz. Quantitative law for Abrasive wear, Bayerku surface fatigue theory. Delamination theory & Fatigue theory of wear, wear resistant materials. Introduction to wear of Polymers and Ceramics. Wear reduction by Surface Improvements, Pitting, Erosion & Stress Corrosion.

Unit III

Surface Interactions: Elastic & Plastic deformation of surfaces. Contact of Solids, Contact of Ideally Smooth Surfaces. Distribution of Pressure over elastic contact of two curvilinear bodies. Formulae for calculation of contact area. Physico-Mechanical properties of surface layers, Characteristics of Surface Geometry. Classes of surface roughness. Contact of rough surfaces. Interaction of surface peaks. Real and contour area of contact.

Unit IV

Lubrication: Definition & Scope. Generalized Reynolds's equation. Flow and shear stress, energy equation. Mechanism of pressure development in bearings. Concept of Boundry Layer.

Unit V

Bearing design considerations & characteristics: Bearing design procedure & steps. Plain slider bearing. Step (Rayleigh step) bearing. Infinitely long journal bearing. Infinitely short journal bearing. Future scope and applications.

Textbooks:

1. Introduction to Tribology of bearings by - B. C. Majumdar., S Chand & Co.
2. Tribology in Industries by Sushil. K. Srivastava, S Chand & Publications.

Reference Books:

1. Hand Book of Tribology – WHILEY
2. Fundamentals of Fluid film lubrication by – Bernard Hamrock, Mc Graw Hill International Edition.
3. Basic Lubrication theory by Alastair Cameron.

Open Elective I

Industrial Engineering and Automation (OE-ME-501)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Workshop Practice.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Analyze and explain productivity concepts and measurements.
2. Explain various Industrial Layout and time study.
3. Exhibit skills towards program evaluation and review technique.
4. Analyze and perform Break even analysis.
5. Understand of High Volume Production Systems, Transfer Devices and Feeder.

Course Contents:

Unit I

Introduction: Engineering economy and costing, cost analysis, methods of depreciation, productivity concepts and measurements, job evaluation, methods of job evaluation, merit rating, wage incentive plan, types of wage incentive plans.

Unit II

Work measurement, time study, predetermined motion and time study (PMTS), work sampling, method study, micro motion study, principles of motion economy.

Unit III

Plant location, Types of Layout, Principles of Facility Layout, Objective Functions, Steps in PPC, Planning, Routing, Scheduling, Loading, Dispatching, Effectiveness of PPC.

Unit IV

PERT, CPM, Resource Allocation and GERT- Program Evaluation and Review Technique (PERT), Critical Path Method (CPM), Scheduling with Resource Constraints. Introduction to quality management, Ergonomics.

Unit V

High Volume Production Systems- Transfer Devices, Feeder classification, Construction and Applications, Automated Flow lines, Analysis of Automated Flow lines for Reliability and Efficiency, Assembly Systems, Robot Technology, Flexible Manufacturing Systems (FMS).

Textbooks:

1. Industrial Engineering by M.S. Mahajan, Dhanpat Rai and Co. (P) Ltd.
2. Introduction to Robotics by S.K. Saha, Tata Magraw Hill

Reference Books:

1. Introduction to Industrial System Engineering by Turner w.c. et Al 1993,Prentice Hall
2. Motion and Time Study, Design and Measurement of Work by Ralph M. Barnes, Wiley Publishers**.**
3. Project Management for Business and Technology by John M Nicholas, PHI
4. Robotics by John M Nicholas, Pearson Education.

Total Quality Management (OE-ME-502)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Industrial Engineering

Course Outcomes (COs):

After completing this course a student will be able to:

1. Describe the dimensional barrier regarding Quality.
2. Summarize the Total quality principles.
3. Demonstrate the tools utilization for quality improvement. Analyze the various types of techniques are used to measure quality
4. Discover the new decision of principle in real time projects.
5. Apply the various quality systems in implementation of Total quality management.

Course Contents:

Unit I

Quality Concepts: Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design. Control on Purchased Product: Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure.

Manufacturing Quality: Methods and Techniques for manufacture, Inspection and control of product, Quality in sales and services, Guarantee, analysis of claims.

Unit II

Quality Management: Organization structure and design, Quality function, decentralization, Designing and fitting organization for different types products and company, Economics of quality value and contribution, Quality cost, optimizing quality cost, seduction programme.

TQM Principles: Leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

Unit III

Tools and Techniques: Seven QC tools (Histogram, Check sheet, Ishikawa diagram, Pareto, Scatter diagram, Control chart, flow chart).

Control Charts: Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts, P-charts and C-charts.

Unit IV

Defects Diagnosis and Prevention: Defect study, identification and analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the

product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.

Unit V

IS0 and its concept of Quality Management: Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors, Auditing, Taguchi method, JIT in some details.

Textbooks:

1. Total Quality Management by Mukherjee, P.N.
2. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
3. Total Quality Management, by Dale H. Bester field, Pearson India.

Reference books:

1. Beyond Total Quality Management, Greg Bounds, McGraw Hill.
2. Bester field D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
3. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.
5. TQM in New Product manufacturing, H. G. Menon, McGraw Hill.

Production Planning and Control (OE-ME-503)

L T P C

3 0 0 3

Prerequisite:

Course Outcomes (COs):

After completion of this course student will be able to:

1. Understand the role Production Planning and control activities in Manufacturing and Services.
2. Understand and perform various Forecasting techniques and problems.
3. Understand and perform various Inventory Management techniques and apply in real manufacturing scenario/How to use MRP/ERP.
4. Demonstrate various Scheduling procedures/Balancing concepts.
5. Understand and Evaluate Dispatching procedures.

Course Contents:

UNIT I

Introduction: Definitions – objectives of production planning and control functions of production planning and control-elements of production control types of production- organization of production planning and control – internal organizations department.

UNIT II

Forecasting: Importance of forecasting – types of forecasting, their uses general principles of forecasting techniques- Qualitative methods and quantitative methods.

UNIT III

Inventory management: Functions inventory- Relevant inventory cost- ABC analysis- VED Analysis- EOQ model – Inventory control systems – P- Systems and Q – Systems Introduction to MRP and ERP, LOB (Line of balance), JIT inventory, Japanese concepts.

UNIT IV

Routing: Definition – routing procedure- Route sheets – Bill of material factors affecting routing procedure. Schedule – definition – difference with loading. Scheduling polices – techniques, standard scheduling methods- job shop, flow shop, Line balancing, aggregate planning- methods for aggregate planning- Chase planning, expediting, control aspects.

UNIT V

Dispatching: Activities of dispatcher- Dispatching procedure - follow up – definition – reasons for existence of functions – types of follow up, applications of computer in production planning and control

Textbooks:

1. K C Jain and L N Agarwal, Production Planning and Control, 6th edition, Khanna Publishers, 2008.
2. M Mahajan, Production Planning and Control, Dhanpat Rai & Co., 2010.

Reference Books:

1. R Paneerselvam, Production & Operations Management, 2nd edition, PHI Publications, 2006.
2. E S Baffa and R K Sarin, Modern Production & Operation Managements, 8th edition, Wiley Publications, 2009.
3. O P Khanna, Industrial Engineering and Management, Dhanpat Rai & Co., 2009.
4. Samuel Eilon, Elements of Production Planning and Control, The Macmillan Company, New York.
5. S D Sharma, Operations Research, Kedarnath Ramnath Publishers, 1996.
6. J K Sharma, Operations Research, 4th edition, Macmillan India Limited, 2009.
7. P Ramamurthy, Production and Operations Management, New Age International Publications, 2007
8. K L Narayana, P Kannaiah and K Venkata Reddy, Machine Drawing, 3rd edition, New Age Publications, 2006.

Value Engineering (OE-ME-504)

L T P C

3 0 0 3

Prerequisite:

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand concepts of value engineering and value analysis.
2. Understand the evaluation techniques of function and problem setting and solving systems.
3. Describe various phases involved in value engineering job plan and techniques of value engineering.
4. Understand the applications of value Analysis of management practice in different organizations.
5. Demonstrate their ability to apply value analysis in various fields.

Course Contents:

UNIT I

Introduction to value analysis: Definition of Value, Value Analysis, Value Engineering, Value management, Value Analysis versus Value Engineering, Value Analysis versus Traditional cost reduction techniques, uses, applications, advantages and limitations of Value analysis. Symptoms to apply value analysis, Coaching of Champion concept.

Type of values: Reasons for unnecessary cost of product, peeling cost Onion concept, unsuspected areas responsible for higher cost, Value Analysis Zone, attractive features of value analysis. Meaning of Value, types of value & their effect in cost reduction. Value analysis procedure by simulation. Detailed case studies of simple products.

UNIT II

Functional cost and its evaluation: Meaning of Function and Functional cost, Rules for functional definition, Types of functions, primary and secondary functions using verb and noun, Function evaluation process, Methods of function evaluation. Evaluation of function by comparison, Evaluation of Interacting functions, Evaluation of function from available data, matrix technique, MISS technique, Numerical evaluation of functional relationships and case studies.

Problem setting & solving system: A problem solvable stated is half solved, Steps in problem setting system, Identification, Separation and Grouping of functions. Case studies.

Goods system contains everything the task requires. Various steps in problem solving, case studies.

UNIT III

Value engineering job plan: Meaning and Importance of Value Engineering Job plan. Phases of job plan proposed by different value engineering experts, Information phase, Analysis phase,

Creative phase, Judgments phase, Development planning phase, and case studies. Cost reduction programs, criteria for cost reduction program, Value analysis change proposal.

Value engineering techniques: Result Accelerators or New Value Engineering Techniques, Listing, Role of techniques in Value Engineering, Details with Case examples for each of the techniques.

UNIT IV

Advanced value analysis techniques: Functional analysis system technique and case studies, Value Analysis of Management Practice (VAMP), steps involved in VAMP, application of VAMP to Government, University, College, Hospitals, School Problems etc., (service type problems).

Unit V

Total value engineering: Concepts, need, methodology and benefits.

Application of value analysis: Application of Value analysis in the field of Accounting, Appearance Design, Cost reduction, Engineering, manufacturing, Management, Purchasing, Quality Control, Sales, marketing, Material Management Etc., Comparison of approach of Value analysis & other management techniques.

Textbooks:

1. Techniques of Value Analysis and Engineering – Lawrence D. Miles - McGraw Hill Book Company - 2nd Edition.
2. Value engineering for Cost Reduction and Product Improvement – M.S. Vittal – Systems Consultancy Services – Edn.1993.
3. Value Management, Value Engineering and Cost Reduction – Edward D Heller – Addison Wesley Publishing Company-1971.

Reference books:

1. Value Analysis for Better Management – Warren J Ridge – American Management Association - Edition1969.
2. Getting More at Less Cost (The Value Engineering Way) – G. Jagannathan - Tata McGraw Hill Pub. Comp Edition1995.
3. Value Engineering – Arther E Mudge - McGraw Hill Book Comp.-Edn1981.

Occupational Health and Safety (BMC-501)

L T P C

3 0 0 0

Prerequisite:

Course Outcomes (COs):

After learning the course the students should be able to:

1. Identify the diseases associated with occupation.
2. Manage safety in industries by suggesting safety measures.
3. Identify the accidental causes & apply the preventions.
4. Identify Fire Explosion & apply PPE.
5. Identify & apply Hazards & Risk identification, Assessment and control techniques.

Course Contents:

Unit I

Occupational Health: Classification of occupational health hazards, dangerous properties of chemical and their health effects, routes of entry of toxic material into human body, permissible exposure limits, Threshold limit value, lethal dose and lethal concentration, Ergonomics, constituents of ergonomics, application of ergonomics for safety & health, occupational diseases due to metals & dusts, fumes & chemical compounds.

Unit II

Safety: Concept, Philosophy & Psychology of safety: Concept of safety, Nature of concept of safety, Philosophy of safety, safety terminology, philosophy of total safety concept, safety psychology, accident causative factors, general psychological factors

Unit III

Accident Causes and prevention: Causation, Accident problem, Reasons for prevention, factors impending safety, Accident prevention

Safety Management: Concept of management, element of management, functions, management principles, safety management & its responsibilities, safety Organization

Electrical Safety: Electricity and Hazardous, Indian standards, effects of electrical parameters on human body, safety measures for electric works

Unit IV

Fire and Explosion: Fire phenomena, classification of fire and extinguishers, statutory and other standards, fire prevention & protection system, explosion phenomena, explosion control devices, fire awareness signs

Personal Protective Equipment: Need of PPE, Indian standards, factors of selection of PPE, non respiratory equipments, respiratory equipments.

Unit V

Hazards & Risk identification, Assessment and control techniques: Hazards, Risks & detection techniques, Preliminary hazard analysis(PHA) & hazard analysis(HAZAN), failure mode effect analysis(FMEA), Hazard and operability(HAZOP) study, Hazard ranking (DOW & MOND index), Fault tree analysis, Event tree analysis(ETA), major accident hazard control, on-site and off-site emergency plans. Safety in different industries as case study.

Industrial Management (BHSM-501)

L T P C

3 0 0 3

Prerequisite:

Course Outcomes (COs):

1. Understand the basic concepts of management and explain the various principles of management
2. Understand the various functions of personal management and solves workers related problem
3. Recall the concept of marketing and examine various marketing strategies.
4. Explain the importance of financial management, relate it with break-even analysis and budget.
5. Understand the various principles of plant management & classify different type of material handling equipment's.

Course Contents:

Unit I

Introduction: Concept and scope of Industrial Management. Productivity: Definition, measurement, productivity index, types of production system, Industrial Ownership.

Unit II

Functions of Management: Taylor's Scientific Management Theory, Fayol's Principles of Management, Social responsibilities of Management, Introduction to Human resources management: Nature of HRM, functions and importance of HRM.

Unit III

Work Study: Introduction, definition, objectives, steps in work study, Method study: definition, objectives, steps of method study, Work Measurement: purpose, types of study — stop watch methods — steps — allowances — standard time calculations — work sampling, Production Planning and Control Inventory Control: Inventory, Cost, Models of inventory control: EOQ, ABC, VED

Unit IV

Quality Control: statistical quality control, Control charts for variables and attributes, Acceptance Sampling- Single sampling- Double sampling plans, Introduction to TQM.

Unit V

Project Management: Project network analysis, CPM, PERT and Project crashing and resource Leveling.

Textbooks:

1. Engineering Management (Industrial Engineering & Management)/ S.C. Sharma & T.R. Banga, Khanna Book Publishing Co. (P) Ltd., Delhi (ISBN: 978-93-86173-072)
2. Industrial Engineering and Management/ P. Khanna, Dhanpatrai publications Ltd.

Reference books:

1. Production & Operation Management /Paneer Selvam /PHI.
2. Industrial Engineering Management/NVS Raju/Cengage Learning.
3. Industrial Engineering Management I Ravi Shankar/ Galgotia.

Design of Machine Elements (BME-601)

L T P C

3 1 0 4

Prerequisite: Basic knowledge of Engineering Drawing and Machine Drawing.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understanding of Design requirements, Design procedure, Design for Static Load by using Theory of failure.
2. Be able to apply knowledge of the stress and strain for analyze and Design for Fluctuating Loads. Develop Logical and Analytical ability to apply Knowledge to Design of Riveted Joints.
3. Apply the knowledge of stress & strain in combined loading condition to design Shaft, Keys and Couplings.
4. Understand the standard geometry, application, failures of Spur and Helical Gear and Design and Developed effectively Spur and Helical Gears for different loading conditions.
5. Understand the standard geometry, applications, failures of Sliding contact bearings and Design and Developed effectively sliding contact bearings for different loading conditions as per manufacturer catalog.

Course Contents:

Unit I

Introduction: Definition, Design requirement of machine elements, Design procedure, standards in design & selection of preferred size. Selection of materials for static & fatigue loads, Indian Standard designation of carbon and alloy steels.

Design for Static Load: Modes of failure, Factor of safety, Revision of concepts of Stresses due to bending, torsion and Theory of failure.

Unit II

Design for 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 Joints: Riveting methods, materials, Types of rivet heads, Types of riveted joints, Caulking and Fullering, Failure of riveted joint, Efficiency of riveted joint, Eccentric loaded riveted joint.

Unit III

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.

Keys and Couplings: Types of keys, splines, Selection of square & flat keys, Strength of sunk key, Couplings, Design of rigid and flexible couplings.

Unit VI

Design of Spur Gears: Conjugate action, involute gears, gear cutting methods, tooth loads, strength of spear gears in bending and in wear. Dynamic loading, Gear materials, design of gears and involute splines. Gear profile corrections, AGMA and Indian standards.

Design of Helical Gears: Tooth relationship, tooth proportions. Design of helical gears, crossed helical gears, AGMA and Indian standards.

Design of Worm and Bevel Gears: Analysis of loads and stresses, power rating, efficiency. Gear standard and proportions.

Unit V

Sliding Contact Bearing: Types, Selection of bearing, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing, Heat generation, Design of journal bearing, Thrust bearing-pivot and collar bearing, Hydrodynamic thrust bearing.

Rolling Contact Bearing: Advantages and disadvantages, Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, Bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing, Selection of rolling contact bearing, Lubrication of ball and roller bearing, Mounting of bearing.

Note: Design data book is allowed in the examination.

Textbooks:

1. V.B. Bhandari, “Machine Design”, Tata McGraw Hill.
2. P.C. Sharma and D.K Aggarwal., “Machine Design”, S.K. Kataria & Sons.
3. Khurmi and Gupta, “Textbook of Machine Design”, Tata McGraw Hill

Reference books:

1. Maleeve Hartman and O.P.Grover, “Machine Design”, CBS Publication & Publishers.
2. Mahadevan, “Design Data Book”, CBS Publishers & Distributors.
3. J.E. Shigley & C.R. Mischke, "Mechanical Engineering Design”, Tata McGraw Hill Co. Inc.
4. Juvinal R C, Marshek K M, “Fundamentals of Machine component Design”, Wiley India.
5. Norton R. . “Machine Design” Pearson.

Heat and Mass Transfer (BME-602)

L T P C

3 1 2 5

Prerequisite: Basic Knowledge of Thermodynamics and Fluid Mechanics.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Explain the laws of heat transfer, modes of heat transfer and fundamentals Conduction.
2. Mathematically model and analyze the consequence of heat and transfer in thermal analyses of engineering systems and fins concepts.
3. Apply empirical correlations for forced, free convection and phase change process.
4. Formulate, evaluate and develop solution for radiation heat transfer problems in different situations.
5. Understand the consequence of heat transfer in thermal analyses of engineering systems like heat exchanger. Analyze different phenomenon occurring in engineering systems involving mass transfer in steady state.

Course Contents:

UNIT I

Introduction to Heat Transfer: Thermodynamics and Heat Transfer. **Modes of Heat Transfer:** Conduction, convection and radiation. Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism.

Conduction: General differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems. Initial and boundary conditions.

Steady State one-dimensional Heat conduction: Simple and Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation; Concept of thermal resistance. Analogy between heat and electricity flow; Thermal contact resistance and over all heat transfer coefficient; Critical radius of insulation.

UNIT II

Fins: Heat transfer from extended surfaces, Fins of uniform cross-sectional area; Errors of measurement of temperature in thermometer wells.

Transient Conduction: Transient heat conduction; Lumped capacitance method; Time constant; Unsteady state heat conduction in one dimension only, Heisler charts.

UNIT III

Forced Convection: Basic concepts; Hydrodynamic boundary layer; Thermal boundary layer; Approximate integral boundary layer analysis; Analogy between momentum and heat transfer in turbulent flow over a flat surface; Mixed boundary layer; Flow over a flat plate; Flow across a

single cylinder and a sphere; Flow inside ducts; Thermal entrance region, Empirical heat transfer relations; Relation between fluid friction and heat transfer; Liquid metal heat transfer.

Natural Convection: Physical mechanism of natural convection; Buoyant force; Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere, Combined free and forced convection.

UNIT IV

Thermal Radiation: Basic radiation concepts; Radiation properties of surfaces; Black body radiation Planck's law, Wein's displacement law, Stefan Boltzmann law, Kirchoff's law; ; Gray body; Shape factor; Black-body radiation; Radiation exchange between diffuse non black bodies in an enclosure; Radiation shields; Radiation combined with conduction and convection; Absorption and emission in gaseous medium; Solar radiation; Green house effect.

UNIT V

Heat Exchanger: Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method; Compact heat exchangers.

Introduction to Mass Transfer: Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion though a stagnant gas film.

Textbooks:

1. Heat and Mass Transfer by R Yadav, Central Publishing House.
2. Heat and Mass Transfer by R K Rajput.

Reference books:

1. Fundamentals of Heat and Mass Transfer, by Incroperra & DeWitt, John Wiley and Sons.
2. Heat and Mass Transfer by Cengel, McGraw-Hill.
3. Heat Transfer by J.P. Holman, McGraw-Hill.
4. Heat and Mass Transfer by Rudramoorthy and Mayilsamy, Pearson Education.
5. Heat Transfer by Ghoshdastidar, Oxford University Press.
6. A text book on Heat Transfer, by Sukhatme, University Press..
7. Heat Transfer by Venkateshan, Ane Books Pvt Ltd.
8. Schaum's outline of Heat Transfer by Pitts & Sisson McGraw-Hill.

Heat and Mass Transfer Lab (BME-652)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand laws of heat transfer, modes of heat transfer and fundamentals of heat exchangers.

2. Mathematically model and analyze the consequence of heat and transfer in thermal analyses of engineering systems.
3. Formulate, evaluate and develop solution for conduction, convection and radiation heat transfer problems in different situations.
3. Apply empirical correlations for forced, free convection and phase change process.
4. Understand, apply principles and analyze mass transfer phenomenon in different processes /systems.

List of Experiment: Minimum 8 experiment of the following

1. Conduction - Composite wall experiment
2. Conduction - Composite cylinder experiment
3. Convection - Pool Boiling experiment
4. Convection - Experiment on heat transfer from tube-natural convection.
5. Convection - Heat Pipe experiment.
6. Convection - Heat transfer through fin-natural convection.
7. Convection - Heat transfer through tube/fin-forced convection.
8. Any experiment - Such as on Stefen's Law, on radiation determination of emissivity, etc.
9. Any experiment - Such as on solar collector, etc. on radiation
10. Heat exchanger - Parallel flow experiment
11. Heat exchanger - Counter flow experiment
12. Any other suitable exp such as on critical insulation thickness.
13. Conduction - Determination of thermal conductivity of fluids.
14. Conduction - Thermal Contact Resistance Effect.

Automobile Engineering (BME-603)

L T P C

3 0 2 4

Prerequisite: Basic Knowledge of I C Engines

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the basic requirements from automobile and technology used in them.
2. Demonstrate understanding of different functional systems of automobile such as brakes, suspension system, steering mechanism, gear box and transmission system.
3. Analyze different functional systems of automobiles and the advancements in them.
4. Carry out calculations pertaining to vehicle dynamics.
5. Understand and analyze impact of automobile on environment, different measures and regulations for its control.

Course Contents:

Unit I

Power Unit and Gear Box: Principles of Design of main components. Valve mechanism. Power and Torque characteristics. Rolling, air and gradient Resistance. Tractive effort. Gear Box. Gear ratio determination. Design of Gear box.

Unit II

Transmission System: Requirements. Clutches. Toque converters. over Drive and free wheel, Universal joint. Differential Gear Mechanism of Rear Axle. Automatic transmission, Steering and Front Axle. Castor Angle, wheel camber & Toe in Toe out etc.. Steering geometry. Ackerman mechanism, Understeer and Oversteer.

Unit III

Braking System: General requirements, Road, tyre adhesion, weight transfer, Braking ratio. Mechanical brakes, Hydraulic brakes. Vacuum and air brakes. Thermal aspects.

Chassis and Suspension System: Loads on the frame. Strength and stiffness. Various suspension systems.

Unit IV

Electrical System: Types of starting motors, generator & regulators, lighting system, Ignition system, Horn, Battery etc.

Fuel Supply System: Diesel & Petrol vehicle system such as Fuel Injection Pump, Injector & Fuel Pump, Carburator etc. MPFI.

Unit V

Automobile Air Conditioning: Requirements, Cooling & heating systems

Cooling & Lubrication System: Different type of cooling system and lubrication system.

Maintenance system: Preventive maintenance, break down maintenance, and over hauling system.

Text Books:

1. Automobile Engineering by K M Gupta
2. Automobile Engineering by R K Rajput
3. Automobile Engineering - Kripal Singh.

Reference books:

1. Automotive Engineering- Hietner
2. Automobile Engineering - Narang.
3. Automotive Mechanics- Crouse
4. Automobile Engineering - Newton and Steeds.

Automobile Engineering Lab (BME-653)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Explain the various types of chassis, frame and functions of I C Engine parts.
2. Distinguish between the manual transmissions with automatic transmission systems.
3. Demonstrate how the steering, brakes and the suspension system operate.
4. Justify the importance of alternative fuels.

Note: - Minimum 8 experiments are done. Experiment no 11 is compulsory.

1. Study of braking systems & experiment on vacuum brake.

2. Study of steering systems & experiment on power steering.

3. Study on lubrication and cooling system.

4. Study on five speed gear box and differential gear box.

5. Study of cut section model of multi cylinder petrol and diesel engine.

6. Study of fuel supply system for petrol and diesel engine.

7. Study of front and rear axle assembly.

8. Comparative study of features of common small cars (such as fiat, Ambassador, Maruti, Matiz, Santro, Indica and its variations) available in India.

9. Comparative study of technical features of common scooters & motorcycles available in India.

10. Comparative Study of Technical features of common heavy vehicles available in India.

11. Visit of an Automobile factory.

Departmental Elective Course-II

Unconventional Manufacturing (DE-ME-601)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Manufacturing Science

Course Outcomes (COs):

After completion of the course a student will be able to:

1. Understand the process capability of unconventional manufacturing process.
2. Understand various non-conventional manufacturing processes.
3. Develop competency to selecting various un-conventional manufacturing processes.
4. Explain the working principles of thermal energy based processes.
5. Understand the Diffusion and Photo- Lithography process for electronic-device.

Course Contents:

Unit I

Introduction: Limitations of conventional manufacturing processes need of unconventional manufacturing processes & its classification and its future possibilities.

Unit II

Unconventional Machining Process: Principle and working and applications of unconventional machining process such as Electro-Discharge machining, electrochemical machining, ultrasonic machining, Abrasive jet machining etc.

Unit III

Unconventional Machining Process (continued): Principle and working and application of unconventional machining processes such as Laser beam machining, Electron beam machining, Ultrasonic machining etc. (these can also be used for welding).

Unit IV

Unconventional welding processes: Explosive welding, Cladding etc. Under water welding, Metalizing, Plasma are welding/cutting etc.

Unit V

Unconventional Forming processes: Principle, working and applications of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electro-Discharge forming, water hammer forming, explosive compaction etc.

Electronic-device Manufacturing: Brief description of Diffusion and Photo- Lithography process for electronic-device manufacturing.

Books

1. Unconventional Machining – V.K. Jain

Reference Books:

1. Modern Machining Processes – P.C. Pandey.

Experimental Stress Analysis (DE-ME-602)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Engineering Mechanics and Mechanics of Solids.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Analyse the 3-D state of stress in components with application of plane stress and plane strain conditions.
2. Analyse 3D state of strain in the components.
3. Understand various practical methods of analyzing strain in the components.
4. Understand the parameters, and practical applications of strain gages.
5. Understanding various aspects of photo elasticity and its application for stress analysis.

Course Contents:

UNIT I

Elementary Elasticity: Stress: Introduction, Stress Equations of Equilibrium, Laws of Stress Transformations, principal Stresses, Two-Dimensional State of Stress, Stresses Relative to Principal Coordinate System, Special States of Stress.

Strain: Introduction, Displacement and Strain, Strain Transformation Equation, Principal Strains, Compatibility, Volume Dilation, Stress Strain Relations, Strain Transformation Equations and Stress Strain Relations for Two-Dimensional State of Stress.

UNIT II

Strain Measurements: Introduction, Properties of Strain Gage Systems, Types of Strain Gages, Grid- Method of Strain Analysis.

Brittle Coating Method: Coating Stresses, Failure Theories, Brittle Coating Crack Patterns, Resin and Ceramic Based Brittle Coating, Test Procedure, Analysis of Brittle Coating Data.

UNIT III

Electrical Resistance Strain Gages: Introduction, Strain Sensitivity in Alloys, Strain Gage Adhesives, Gage Sensitivity and Gage Factor.

Strain Gage Circuit: Potentiometer and its Application, Wheat-Stone Bridge, Bridge Sensitivity, Null Balance Bridges.

Analysis of Strain Gage Data: Three Element Rectangular Rosette, Delta Rosette, Stress Gage, Plane Shear-Gage.

UNIT IV

Theory of Photo elasticity: Introduction, Temporary Double Refraction, Stress Optic Law, Relative Retardation, Stressed Model in Plane Polariscope, Effect of Principal Directions, Effect of

Principal Stress Difference, Stressed Model in Circular Polariscope, Light and Dark Field arrangements, Tardy Compensation, Fringe Sharpening and Multiplication by Partial Mirrors.

UNIT V

Two Dimensional Photo elasticity: Introduction, Isochromatic Fringe Patterns, Isoclinic Fringe Patterns, Compensation Techniques, Calibration Methods, Separation Methods, Shear Difference Method, Electrical Analogy Method, Oblique Incidence Method, Materials for Two-Dimensional Photoelasticity.

Text Books:

1. Experiment Stress Analysis by Dr. Sadhu Singh, Khanna Publishers.

Reference Books:

1. Experiment Stress Analysis by James W. Dally and William F. Riley, International Student Edition, McGraw-Hill Book Company.

Reliability and Maintenance Engineering (DE-ME-603)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Power Plant Engineering.

Course Outcomes (COs):

After completion of this course student will be able to:

1. Explain maintenance objectives and functions, need for maintenance plan and organization, and cost of maintenance, equipment and production delays.
2. Understand equipment wear records and standards and various kinds of NDT methods for predictive maintenance.
3. Explain maintenance of mechanical drives such as belt drive, chain drive and gears
4. Understand the maintenance of pumps, compressors and control valves.
5. Explain the principles and techniques applicable in life testing and reliability improvements.

Course Contents:

UNIT I

Introduction to maintenance: Need for maintenance. Types of maintenance, breakdown, corrective and preventive maintenance. Maintenance planning, Scheduled maintenance. Cost of maintenance versus Cost of equipment and production delays. Inspection: Inspection intervals, Inspection reports, card history system.

UNIT II

Predictive maintenance: Equipment wear records, standards. Equipment used in predictive maintenance. Computerized maintenance. The role of computers in a maintenance programme. Types if lubrication system and selection of lubricants. Non-destructive testing: Liquid Penetrate, Magnetic particles, Ultrasonic testing, and Vibration analysis. Oil analysis Radiographic testing.

UNIT III

Maintenance of mechanical drives: Bearings: Overheating, noise, vibration. Chain drives: Normal wear in chain drives. Tension in chain drives, Sprockets: Lubrication, Belt drives: Tension in belts, slip &creep. Gears: Normal wear in gears, Lubrication &alignment problems. Shock, overloading. Couplings: Rigid flexible couplings.

UNIT IV

Maintenance of fluid power systems: Pumps: Noise& heat, Compressors: Heating, noise, vibration problems. Maintenance of Control valves.

UNIT V

Life testing-reliability: Life testing-Objectives-failure data analysis, Mean failure rate, mean time to failure, mean time between failures, hazard rate, system reliability: series &parallel and mixed

configuration-simple problems. Maintainability and availability. Reliability of acceptance sampling based on reliability test-O. C Curves.

Quality and reliability: Reliability improvements-techniques, use of Pareto analysis-Design for reliability, redundancy unit and stand by redundancy, Optimization of reliability.

Text Books:

1. Stainer, Plant Engg Hand Book"
2. Morrow, Maintenance Engg Hand Book"

Reference Books:

1. Terry Wireman, "Preventive Maintenance", Reston Publishing Company, Prentice Hall.
2. Miller & Blood, Modern Maintenance Management".

Additive Manufacturing (DE-ME-604)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Computer Aided Design.

Course Outcomes (COs):

After completion of this course student will be able to:

1. Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation.
2. Formulate and solve typical problems on reverse engineering for surface reconstruction from physical prototype models through digitizing and spline based surface fitting.
3. Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.
4. Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
5. Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts.

Course Contents:

UNIT I

Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages, and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

UNIT II

Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. **Solid ground curing (SGC)**: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based Rapid Prototyping Systems: Laminated **Object Manufacturing (LOM):** Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT III

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case

studies. **Three-dimensional Printing (3DP):** Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. **Rapid Tooling**: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; **Indirect Rapid Tooling Methods:** Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

UNIT IV

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. **Rapid Prototyping Software's**: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

UNIT V

Rapid prototyping Applications: Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

Text Books:

1. Rapid prototyping; Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific Publications.
2. Rapid Manufacturing /D.T. Pham and S.S. Dimov/Springer

Reference Books:

1. Terry Wohlers, Wholers Report 2000, Wohlers Associates.
2. Rapid Prototyping and Manufacturing /PaulF.Jacobs/ASME.

Open Elective Course II

Composite Materials (OE-ME-601)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Materials Science.

Course Outcomes (COs):

1. Knowledge of the different types of engineering materials.
2. Knowledge of the types of reinforcements and fibers.
3. Understand the various types of composites used in engineering and their properties.
4. Describe the processing of composite materials and manufacturing techniques.
5. Understand and analyze the various methods of testing the composites.

Course Contents:

UNIT I

Introduction: Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermoset sand Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.

UNIT II

Types of Reinforcements/Fibers: Role and Selection of reinforcement materials, Types of fibers, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc. Mechanical properties of fibres. Material properties that can be Improved by forming a composite material and its engineering potential.

UNIT III

Various types of composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC),Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC);Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer(FRP) Composites, Laminar Composites, Particulate Composites.

UNIT IV

Fabrication methods: Processing of Composite Materials: Overall considerations, Auto clavecuring, Other Manufacturing Processes like filament welding, compression moulding, resin transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peelplies, release films and fabrics, Bleeder and breather plies, bagging films, maximum stress and strain criteria, Von Mises Yield criterion for isotropic materials.

UNIT V

Testing of Composites and Analysis: Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc. Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.

Text Books:

1. Mechanical Metallurgy, by G. Dieter, McGraw Hill.
2. Engineering Materials: Polymers, Ceramics and Composites, by A.K Bhargava Prentice Hall India.
3. Analysis and Performance of Fiber Composites, by Agarwal, McGraw Hill.

Reference Books:

1. Materials characterization, Vol. 10, ASM hand book.
2. Thermal Analysis of Materials, by R.F. Speyer, Marcel Decker.
3. Engineering Mechanics and Composite Materials, by Daniels, Oxford University Press.
4. Material Science and Engineering (SIE) with CD, by Smith, McGraw Hill.
5. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.

Entrepreneurship (OE-ME-602)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of industrial management.

Course Outcomes (COs):

1. Understand entrepreneurship and its related theory and government policies
2. Understand various Business Enterprises and Ownership Structure
3. Prepare project report and able to understand project evaluation method.
4. Understand various strategies and policies in management and enterprises.
5. Understand Institutional support towards the development of entrepreneurship.

Course Contents:

Unit I

Entrepreneurship: Definition, requirements to be an entrepreneur, entrepreneur and intrapreneur, entrepreneur and manager, growth of entrepreneurship in India, women entrepreneurship, rural and urban entrepreneurship.

Entrepreneurial Motivation: motivating factors, motivation theories-Maslow's Need Hierarchy Theory, McClelland's Acquired Need Theory, government's policy actions towards entrepreneurial motivation, entrepreneurship development programme.

Unit II

Business Enterprises and Ownership Structure Small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, companies and co-operatives firms: their formation, capital structure and source of finance.

Unit III

Project Management: Identification and selection of projects; project report: contents and formulation, concept of project evaluation, methods of project evaluation: internal rate of return method and net present value method.

Unit IV

Management of Enterprises: Strategy & policy, introduction to human resource management, marketing strategies, financial management & strategies: raising and managing capital, shares, debentures and bonds, cost of capital; break- even analysis.

Unit V

Institutional Support and Policies: Institutional support towards the development of entrepreneurship in India: Institutional framework, venture capitalist; technical consultancy organizations (TCOs), government policies for small scale enterprises.

Text Books:

1. Khanka, S S. 'Entrepreneurial Development', S Chand & Company Ltd. New Delhi.
2. Desai, Vasant, 'Project Management and Entrepreneurship', Himalayan Publishing House, Mumbai, 2002.
3. Gupta and Srinivasan, 'Entrepreneurial Development', S Chand & Sons, New Delhi.

Reference Books:

1. Ram Chandran, 'Entrepreneurial Development', Tata McGraw Hill, New Delhi
2. Saini, J. S. 'Entrepreneurial Development Programmes and Practices', Deep & Deep Publications (P), Ltd.
3. Holt, Davis, 'Entrepreneurship: New Venture Creations, PHI.

Mechanical System Design (OE-ME-603)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Industrial Engineering.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the attributes characterizing a system and case study.
2. Explain the system modelling and case study compound bar system.
3. Differentiate and understand the graph modelling, graph analysis and materials handling systems.
4. Understand the method for optimization model with single system.
5. Justify the inventory control in production plant.

Course Contents:

UNIT I

Engineering process and System Approach Basic concepts of systems, Attributes characterizing a system, types of system, Application of system concepts, Advantages of system approach, Problems concerning systems, Concurrent engineering, A case study-Viscous lubrication system in wire drawing.

Problem Formulation: Nature of engineering problems, Need statement, hierarchical nature of systems, hierarchical nature of problem environment, problem scope and constraint, A case study: heating duct insulation system, high speed belt drive system.

UNIT II

System Theories: Introduction, System Analysis, Black box approach, state theory approach, component integration approach, Decision process approach, A case study- automobile instrumentation panel system.

System modeling Introduction, Model types and purpose, linear systems, mathematical modeling, concepts, A case study compound bar system.

UNIT III

Graph Modeling and Analysis Graph Modeling and analysis process, path problem, Network flow problem, A case study: Material handling system.

Optimization Concepts Optimization processes, Selection of goals and objectives-criteria, methods of optimization, analytical, combinational, subjective. A case study: aluminum extrusion system.

UNIT IV

System Evaluation Feasibility assessment, planning horizon, time value of money, Financial analysis, A case study: Manufacture of maize starch system. 4 Calculus Method for Optimization

Model with single decision variable, model with two decision variables, model with equality constraints, model with inequality constraints, A case study: Optimization of an insulation system.

UNIT V

Decision Analysis Elements of a decision problem, decision making, under certainty, uncertainty risk and conflict probability, density function, Expected monetary value, Utility value, Baye's theorem, A case study: Installation of machinery. 4 System Simulation Simulation concepts, simulation models, computer application in simulation, spread sheet simulation, Simulation process, problem definition, input model construction and solution, limitation of simulation approach, A case study: Inventory control in production plant.

Text Books:

1. Engineering Design, by Dieter, McGraw Hill.
2. Optimization Techniques-SS Rao.
3. Design Engineering-JR Dixon, TMH, New Delhi.
4. Engineering Design-Robert Matousck, Blackie and son ltd. Glasgow.

Reference Books:

1. An Introduction to Engineering Design Method-V Gupta and PN Murthy, TMH, New Delhi.
2. Design and Planning of Engineering systems-DD Reredith, KV Wong, RW Woodhead, and RR Worthman, Prentice Hall Inc., Eaglewood Cliffs, New Jerse.
3. System Analysis and Project Management-Devid I Cleland, William R King, McGraw Hill.

Product Design and Development (OE-ME-604)

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Prerequisite:

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand how to create new product based on mechanical design engineering.
2. Understand all mechanical aspects of product design by incorporating concept, creativity, structural, manufacturing, esthetic etc.
3. Solve open-ended problem belongs to design engineering that meet the requirements.
4. Understand various product designing methods.
5. Understand human factors and cost evaluation in industrial design concepts.

Course Contents:

Unit I

Design Fundamentals:

The importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.

Unit II

Customer oriented design & Societal Considerations: Identification of customer needs- customer requirements- Quality Function Deployment Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics. Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society.

Unit III

Material selection processing and Design: Material Selection Process – Economics – Cost Vs Performance – Weighted property Index – Value Analysis – Role of Processing in Design – Classification of Manufacturing Process – Design for Manufacture – Design for Assembly – Designing for castings, Forging, Metal Forming, Machining and Welding – Residual Stresses – Fatigue, Fracture and Failure.

Unit IV

Design Methods: creativity and problem solving- creative thinking methods- generating design concepts - systematic methods for designing –functional decomposition – physical decomposition –

functional representation – morphological methods-TRIZ- axiomatic design. Decision making theory- utility theory –decision trees –concept evaluation methods.

Unit V

Industrial Design concepts: Human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost –overhead costs – activity based costing – methods of developing cost estimates – manufacturing cost –value analysis in costing.

Text books:

1. Product Design & Manufacturing by A. K. Chitab & R. C. Gupta, PHI (EEE).
2. Product Design and Development by Karl T Ulrich, Steven D. Eppinger.
3. Product Design, by Kevin Otto, Kristin wood, Pearson Education Inc.

Reference books:

1. The Technology of Creation Thinking by R.P. Crew ford, Prentice Hall.
2. The Art of Thought by Grohem Walls, Bruce & Co., New York.
3. Product Design & Decision Theory by M.K. Starr, Prentice Hall.
4. Human Factor Engg. by Mccormick E.J., McGrawHill.
5. Engineering: An Introduction to Creative profession by G.C. Beakley, H.W. Leach, Macmillan.
6. Industrial Design In Engineering – A marriage of Techniques by Charles H. Flurscheim, The Design Council - London.
7. Quality Control & Reliability Analysis by Bijendra Singh, Khanna Publications.

Economics for Industry (BHSM-601)

L T P C

3 0 0 3

Prerequisite: Basic knowledge of economics.

Course outcomes (COs):

At the end of the course, the students will be able to:

1. Define the main concepts and describe the models and methods in economic analysis.
2. Explain economic events in individual markets and the aggregate economy using basic theory and tools.
3. Apply supply and demand analysis to relevant economic issues.
4. Explain how individual decisions and actions as a member of society affect the economy locally, nationally and internationally.
5. Distinguish between perfect competition and imperfect competition and explain the welfare loss in non-competitive markets.

Course Contents:

UNIT I

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.

UNIT II

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;

UNIT III

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.

UNIT IV

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

UNIT V

Nature and characteristics of Indian economy, concepts of LPG, elementary concepts of National Income, 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)

Textbooks:

1. Koutsoyiannis A, “Modern Microeconomic”, Macmillan Education Ltd.
2. Dwivedi DN, “Principles of Microeconomics”, Pearson Education.
3. Premvir Kapoor, Sociology and Economics for Engineers, Khanna Publishing House (Edition 2018).

Reference books:

1. Salvatore D, “Principles of Microeconomics”, Oxford University Press.
2. Cowell, FA, “Microeconomic Principles and Analysis”, Oxford University Press.

Mechanical Vibration (BME-701)

L T P C

3 0 2 4

Prerequisite: Basic Knowledge of Engineering Mathematics.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the basic concepts of vibrations.
2. Develop analyze the one degree to multi-degree of freedom vibration problems.
3. Understand the vibration control mechanisms and systems.
4. Practice the numerical techniques used for solving the vibrational models of mechanical systems.
5. Analysis of different method such as Rayleigh's, Dunkerley's, and Critical Speed of shaft with one disc with and without damping.

Course Contents:

UNIT I

Introduction: Periodic motion, harmonic motion, superposition of simple harmonic motions, beats, Fourier analysis.

Single Degree Freedom System: Free vibration, Natural frequency, Equivalent systems, Energy method for determining natural frequency, response to an initial disturbance, Torsional vibrations, Damped vibrations, Vibrations of systems with viscous damping, Logarithmic decrement.

UNIT II

Single Degree Freedom: Forced Vibration: Forced vibration, Harmonic excitation with viscous damping, steady state vibrations, Forced vibrations with rotating and reciprocating unbalance, Support excitation, Vibration isolation, Transmissibility, Vibration measuring instruments, Displacement, velocity and acceleration measuring instruments

UNIT III

Two Degree Freedom systems: Introduction, Principal modes, Double pendulum, Torsional system with damping, coupled system, undamped dynamic vibration absorbers, Centrifugal pendulum absorbers, Dry friction damper.

UNIT IV

Multi Degree Freedom system: Exact Analysis: Undamped free and forced vibrations of multi degree freedom systems, influence number, Reciprocal theorem, Torsional vibration of multi degree rotor system, Vibration of gear system, Principal coordinates, Continuous systems- Longitudinal vibrations of bars, Torsional vibrations of circular shafts.

UNIT V

Multi Degree Freedom system: Numerical Analysis: Rayleigh's, Dunkerely's, Holzer's and Stodola methods, Rayleigh-Ritz method.

CRITICAL SPEED OF SHAFTS: Shaft with one disc with and without damping, Multi-disc shafts, Secondary critical speed.

Text Books:

1. Mechanical Vibrations – G. K. Groover, Jain Brothers, Rooekee.
2. Mechanical Vibrations – JS Rao & K Gupta, New Age.
3. Mechanical Vibration by S S Rao.

Reference Books:

1. Mechanical Vibrations – P. Srinivasan, TMH.
2. Mechanical Vibrations – W. T. Thomson.
3. Mechanical Vibrations – Tse, Morse & Hinkle.
4. Mechanical Vibrations – V. Rama Murthy, Narosa Publications.

Mechanical Vibration Lab (BME-751)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the basic concept of pendulum.
2. Explain analyze the one degree vibration problems.
3. Understand the forced vibration of spring mass system.
4. Solving the vibrational models of mechanical systems.
5. Analysis of Torsional Vibration.

Note: List of Experiments (Any 8 Experiments)

1. To verify the relation simple pendulum.
2. To determine the radius of gyration of compound pendulum.
3. To determine the radius of gyration & moment of inertia of bi-filar suspension.
4. To study the undamped torsional vibration of single rotor system.
5. To Study the undamped torsional vibrations of double rotor system.
6. To study the longitudinal vibration of helical coiled spring.
7. To study the undamped forced vibration of spring mass system.
8. To study the force damped vibration of spring mass system.
9. To study the undamped forced vibration of simply supported beam.
10. To study the damped forced vibration of simply supported beam.
11. To Study about the torsional vibration.

Advanced Welding Technology (BME-702)

L T P C

2 0 0 2

Prerequisite: Basic Knowledge of Workshop Technology and Manufacturing Science.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the theoretical and practical aspects of welding and it's phenomena.
2. Understand the various welding process.
3. Describe the basic metallurgy of the melted and heat affected zone of a metal or alloy and heat transfer involved in different welding process.
4. Understand the various process involved in repair and maintenance of welding and the weldability of different metal.
5. Demonstrate their ability to check the weldment quality using various inspection and testing methods.

Course Contents:

Unit I

Introduction: Welding as compared with other fabrication processes, Importance and application of welding, classification of welding processes, Health & safety measures in welding.

Welding Power Sources: Physics of welding Arc, Basic characteristics of power sources for various arc welding processes, Transformer, rectifier and generators. Physics of Welding Arc: Welding arc, arc initiation, voltage distribution along the arc, arc characteristics, arc efficiency, heat generation at cathode and anode, Effect of shielding gas on arc, isotherms of arcs and arc blow. Metal Transfer: Mechanism and types of metal transfer in various arc welding processes.

Unit II

Welding Processes: Manual Metal Arc Welding (MMAW), TIG, MIG, Plasma Arc, Submerged Arc Welding, Electro gas and Electro slag, Flux Cored Arc Welding, Resistance welding, Friction welding, Brazing, Soldering and Braze welding processes, Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding, Friction Stir Welding, Underwater welding & Microwave welding.

Unit III

Heat Flow Welding: Calculation of peak temperature; Width of Heat Affected Zone (HAZ);cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.

Unit IV

Repair & Maintenance Welding: Hard facing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

Weldability: Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and aluminium. Micro & Macro structures in welding.

Unit V

Weld Design: Types of welds & joints, Joint Design, Welding Symbols, weld defects, Inspection/testing of welds, Introduction to Welding Procedure Specification & Procedure Qualification Record.

Text Books:

1. Little R.L., "Welding and welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
2. Parmer R.S., "Welding Engineering and Technology", 1st Edition, Khanna Publishers, New Delhi, 2008.
3. Parmer R.S., "Welding Processes and Technology", Khanna Publishers, New Delhi, 1992.

Reference Books:

1. AWS- Welding Hand Book. 8th Edition. Vol- 2. "Welding Process".
2. Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House.
3. Davis A.C., "The Science and Practice of Welding", Cambridge University Press, Cambridge, 1993.
4. Nadkarni S.V. "Modern Arc Welding Technology", Oxford IBH Publishers, 1st Edition, 2005.
5. Schwartz M.M. "Metals Joining Manual". McGraw Hill Books, 1979.
6. Tylecote R.F. "The Solid Phase Welding of Metals". Edward Arnold Publishers Ltd. London.

Departmental Elective-III

Refrigeration and Air Conditioning (DE-ME-701)

L T P C

3 0 2 4

Prerequisite: Basic Knowledge of Engineering Thermodynamics.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning system.
2. Analyse performance of vapor compression refrigeration system.
3. Study the working principles of vapor absorption system and different refrigerants used.
4. Analyse the air conditioning processes using principles of Psychrometry.
5. Study the different refrigeration equipment's and its application in cold storage ,ice plant.

Course Contents:

Unit I

Refrigeration: Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect & C.O.P.

Air Refrigeration cycle: Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART).

Unit II

Vapour Compression System: Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle, Multistage vapour compression system requirement, Removal of flash gas, Intercooling.

Unit III

Vapour Absorption system: Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram , Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison. Three fluid system.

Refrigerants: Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants. Ozone layer depletion and global warming considerations of refrigerants.

Unit IV

Air Conditioning: Introduction to air conditioning, Classification of air conditioning system, Comfort air conditioning, Industrial air conditioning, Winter air conditioning, Summer air conditioning, Unitary and central air conditioning System. Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Effective temperature and comfort chart, Cooling and heating load calculations, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP). Air Washers, Cooling towers.

Unit V

Refrigeration Equipment & Application: Elementary knowledge of refrigeration & air conditioning equipment's compressors, condensers, evaporators & expansion devices, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans.

Text Books:

1. Refrigeration and Air conditioning by C.P Arora, McGraw-Hill.
2. Refrigeration and Air conditioning, by Manohar Prasad, New Age International (P) Ltd. Publication.
3. Refrigeration and Air conditioning by R. C. Arora, PHI.

Reference Books:

1. Principles of Refrigeration by Roy J. Dossat. Pearson Education.
2. Refrigeration and Air conditioning by stoecker & Jones. McGraw-Hill.
3. Refrigeration and Air conditioning by Arora & Domkundwar. Dhanpat Rai.
4. Thermal Environment Engg. By Kuhen, Ramsey & Thelked.

Refrigeration and Air Conditioning Lab (DE-ME-751)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the concept of refrigeration test rig and its applications.
2. Understand the concept of different types of expansion devices and its application.
3. Remembering concept of evaporators in refrigeration systems.
4. Learn and use of condensers.
5. Analyze the basic components of air conditioning system.
6. To study basic components of air-conditioning system.
7. Evaluate the various performance parameters use in refrigeration test rig.

8. Understand the concept of air washer and window air conditioner.

Minimum eight experiments out of the following:

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. To study different types of expansion devices used in refrigeration system.
3. To study different types of evaporators used in refrigeration systems.
4. To study different types of condensers.
5. To study basic components of air-conditioning system.
6. Experiment on air-conditioning test rig & calculation of various performance parameters.
7. To study air washers.
8. Study of window air conditioner.
9. Experiment on Ice-plant.
10. Study of Hermetically sealed double stag compressor.
11. Experiment on Desert coolers.

VISIT: **Visit** of a central air conditioning plant / cold-storage and its detailed study or a minor project related to any topic on course of Refrigeration and air conditioning.

Design and Analysis of Heat Exchangers (DE-ME-702)

L T P C

3 0 2 4

Prerequisite: Basic Knowledge of Heat and Mass Transfer.

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand LMTD method and NTU method of analysis of common types of heat exchangers.
2. Understand the method to design of heat exchangers subject to fouling.
3. Understand the design procedure of double pipe heat exchangers and Shell & tube heat exchangers.
4. Understand the designing aspects of compact heat exchangers and thermal design of shell & tube condensers.
5. Describe the thermal analysis of evaporator and understand performance evaluation of Heat transfer Enhancement technique.

Course Contents:

Unit I

Basic design methodologies: Classification of heat exchanger, selection of heat exchanger, Thermal-Hydraulic fundamentals, Overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multipass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, Fouling, Rating and sizing problems, heat exchanger design methodology.

Unit II

Fouling of heat exchangers: Basic consideration, effect of fouling on heat transfer and pressure drop, cost of fouling, design of heat exchangers subject to fouling, fouling resistance, cleanliness factor, techniques to control fouling.

Unit III

Design of double pipe heat exchangers: Thermal and Hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop.

Design of Shell & tube heat exchangers: Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method.

Unit IV

Design of compact heat exchangers: Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop.

Condenser: Shell and tube condenser, plate condenser, air cooled condenser, direct contact condenser, condenser for refrigeration and air-conditioning, thermal design of shell and tube condenser.

Unit V

Evaporator: Evaporator for refrigeration and air-conditioning, thermal analysis of evaporator, standards for evaporators and condensers.

Heat transfer enhancement and performance evaluation: Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis

Text Books:

1. Heat Exchanger Selection, Rating and Thermal Design by Sadik, Kakac, CRC Press.
2. Fundamentals of Heat Exchanger Design by Ramesh K Shah, Wiley Publication

Reference Books:

1. Compact Heat Exchangers by Kays, V.A. and London, A.L., McGraw Hill.
2. Heat Exchanger Design Handbook by Kuppan, T, Macel Dekker, CRC Press.
3. Heat Exchanger Design Hand Book by Schunder E.U., Hemisphere Publication.
4. Process Heat transfer by Donald Q Kern, McGraw Hill

Design and Analysis of Heat Exchangers Lab (DE-ME-752)

Course Outcomes (COs):

After completing this course a student will be able to:

1. Understand the concept of LMTD method and Applications.
2. Understand the concept effectiveness-NTU method and Applications.
3. Understand the concept and analysis of double pipe heat exchanger with parallel and counter flow arrangement.
4. Understand the design and analysis of shell and tube type heat exchangers.
5. Understand the concept of plate type heat exchanger.

Minimum Six Experiments out of the following:

1. Design of heat exchange equipment by using LMTD method.
2. Design of heat exchange equipment by using effectiveness– NTU method.
3. Design and analysis of double pipe heat exchanger with parallel and counter flow arrangement.
4. Design and analysis of shell and tube type heat exchanger.
5. Design and analysis of plate type heat exchanger.
6. Design of evaporator for refrigeration system.
7. Design of condenser for refrigeration system.

Open Elective Course III

Non-Conventional Energy Resources (OE-ME-701)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Power Plant Engineering.

Couse Outcomes (COs):

1. Illustrate the generation of electricity from various Non-Conventional sources of energy, have a working knowledge on types of fuel cells.
2. Study the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation.
3. Study the working principle of geothermal energy, Magneto-hydrodynamics (MHD) and fuel cell technology for energy generation.
4. Explore the concepts involved in wind energy conversion system by studying its components, types and performance.
5. Study the working principle of bio mass, wave and tidal wave and OTEC.

Course Contents:

Unit I

Introduction: Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits.

Solar Cells: Theory of solar cells. solar cell materials, solar cell array, solar cell power plant, limitations.

UNIT II

Solar Thermal Energy: Solar radiation, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

UNIT III

Geothermal Energy: Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations.

Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations.

Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations.

UNIT IV

Thermo-electrical and thermionic Conversions: Principle of working, performance and limitations.

Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. performance and limitations of energy conversion systems.

UNIT V

Bio-mass: Availability of bio-mass and its conversion theory.

Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations.

Wave and Tidal Wave: Principle of working, performance and limitations. Waste Recycling Plants.

Text Books:

1. Raja etal, "Introduction to Non-Conventional Energy Resources" Scitech Publications.
2. D.S. Chauhan,"Non-conventional Energy Resources" New Age International.
3. C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.

Reference Books:

1. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006.
2. M.V.R. Koteswara Rao, "Energy Resources: Conventional & Non-Conventional " BSP Publications,2006.

Nanotechnology (OE-ME-702)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Materials Science.

Course Outcomes (COs):

After completion of this course student will be able to:

1. Explain the fundamental principles of nanotechnology and their application to engineering.
2. Apply engineering and physics concepts to the Nano-scale and non-continuum domain.
3. Study the properties of individual Nano particles, metal Nano clusters and semi conducting nanomaterial.
4. Discuss and evaluate state-of-the-art characterization methods for nanomaterial, and determine nanomaterial safety and handling methods required during characterization.
5. Explain methods of fabricating nanostructures of carbon Buckey Ball, Carbon nano-tubes

Course Contents:

Unit I

Introduction: Definition of Nano-Science and Nano Technology, Applications of Nano-Technology.

Introduction to Physics of Solid State: Structure: Size dependence of properties; crystal structures, face centered cubic nanoparticles; Tetrehedrally bounded semiconductor structures; lattice vibrations. **Energy Bands:** Insulators, semiconductor and conductors; Reciprocal space; Energy bands and gaps of semiconductors; effective masses; Fermi Surfaces.

Localized Particles: Acceptors and deep taps; mobility; Excitons.

Unit II

Quantum Theory For Nano Science: Time dependent and time independent Schrodinger wave equations. Particle in a box, Potential step: Reflection and tunneling (Quantum leak). Penetration of Barrier, Potential box(Trapped particle in 3D:Nanodot), Electron trapped in 2D plane(Nano sheet), Quantum confinement effect in nano-materials.

Quantum Wells, Wires and Dots: Preparation of Quantum Nanostructure; Size and Dimensionality effect, Fermigas; Potential wells; Partial confinement; Excitons; Single electron Tunneling, Infrared etectors; Quantum dot laser Superconductivity.

Properties of Individual Nano particles, Metal Nano clusters: Magic Numbers; Theoretical Modelling of Nanopraticles; geometric structure; electronic structure; Reactivity; Fluctuations Magnetic Clusters; Bulle to Nano structure.

Semi conducting Nanoparticles: Optical Properties; Photo fragmentation; Coulmbic explosion.

Rare Gas & Molecular Clusters: Inert gas clusters; Superfluid clusters molecular clusters.

Unit III

Growth Techniques of Nanomaterials: Lithograpahic and Nonlithograpahic techniques, Sputtering and film deposition in glow discharge, DC sputtering technique (p-$CuAlO_2$ deposition). Thermal evaporation technique, E-beam evaporation, Chemical Vapour deposition(CVD), Synthesis of carbon nano-fibres and multi-walled carbon nanotubes, Pulsed Laser Deposition, Molecular beam Epitoxy, Sol-Gel Techniuqe (No chemistry required), Synthesis of nanowires/rods, Electrodeposition, Chemical bath deposition, Ion beam deposition system, Vapor-Liquid –Solid (VLS) method of nanowires. **8**

Unit IV

Methods of Measuring Properties: Structure: Crystallography, particle size determination, surface structure,

Microscopy: Scanning Prob Microscopy (SPM), Atomic Force Microscopy (AFM), Field Ion Microscopy, Scanning Electron Microscopy, Transmission Elecrtron Microscopy (TEM)

Spectroscopy: Infrared and Raman Spectroscopy, X-ray Spectroscopy, Magnetic resonance, Optical and Vibrational Spectroscopy, Luninscence.

Unit V

Buckey Ball: Nano structuresof carbon(fullerene): **Carbon nano-tubes:** Fabrication , structure. electrical, mechanical, and vibrational properties and applications. Nano diamond, Boron Nitride Nano-tubes, single elecron transistors, Moelcular machine, Nano-Biometrics, Nano Robots.

Text Books:

1. A.K.Bandyopadhyay, “Nano Materials” New Age International.
2. “Introduction to S.S. Physics” - (7^{th} Edn.) Wiley 1996.

Reference Books:

1. C.P.Poole Jr F.J. Owens, “Introduction to Nanotechnology”. (5).
2. S. Sugano & H. Koizuoni, “Microcluster Physics” –Springor 1998.
3. “Handboole of Nanostructured Materials & Nanotechnology” vol.-5. Academic Press 2000.

Non-Destructive Evaluation (OE-ME-703)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Material Science and Engineering.

Course Outcomes (COs):

After completion of this course student will be able to:

1. Obtain the fundamental knowledge about different NDT methods and visual inspection.
2. Explain the principles and testing knowledge of DPT(liquid penetrate inspection) and MPT for product testing.
3. Explain the principles and techniques in Radiography Testing.
4. Describe the knowledge about Ultrasonic Testing for products.
5. Understand the materials and testing procedure for Eddy Current Inspection& Thermography Testing.

Course Contents:

Unit I

Introduction: Scope and advantages of NDT, Comparison of NDT with Destructive Testing, some common NDT methods used since ages, Terminology, Flaws and Defects, Visual inspection, Equipment used for visual inspection. Ringing test, chalk test (oil whitening test). Uses of visual inspection tests in detecting surface defects and their interpretation, advantages & limitations of visual inspection.

Unit II

Tests: Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques, Test stations, Advantages, types of penetrants and developers, Zyglo test, Illustrative examples and interpretation of defects. Magnetic particle Inspection – scope and working principle, Ferro Magnetic and Non ferromagnetic materials, equipment & testing. Advantages, limitations Interpretation of results, DC& AC magnetization, Skin Effect, use of dye & wet powders for magna glow testing, different methods to generate magnetic fields, Applications.

Unit III

Radiographic methods: Introduction to electromagnetic waves and radioactivity, various decays, Attenuation of electromagnetic radiations, Photo electric effect, Rayleigh's scattering (coherent scattering), Compton's scattering (Incoherent scattering), Pair production, Beam geometry and Scattering factor. X-ray radiography: principle, equipment & methodology, applications, types of radiations and limitations. γ-ray radiography – principle, equipment., source of radioactive materials & technique, advantages of γ-ray radiography over X-ray radiography Precautions against radiation hazards. Case Study - casting and forging.

Unit IV

Ultrasonic testing methods: Introduction, Principle of operation, Piezoelectricity. Ultrasonic probes, CRO techniques, advantages, Limitation & typical applications. Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements. Case Study –Ultrasonography of human body.

Unit V

Special NDT Techniques: Eddy Current Inspection: Principle, Methods, Equipment for ECT, Techniques, Sensitivity, advanced ECT methods. Application, scope and limitations, types of Probes and Case Studies. Introduction to Holography, Thermography and Acoustic emission Testing.

Text Books:

1. Non-Destructive Testing and Evaluation of Materials, by- Prasad, McGraw Hill Education
2. Practical Non-destructive Testing, by- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Wood head Publishing.
3. Non-Destructive Testing Techniques, by- Ravi Prakash, New Age International.

Reference Books

1. Nondestructive Testing Handbook,by Robert C. McMaster, American Society for Nondestructive.
2. Introduction to Nondestructive Testing: A Training Guide, by- Paul E. Mix, wiley.
3. Electrical and Magnetic Methods of Non-destructive Testing, by- J. Blitz, springer.
4. Practical non destructive testing by Raj, Baldev.
5. Basics of Non-Destructive Testing, by Lari & Kumar, KATSON Books.

Introduction to Mechanical Micro Machining (OE-ME-704)

L T P C

3 0 0 3

Prerequisite: Basic Knowledge of Conventional machining processes..

Course Outcomes (COs):

1. Understand of process of Ultra Sonic Micro Machining, Abrasive Jet Micro Machining, Water Jet Micro Machining etc.
2. Explain the Beam Energy based micro machining, Electron Beam Micro Machining, Laser Beam Micro Machining, Electric Discharge Micro Machining etc.
3. To understand the Magneto Rheological abrasive flow finishing, Magnetic Float polishing, Elastic Emission Machining etc.
4. Understand of Micro bending with LASER, LASER micro welding, Electron beam for micro welding.
5. Understand the Metrology for micro machined components and Machining of Micro gear, micro nozzle, micro pins, Applications.

Course Contents:

UNIT I

MICRO MACHINING: Ultra Sonic Micro Machining, Abrasive Jet Micro Machining, Water Jet Micro Machining, Abrasive Water Jet Micro Machining, Micro turning, Chemical and Electro Chemical Micro Machining, Electric discharge micro machining.

UNIT II

MICRO MACHINING: Beam Energy based micro machining, Electron Beam Micro Machining, Laser Beam Micro Machining, Electric Discharge Micro Machining, Ion Beam Micro Machining, Plasma Beam Micro Machining, Hybrid Micro machining, Electro Discharge Grinding, Electro Chemical spark micro machining, Electrolytic in process Dressing.

UNIT III

NANO POLISHING: Abrasive Flow finishing, Magnetic Abrasive Finishing, Magneto rheological finishing, Magneto Rheological abrasive flow finishing, Magnetic Float polishing, Elastic Emission Machining, chemo-mechanical Polishing.

UNIT IV

MICRO FORMING AND WELDING: Micro extrusion, Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting, Micro bending with LASER, LASER micro welding, Electron beam for micro welding.

UNIT V

RECENT TRENDS AND APPLICATIONS: Metrology for micro machined components, Ductile regime machining, AE based tool wear compensation, Machining of Micro gear, micro nozzle, micro pins, Applications.

Text Books:

1. Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group, 2012.
2. Jain V.K., ‗Introduction to Micro machining' Narosa Publishing House, 2011
3. Jain V.K., Advanced Machining Processes, Allied Publishers, Delhi, 2002.

Reference Books:

1. Janocha H., Actuators – Basics and applications, Springer publishers – 2012
2. Bharat Bhushan, Handbook of nanotechnology, springer, Germany, 2010.
3. Bandyopadhyay. A.K., Nano Materials, New age international publishers, New Delhi, 2008, ISBN:8122422578.
4. Mcgeoug. J.A., Micromachining of Engineering Materials, CRC press 2001, ISBN-10:0824706447.

Computer Aided Design and Manufacturing (BME-801)

L T P C

3 0 2 4

Prerequisite: Basic Knowledge of Computer.

Course Outcomes (COs):

1. Acquire the knowledge of geometric modelling and Execute the steps required in CAD software for developing 2D and 3D models and perform transformations.
2. Develop mathematical models to represent curves and surfaces.
3. Develop programs for NC and CNC to manufacture industrial components.
4. Illustrate group technology, CAPP and CIM concepts.
5. Understand the concept of FMS and Robotics.

Course Contents:

Unit I

Fundamentals of CAD/CAM, Automation , design process, Application of computers for design, Benefits of CAD, Design workstation, Graphic terminal, CAD software- definition of system software and application software, CAD database and structure. Geometric Transformations, Geometric Modelling: Wireframe model: solid modelling: Boundary Representation (B-rep), Constructive Solid Geometry (CSG), Parametric Modelling Technique ; Mass , volumetric properties calculations; surface modelling, concepts of hidden-line removal and shading: Mechanical Assembly Kinematics analysis and simulation.

Unit II

Representation of curves and surfaces: Non-parametric and parametric representation of curves. Parametric representation of Hermite Cubic, Beizer and B-spline curves; Surface and its analysis. Representation of Analytical and synthetic surfaces.

Overview of FEM, Advantages and applications, recent advance in FEM, FEA software Basic principles and general procedure of FEM.

Unit III

NC Control Production Systems: Numerical control, Elements of NC system, coordinate systems; features of NC machine tools, NC part programming: Methods of NC part programming, manual part programming, Computer assisted part programming, Post Processor, Computerized part program, CNC, DNC and Adaptive Control Systems.

Unit IV

Group Technology (GT): Part families; part classification and coding system: Group technology machine cells, Advantages of GT.

Computer Aided Process Planning: Introduction and benefits of CAPP. Types of CAPP systems, machinability, data selection systems in CAPP.

Computer Integrated Manufacturing Systems: Basic Concepts of CIM: CIM Definition, The meaning of Manufacturing, Types of Manufacturing systems; Need, Elements, Evolution of CIM; Benefits of CIM.

UNIT V

Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations; FMS benefits

Robotics: Classification and specification–drive and controls–sensors-end effectors-grippers-tool handling and work handling–machine vision–robot programming concepts–case studies in assembly.

Text Books:

1. Dr. Sadhu Singh - Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition,2000.
2. P. Radha krishnan, - CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.S. Subramanayanand V. Raju.
3. Groover M.P. and - CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall Zimmers EW. International, New Delhi, 1992.

Reference Books:

1. Chris Mcmahon and - CAD/CAM – Principle Practice and Manufacturing Management, Jimmie Browne Addision Wesley England, Second Edition,2000.
2. Ibrahim Zeid - CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd.,Company Ltd., New Delhi, 1992.
3. Mikell P.Groover - Automation , Production Systems and Computer Integrated Manufacturing, Second edition, Prentice Hall of India, 2002.
4. S.Kant Vajpayee - Principles of Computer Integrated Manufacturing, Prentice Hall ofIndia, 1999.
5. David Bed worth - Computer Integrated Design and Manufacturing, TMH, 1998.

Computer Aided Design and Manufacturing (BME-851)

Course Outcomes (COs):

1. Modeling of simple machine parts and assemblies from the part drawings using standard CAD packages.
2. Generate CNC Turning and Milling codes for different operations using standard CAM packages. Write manual part programming using ISO codes for turning and milling operations.

List of Experiments: (Total 8 Experiments are to carried out. 4 Experiments each from CAD and CAM.)

A. CAD Experiments:

1. Line Drawing or Circle Drawing experiment: Writing and validation of computer program.
2. Geometric Transformation algorithm experiment for translation/rotation/scaling: Writing and validation of computer program.
3. Design of machine component or other system experiment: Writing and validation of computer program.
4. Understanding and use of any 3-D Modelling Software commands.
5. Pro/E/Idea etc. Experiment: Solid modelling of a machine component.
6. Writing a small program for FEM for 2 spring system and validation of program or using a FEM Package.

B. CAM Experiments:

1. To study the characteristic features of CNC machine.
2. Part Programming (in word address format) experiment for turning operation (including operations such as grooving and threading) and running on CNC machine.
3. Part Programming (in word address format or ATP) experiment for drilling operation (point to point) and running on CNC machine.
4. Part Programming (in word address format or ATP) experiment for milling operation (contouring) and running on CNC machine.
5. Experiment on difference between ordinary and NC machine, study or retrofitting.
6. Experiment on study of system devices such as motors and feedback devices.
7. Experiment on Mechatronics and controls.

Thermal Turbo Machines (BME-802)

L T P C

3 0 0 3

Prerequisite: Course on Applied Thermodynamics.

Course Outcomes (COs):

After completion of this course student will be able to:

1. Understand the principles of operation of thermal turbo machines.
2. Design different work absorbing turbo machines like compressors and pumps.
3. Design different work producing turbo machines like gas and steam turbines.
4. Understand the functional parameters and components in different turbo machines.

Course Contents:

UNIT I

Introduction of turbo machinery, classification of turbo machines, Review of laws of thermodynamics & SFEE in reference to turbo machinery, Euler's energy transfer equation for turbo machines, Definition of various efficiencies, Preheat factor, Reheat factor, Blade classification, Blade terminology, Cascade testing, Velocity diagrams for axial and radial turbo machinery and pumps.

UNIT II

Centrifugal compressors - Principle of operation, work done and pressure rise, Velocity diagram for centrifugal compressor, Slip factor, Stage pressure rise, Loading coefficient, Diffuser, degree of reaction, Effect of impeller blade profile, Pre-whirl and inlet guide vanes, Centrifugal Compressor characteristic curves.

Axial flow compressor- Principle of operation and working, Energy transfer, Velocity diagram for axial compressor, Factors affecting stage pressure ratio, Blockage in compressor annulus, Degree of reaction, 3-D flow, Design process, blade design, calculation of stage performance, Axial compressor performance characteristic curves.

UNIT III

Axial flow turbines-Elementary theory of axial flow turbine, Energy transfer, Velocity diagram, Types of blades, Vortex theory, Choice of blade profile, pitch and chord, Estimation of stage performance, Characteristic curves.

UNIT IV

Steam turbines: Constructional details, working of steam turbine.

Pumps: Classification of Pumps, Main components, indicator diagram and modification due to piston acceleration, Performance characteristics, Cavitation and its control, miscellaneous types of pumps.

Radial flow turbines: Elementary theory of radial flow turbines, Enthalpy- Entropy diagram, State losses, Estimation of stage performance, Performance characteristics.

UNIT V

Gas Turbine Starting & Control Systems: Starting ignition system, Combustion system types, Safety limits & control.

Turbine Blade cooling: Different cooling techniques, Types of coolants, Comparative evaluation of different cooling techniques.

Text Books:

1. Thermal Turbo machines, Onkar Singh, Wiley India Pvt. Ltd.
2. Gas turbine theory: Cohen & Rogers, Addison Weslay Longman Ltd.
3. Gas Turbine- Ganeshan, Tata Mc Graw Hill.

Reference Books:

1. Design of high efficiency turbo machinery and gas turbines, David Gordon Wilson, Theodosios Korakianitis, Prentice Hall International.
2. Turbo machinery : S.M. Yahya.
3. Turbine, Compressors and Fans, S.M. Yahya, Tata Mc Graw Hill.
4. Turbo machines , D. G. Shepherd.

Departmental Elective IV

Reverse Engineering (DE-ME-801)

L T P C

3 0 0 3

Prerequisite: Basic knowledge of Additive manufacturing.

Course Outcomes (COs):

1. Acquire basic knowledge about the main opportunities provided by Reverse Engineering and Rapid Prototyping tools.
2. Represents an opportunity to learn how to conduct detailed product design by benefitting from cutting-edge technologies.

Course Contents:

UNIT I

Introduction to New Product Development. Tasks of detailed design, new frontiers of Computer-Aided Design tools.

UNIT II

Reverse Engineering: Objectives and common application fields. Existing technologies. Contact systems.

UNIT III

Non-contact systems. Manipulation of acquired data. Practical experiences.

UNIT IV

Introduction to the Basic Principles of Additive Manufacturing. Design for Additive Manufacturing.

UNIT V

Employment of Reverse Engineering and Rapid Prototyping technologies in different industrial fields with an outlook on the South Tyrolean industrial fabric.

Text Books:

1. Eldad Eilam's Reversing: Secrets of reverse engineering.
2. Hacking the Xbox: An Introduction to Reverse Engineering.
3. The IDA Pro Book: The Unofficial Guide to the World's Most Popular Disassembler.

Reference Books:

1. The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory.
2. Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software.
3. The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System 2nd Edition.

Computational Fluid Dynamics (DE-ME-802)

L T P C

3 0 0 3

Prerequisite: Basic knowledge Engineering Fluid Mechanics.

Course Outcomes (COs):

After completion of this course student will be able to:

1. Apply the physical principles to derive the governing equations which govern fluid flow and heat transfer.
2. Solve the diffusion problems using finite difference methods.
3. Solve the diffusion problems using finite volume methods.
4. Understand the various concepts of Finite Volume Method for Convection Diffusion.
5. Apply various algorithms to analyze the flow field and understand the turbulence models for the given problem.

Course Contents:

UNIT I

Governing Equations and Boundary Conditions: Basics of computational fluid dynamics. Governing equations of fluid dynamics. Continuity, Momentum and Energy equations. Chemical species transport. Physical boundary conditions, Time-averaged equations for Turbulent Flow. Turbulent–Kinetic Energy Equations Mathematical behavior of PDEs on CFD. Elliptic, Parabolic and Hyperbolic equations.

UNIT II

Finite Difference Method: Derivation of finite difference equations. Simple Methods. General Methods for first and second order accuracy, solution methods for finite difference equations. Elliptic equations. Iterative solution Methods. Parabolic equations. Explicit and Implicit schemes. Example problems on elliptic and parabolic equations.

UNIT III

Finite Volume Method (FVM) for Diffusion: Finite volume formulation for steady state One, Two- and Three-dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank. Nicolson and fully implicit schemes.

UNIT IV

Finite Volume Method for Convection Diffusion: Steady one-dimensional convection and diffusion. Central, upwind differencing schemes properties of discretization schemes. Conservativeness, Boundedness, Transportive, Hybrid, Power-law, QUICK Schemes.

UNIT V

Calculation Flow Field by FVM: Representation of the pressure gradient term and continuity equation. Staggered grid. Momentum equations. Pressure and Velocity corrections; Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models. High and low Reynolds number models.

Text Books:

1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, by Versteeg, Pearson, India.
2. Numerical Heat Transfer and Fluid Flow, by Patankar, Tayers&Francis.
3. Computational Heat Transfer, by Jaluriaans Torrance, CRC Press.
4. Introduction to Computational Fluid Dynamics, by Prodip Niyogi. Pearson India.

Reference Books:

1. Computational Fluid Dynamics, by Anderson, Mc Graw Hill.
2. Computational Fluid Dynamics, by Chung, Cambridge University Press.
3. Computer Simulation of flow and heat transfer, by Ghoshdastidar McGraw Hill.
4. Computational Fluid Flow and Heat Transfer, by Muralidhar and Sundararajan, Narosa Publishing House.
5. Computational Fluid Dynamics: Principles and Applications, by Blazek, Elsevier Science & Technology.

Open Elective IV

Power Plant Engineering (OE-ME-801)

L T P C

3 1 0 4

Prerequisite: Basic Knowledge of Thermodynamics and I C Engines.

Course outcomes (COs):

1. Understand the basics of power plants.
2. Analyze the working and layout of the of steam power plant.
3. Define the working principles of Diesel power plant, its layout, safety principles and compare it with other types of plants.
4. Discuss the working principle and basic components of the nuclear power plants and Hydro-electric power plants and safety precautions involved with it.
5. Discuss and analyze the mathematical and working principle of different electrical equipment involved in the generation of the power.

Course Contents:

Unit I

Introduction: Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant units. Power plant economics and selection. Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.

Unit II

Steam power plant: General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizes and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.

Unit III

Diesel power plant: General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant. Gas turbine power

plant: Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant, Integrated Gasifier based Combined Cycle (IGCC) systems.

Unit IV

Nuclear power plant: Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants. Hydroelectric and Non-Conventional Power Plant: Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

Unit V

Electrical system: Generators and generator cooling, transformers and their cooling, bus bar, etc. Energy Saving and Control: Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

Text Books:

1. Power Plant Engineering by P.K. Nag, Tata McGraw Hill.
2. Steam & Gas Turbines & Power Plant Engineering by R. Yadav, Central Pub. House.
3. Power Plant Engineering by Gupta, PHI India.

Reference Books:

1. Power Plant Engineering, by F.T. Morse, Affiliated East-West Press Pvt. Ltd.
2. Power Plant Engineering by Hedge, Pearson India.
3. Power Plant Technology, by Wakil, McGraw Hill.
4. Power Plant Engineering. Mahesh Verma, Metropolitan Book Company Pvt. Ltd.

Optimization Method in Engineering (OE-ME-802)

L T P C

3 1 0 4

Prerequisite: Course on calculus, matrix

Course Outcomes (COs):

After completion of the course a student will be able:

1. Learn one dimensional optimization methods.
2. Learn constrained optimization of multi-variable function.
3. Apply integer programming methods.
4. Dynamic programming and operation research problems
5. Learn soft computing based optimization.

Course Contents:

Unit I

Unconstrained Optimization: Optimizing Single-Variable Functions, Conditions for Local Minimum and Maximum, Optimizing Multi-Variable Functions.

Unit II

Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Direct Search Method, Lagrange Multipliers Method, Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn –Tucker Sufficient Conditions.

Unit III

Optimization: Quasi-Newton Methods and line search, least squares optimization, Gauss Newton, Extensions of LP to Mixed Integer Linear Programming (MILP), Non-Linar Programming, The Newton Algorithm, Non-Linear Least Squares, Sequential Quadratic Programming (SQP), Constrained Optimization, Multi-Objective Optimization, Branch and Bound Approaches.

Unit IV

Optimization in Operation Research: Dynamic Programming, Minimax and Maximax Algorithm, Discrete Simulation, Integer Programming – Cutting Plane Methods, Separable Programming, Goal Programming, Integer Linear Programming.

Unit V

Soft computing based optimization, Practical aspects of optimization.

Text books:

1. Engineering Optimization Theory and Practice by Rao S.S.
2. Methods of Optimization by Walsh G R.
3. Integer and Combinational Optimization by G.L.Nemhauser and L.A.Wolsey.
4. Operations Research: Applications and Algorithms by Winston W L

Reference books:

1. Model Building in Mathematics Programming by Williams H.P.
2. Integer and Combinational Optimization by G.L.Nemhauser and L.A.Wolsey
3. Discrete Optimization by R.G. Parker and R.L. Rardin.
4. Combinational Optimization: Algorithms and Complexity by C.H. Papadimitrious and K.Stegilite
5. Multi-objective evolutionary optimization for Product Design and Manufacturing by LihuiWang
6. Genetic Algorithms by Kalyanmoy Deb
7. Genetic Algorithms in search, optimization and machine learning by David E Goldberg, Pearson Springer.

Fracture Mechanics (OE-ME-802)

L T P C

3 1 0 4

Prerequisite: Basic Knowledge of Mechanics of Solids and Theory of Elasticity.

Course Outcomes (COs):

1. Basic Understanding of Crack in a Structure, Fracture Toughness, Types of Fracture.
2. Analyze elastic and elastic-plastic stress fields at the crack-tip in a solid material..
3. Estimate crack growth based on energy balance.
4. Demonstrate standard fracture mechanics tests for finding J-Integral and Crack Opening Displacement.
5. Inspect a solid material for the presence of crack.

Course Contents:

Unit I

Introduction: A Crack in a Structure, Fracture Toughness. Micro and Macro Phenomena of Fracture - Microscopic Aspects: Surface Energy, Theoretical Strength, Microstructure and Defects, Crack Formation - Macroscopic Aspects: Crack Growth, Types of Fracture, Mechanisms of Fracture and Crack Growth - Cleavage Fracture, Ductile Fracture, Fatigue Cracking, Environment Assisted Cracking, Creep Fracture, Service Failure Analysis

Unit II

Linear Elastic Stress Fields in Cracked Bodies • Introduction • Crack Deformation Modes and Basic Concepts, Westergaard Method, Singular Stress and Displacement Fields, Stress Intensity Factor Solutions, Three-Dimensional Cracks

Linear Elastic-Plastic Stress Fields in Cracked Bodies: Approximate Determination of the Crack-Tip Plastic Zone, Irwin's Model, Dugdale's Model

Unit III

Crack Growth Based on Energy Balance: Introduction, Energy Balance During Crack Growth, Griffith Theory, Graphical Representation of the Energy Balance Equation, Equivalence between Strain Energy Release Rate and Stress Intensity Factor, Compliance, Crack Stability.

Unit IV

Fracture Criteria: Critical Stress Intensity Factor Fracture Criterion, J-Integral and Crack Opening Displacement Fracture Criteria, Strain Energy Density Failure Criterion: Mixed-Mode Crack Growth.

Dynamic Fracture Introduction, Mott's Model , Stress Field around a Rapidly Propagating Crack , Strain Energy Release Rate, Crack Branching, Crack Arrest ,Experimental Determination of Crack Velocity and Dynamic Stress Intensity

Unit V

Introduction to Fatigue Fracture, Environment-Assisted Fracture, Creep Fracture and Crack Detection Methods such as Dye Penetration, Magnetic Particles, Eddy Current, Radiography, Ultrasonic, and Acoustic Emission**.**

Text Books:

1. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw Hill Education Pvt. Ltd.
2. T.L. Anderson, "Fracture Mechanics - Fundamentals and Applications", CRC - Taylor and Francis.

Reference Books:

1. E.E. Gdoutos, "Fracture Mechanics - An Introduction", Springer.
2. D. Broek, "Elementary Engineering Fracture Mechanics", Kluwer Academic Publishers.
3. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", Wiley India Pvt. Ltd.

Machine Tool Design (OE-ME-804)

L T P C

3 1 0 4

Prerequisite: Basic Knowledge of Workshop Technology.

Course Outcomes (COs):

After successful completion of this course students will be able to

1. Understand classification of machine tools with their nomenclature, specification and uses.
2. Explain working of various drives mounted in machine tools.
3. Analyze the speed and feed box with the regulation of speed and feed rates.
4. Design components like structural bed, column, power screws etc.
5. Apply knowledge to study dynamics of machine tool and its control.

Course Contents:

UNIT I

Introduction: Developments is machine tools, types of machine tools surface, profits and paths produced by machine tools. Features of construction and operations of basic machine tools e.g. lathe, drill, milling shapes and planers, grinding machine etc. General requirement of machine tool design. Machine tool design process. Tool wear, force Analysis.

UNIT II

Machine Tools Drives: Classification of machine tool drives, group Vs individual drives, Selection of electric motor, A brief review of the elements of mechanical transmission e.g. gear, belt and chain drives, Slider-crank mechanism, cam mechanism, nut & Screw transmission, Devices for intermittent motion, reversing & differential mechanisms. Couplings and clutches Elements of hydraulic transmission system. e.g. pumps, cylinder, directional control valves, pressure valves etc., Fundamentals of Kinematics structure of machine tools.

UNIT III

Regulation of Speed and Feed rates: Laws of stepped regulation, selection of range ratio, standard progression ratio, selection of best possible structural diagram, speed chart, Design of feed box, developing gearing diagrams. stepless regulation of speed and feed in machine tool, speed and feed control.

UNIT IV

Design of Machine Tool Structure: Requirements and design criteria for machine tool structures, selection of material Basic design procedure for machine tool structures, design of bed, column and housing, Model technique in design.

Design of guide ways and power screws: Basic guide way profiles, designing guide way for stiffness a wear resistance, hydrostatic and antifriction grand ways. Design of sliding friction power

Screws. Design of spindlier & spindle supports. Layout of bearings, selection of bearings for machine tools.

UNIT V

Dynamics of machine tools: General procedure for assessing the dynamic stability of cutting process, closed loop system, chatter in machine tools.

Control Systems: Functions, requirements & types of machine tool controls, controls for speed & feed change. Automatic and manual Controls. Basics of numerical controls. Machine tool testing.

Text Books:

1. N.K. Mehta, "Machine Tool Design and Numerical Control" Second Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1984.
2. S.K. Basu and D.K. Pal, "Design of Machine Tools", Fourth Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1990.
3. G.C. Sen and A. Bhattacharya, "Principles of Machine Tools", Second Edition, New Central Book Agency (P) Ltd., Kolkata, 1988.

Reference Books:

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Institute of Engineering & Technology

Dr. Bhim Rao Ambedkar University, Agra

Khandari Campus, Agra

Class : B.E. (Mechanical Engineering)

Session 2021-2022 | **2nd Year** | **Batch : 2020-2024**

S.No.	College No.	Roll No.	Enroll No.	Cat.	Gen.	Candidate Name	Father's Name
1	20ME01	2009005531001	A-20006069	SC	M	ABHAY PRATAP SINGH	MUKESH KUMAR
2	20ME02	2009005531002	A-20006070	GEN	M	ABHISHEK DUBEY	PANCHDEV DUBEY
3	20ME03	2009005531003	A-20006071	OBC	M	ABHISHEK JAISWAL	JAIPRAKASH JAISWAL
4	20ME04	2009005531004	A-20006072	SC	M	ADITYA SINGH	VINOD KUMAR
5	20ME05	2009005531005	A-20006073	GEN	F	ADRIKA YADAV	LATE RAJ KUMAR YADAV
6	20ME06	2009005531006	A-20006074	OBC	M	AINSTEEN YADAV	JITENDRA YADAV
7	20ME07			OBC	M	AJAY KUMAR	SHYAM LALIT
8	20ME08	2009005531007	A-20006075	GEN	M	AKASH SHRIVASTAV	SHYAM DEV
9	20ME09	2009005531008	A-20006076	GEN	M	AMIT KUMAR	RAJESH KUMAR PAL
10	20ME10	2009005531009	A-20006077	OBC	M	ANIKET PATEL	AWDHESH PATEL
11	20ME11	2009005531010	A-20006078	OBC	M	ANKIT KUMAR GUPTA	ARVIND KUMAR GUPTA
12	20ME12	2009005531011	A-20006079	OBC	M	ASHUTOSH RANJAN	SATENDRA SINGH
13	20ME13	2009005531012	A-20006080	SC	M	ASVNI KUMAR BHARTI	BECHAN PRASAD
14	20ME15	2009005531013	A-20006081	OBC	M	CHANDAN RAJBHAR	RAJPATI RAJBHAR
15	20ME16			GEN	M	DHANANJAY SINGH	SATISH CHAND SINGH
16	20ME17	2009005531014	A-20006082	SC	M	DIVYADITYA KUMAR GAURAV	SHYAMPYARE
17	20ME18	2009005531015	A-20006083	GEN	M	GAURANG BINDAL	INDRESH BINDAL
18	20ME19	2009005531016	A-20006084	SC	M	GAURAV KUMAR	SANJAY KUMAR
19	20ME20	2009005531017	A-20006085	SC	M	GAURAV KUMAR	SHAILENDRA KUMAR
20	20ME21	2009005531018	A-20006086	GEN	F	GAYATRI	BALVEER SINGH
21	20ME22	2009005531019	A-20006087	GEN	M	HIMANSHU MISHRA	ANIL MISHRA
22	20ME23	2009005531020	A-20006088	SC	M	JAI SUSHANT GAUTAM	JAI PAL SINGH
23	20ME24	2009005531021	A-20006089	OBC	M	JAYANT SAINI	DHARMENDRA KUMAR
24	20ME25	2009005531022	A-20006090	GEN	M	KAMALESH KUMAR YADAV	MANGALA PRASAD
25	20ME26	2009005531024	A-20006092	GEN	M	LAXMI NARAYAN SHARMA	ASHOK KUMAR SHARMA
26	20ME28	2009005531025	A-20006093	GEN	M	MOHIT SINGH	HEMENDRA PAL SINGH
27	20ME29	2009005531026	A-20006094	GEN	M	MUKUND MANI TIWARI	MADHURENDRA MANI TIWARI
28	20ME30	2009005531027	A-20006095	GEN	M	NITIN KUMAR	MUKESH CHANDRA
29	20ME31			SC	M	NITIN KUMAR	PRADEEP KUMAR
30	20ME32			GEN	M	OM PRAKASH MAURYA	RAM AJOR MAURYA
31	20ME33	2009005531028	A-20006096	GEN	M	PRACHAND PRATAP MISHRA	NAGENDRA MISHRA
32	20ME34	2009005531029	A-20006097	OBC	M	RAJA VISHWAKARMA	GHANSHYAM VISHWAKARMA
33	20ME35	2009005531030	A-20006098	GEN	M	RAMAN KUMAR	SANTOSH KUMAR
34	20ME36	2009005531031	A-20006099	OBC	M	SACHIN CHAUHAN	DHARMATMA CHAUHAN
35	20ME37			OBC	M	SACHIN MAURYA	JANARDAN KUMAR MAURYA
36	20ME38	2009005531032	A-20006100	GEN	F	SAUMYA KESHERWANI	SANJAY KESHARWANI
37	20ME39	2009005531033	A-20006101	OBC	M	SHIVA KASHYAP	LAXMAN PRASAD
38	20ME40	2009005531034	A-20006102	OBC	M	SHREYANSH GANGWAR	VIJENDRA GANGWAR
39	20ME41	2009005531035	A-20006103	OBC	M	SRIJAN YADAV	RAMTEJ YADAV
40	20ME42			GEN	M	TUSHAR SRIVASTAVA	ANAND KUMAR SRIVASTAVA
41	20ME43	2009005531036	A-20006104	GEN	M	VIKAS SINGH	RAM RAJ SINGH
42	20ME44	2009005531038	A-20006106	GEN	M	VISHAL DIXIT	GHANSHYAM DIXIT
43	20ME45	2009005531039	A-20006107	SC	M	VISHAL KUMAR	TILAK RAM
44	20ME46			OBC	M	NIRANJAN CHAUHAN	SHIVMANGAL CHAUHAN
45	20ME47			SC	M	SUDHEER KUMAR	SATISH CHANDRA
46	20ME48	2009005531037	A-20006105	SC	M	VINEET SINGH	RAJVEER SINGH
47	20ME49	2009005531040	A-20006108	SC	M	VIVEK SINGH	BALVEER SINGH
48	20ME50	2009005531023	A-20006091	GEN	M	LALIT KUMAR	BACHCHU SINGH

Signature Not Verified

RAJEEV KUMAR
Digitally Signed By Registrar

49	20MED51	2109005534001		OBC	F	AADRIKA SINGH	RANJIT SINGH
50	20MED52	2109005534002		OBC	M	AASIF ALI	ASLAM KHAN
51	20MED53	2109005534003		OBC	M	ADARSH KUMAR YADAV	ANIL YADAV
52	20MED54	2109005534005		GEN-EWS	M	ANURAG PARIHAR	SHAILENDRA SINGH PARIHAR
53	20MED56			ST	M	GAUTAM KUMAR CHAUDHARY	RAM ACHAL
54	20MED57	2109005534006		OBC	M	JASVANT SINGH	RAMESH CHANDRA
55	20MED58	2109005534007		OBC	M	JEETESH KUMAR	YADUVIR SINGH
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58	20MED61	2109005534010		SC	F	PRIYANKA GAUTAM	RAMPRASAD GAUTAM
59	20MED62	2109005534011		OBC	M	SAGAR	RAJEEV KUMAR CHAURASIA
60	20MED63	2109005534012		OBC	M	SHIV PAL	SUGREEM
61	20MED64	2109005534013		OBC	M	VAHAN SINGH	KARTAR SINGH
62	20MED65	2109005534004		GEN	F	AKRATI DEV	PRABHAT SAXENA

Incharge

Director