

## Department of Mechanical and Manufacturing Engineering

The Department of Mechanical Engineering, MIT was established in the year 1960 and has steadily grown from its humble beginning to a full-fledged composite Department of Mechanical and Manufacturing Engineering.

Since its inception, it has grown by leaps and bounds and today serves as the largest department in the institute in terms of student and faculty strength. The department provides education in different domains of mechanical engineering such as Industrial and Production, Manufacturing, Design and thermal engineering.

### Academic Programs offered

1. Bachelor of Technology (B. Tech.)
  - Mechanical Engineering (since 1960)
  - Industrial & Production Engineering (since 1975)
2. Master of Technology (M. Tech.)
  - Computer Aided Mechanical Design & Analysis (since 2003)
  - Manufacturing Engineering & Technology (since 2005)
  - Advanced Thermal Power & Energy Systems (since 2013)
3. PhD.

### Core Competency of the Department

- Composite Materials
- Computational Fluid Dynamics
- Computer Aided Engineering
- Computer Integrated Manufacturing
- Corrosion Engineering
- Cutting Tools & Machining
- Engineering Management
- Industrial Engineering
- IC Engine & Combustion
- System Dynamics
- Thermal Science
- Tribology

### Resources and Facilities

- Well established CAD/Automation and Mechanical Laboratories with latest software and hardware equipments.
- Highly qualified and dedicated teaching faculty, many with PhD's, citations, awards and accolades.
- Faculty to Student ratio of 1:15
- Well established workshop facility located on a 30,000 sq. ft area.
- Practice school for final year students and internship at reputed Industries in India and abroad.

### Training, Research and Consultancy

- Finite Element Analysis (FEA) using ANSYS
- Pneumatic & Hydraulic Control
- Solid Modeling with CATIA
- CFD Analysis on FLUENT
- Active engagement by many faculties on Research & Consultancy work with many Industries.
- Industry specific short courses.

### Laboratories

Well equipped laboratories on CAD/Automation, Heat Engines, Metrology, Machine Tools, Material Science, Vibration, Heat Transfer, Industrial Engineering and Fuel Testing, Advanced Material Testing Lab.

### Specialized Facilities

Computerized IC Engine Test Rig, Abrasive Water Jet Machining, Coordinate Measuring Machine, LASER Interferometer, Profile Projector, Surtronic 3+ Roughness Tester, Image Analyzer, Tensometer, Pin on Disc Wear Testing, Three Body Abrasive Wear Testing, Journal Bearing Test Rig, CNC Turning and Machining Centers, CAD Work Stations, Computerized Centrifugal Fan Test Rig, Microvickers Hardness Tester, Image Analyser, Forced Vibration Setup, Solar Concentrator Training System, Air Conditioning System.



## Faculty List

### Professor and Head

Dr Divakara Shetty S, Ph.D (Manipal University)

### Professor

Dr Raghuvir Pai B, Ph. D (IIT, Kharagpur)  
Dr N Yagnesh Sharma, Ph.D (IIT, Kharagpur)  
Dr Raviraja, Ph.D (Mysore University)  
Dr Jagannath K, Ph.D (Manipal University)  
Dr Satyashankar Sharma, Ph.D (Manipal University)  
Dr N S Mohan, Ph.D (Manipal University)  
Dr D Srikanth Rao, Ph.D (Manipal University)  
Dr Anjaiah D, Ph.D (Manipal University)  
Dr Rajendra B, Ph.D (NITK, Suratkal)  
Dr K Vasudeva Karanth, Ph.D (Manipal University)  
Dr P Krishnananda Rao, Ph.D (Manipal University)  
Dr Achutha Kini U, Ph.D (Manipal University)

### Associate Professor - Senior Grade

Mr Kantharaj A N, MTech  
Mr Ramadev Herle, MTech  
Mr H Rajaram Hande, MTech  
Mr Nagaraja, MTech  
Mr Rajagopala Chadaga, MTech  
Mr Pradeep Kumar Shetty, MTech  
Dr Krishna Murthy, Ph.D(VTU)  
Mr Augustine B V Barboza, MTech  
Dr M Vijaya Kini, Ph.D (Manipal University)  
Dr Arunachala U Chandavar, Ph.D (VTU)  
Dr Vijay G S, Ph.D (VTU)

### Associate Professor

Dr C Raghavendra Kamath, Ph.D (NITK, Suratkal)  
Dr Raviraj Shetty, Ph.D (Manipal University)  
Dr Shiva Kumar, Ph.D (VTU)  
Dr Y Srihari Upadhyaya, Ph.D (VTU)  
Dr Murthy B R N, Ph.D (Manipal University)  
Dr Raghvendra Prabhu P, Ph.D (Manipal University)  
Dr B Shivamurthy, Ph.D (NITK, Suratkal)

### Assistant Professor - Selection Grade

Mr. Udaykumar Shetty S V, MTech  
Mr Sathish Rao U, MTech  
Mr Rajesh Nayak, MTech  
Ms Jayashree P K, MTech  
Mr Chandrakant R Kini, MTech

### Assistant Professor - Senior Grade

Mr U Satisha Prabhu, MTech  
Dr Deepak D, Ph.D (Manipal University)  
Mr Rakesh L, MTech  
Mr Shivaprakash Y M, MTech  
Mr Gowrishankar M C, MTech

Mr A Amar Murthy, MTech  
Mr Madhwesh N, MTech  
Mr Ashwin Kumar Devraj, MTech  
Dr S M Abdul Khader, Ph.D (Manipal University)  
Mr Kevin A Mathias, MTech  
Mr Manjunath M S, MTech  
Mr Vishal Shenoy P, MTech  
Mr Srinivas Shenoy H, MTech  
Ms Anupama Rajendra Hiremath, MTech  
Mr S Narayanan, MTech  
Mr Subash Acharya, MTech

### Assistant Professor

Mr Sawan Shetty, MTech  
Ms Bhagyalaxmi, MTech  
Mr Nitesh Kumar, MTech  
Mr George Varghese, MTech  
Mr Ritesh Bhat, MTech  
Mr Gurumurthy B M, MTech  
Mr Ramakrishna Vikas S, MTech  
Mr Harisha S R, MTech  
Mr Navaneet Krishna Vernekar, MTech  
Mr Nithesh Naik, MTech  
Mr Rohit N Shenoy, MTech  
Mr C S Suhas Kowshik, MTech  
Mr Gowrava Shenoy B, MTech  
Mr Jamaluddin Hindi, MTech  
Mr Aruna Prabhu, MTech  
Mr Krishna Kumar P, MTech  
Mr Pramod Mallar, MTech  
Mr Arunkumar H S, MTech  
Mr Pavan Hiremath, MTech  
Mr Ganesh A, MTech  
Mr Jonathan Monteiro, MTech  
Mr Muralishwara K, MTech  
Mr Vinyas, MTech  
Mr Harishkumar Kamat, MTech  
Mr Ranju Mamachan, MTech  
Mr Manjunath Shettar, MTech  
Mr Nakul Sreedhar, MTech  
Mr Dilifa Jossley Noronha, MTech  
Mr Nagaraj Shetty, MTech  
Mr Suhas Y Nayak, BE (on Contract)

## B. Tech in MECHANICAL ENGINEERING

Year	THIRD SEMESTER										FOURTH SEMESTER									
	Subject Code	Subject Name	L	T	P	C	Subject Code	Subject Name	L	T	P	C								
<b>II</b>	MAT 2101	Engineering Mathematics – III	2	1	0	3	MAT 2210	Engineering Mathematics – IV	2	1	0	3								
	MME 2101	Thermodynamics – I	2	1	0	3	MME 2201	Thermodynamics – II	2	1	0	3								
	MME 2102	Kinematics of Machinery	3	1	0	4	MME 2202	Fluid Mechanics	3	1	0	4								
	MME 2103	Strength of Materials	2	1	0	3	MME 2203	Dynamics of Machinery	2	1	0	3								
	MME 2104	Material Science and Metallurgy	3	0	0	3	MME 2204	Automobile Engineering	3	0	0	3								
	MME 2105	Manufacturing Technology	4	0	0	4	*** ****	Open Elective – I	3	0	0	3								
	MME 2116	Computer-Aided Mechanical Drawing	0	0	6	2	MME 2217	Mechanical Lab – I	0	0	3	1								
	MME 2118	Workshop Practice – I	0	0	3	1	MME 2218	Workshop Practice – II	0	0	3	1								
							MME 2219	Strength of Materials Lab	0	0	3	1								
		<b>16</b>	<b>4</b>	<b>9</b>	<b>23</b>			<b>15</b>	<b>4</b>	<b>9</b>	<b>22</b>									
<b>III</b>	<b>FIFTH SEMESTER</b>																			
	MME 3101	Turbo Machines	3	1	0	4	HUM 4001	Essentials of Management	2	1	0	3								
	MME 3102	Mechanical Design – I	3	1	0	4	MME 3201	Heat Transfer	3	1	0	4								
	MME 3103	CAD-CAM	3	0	0	3	MME 3202	Mechanical Design – II	3	1	0	4								
	MME 3104	Metrology and Measurements	3	0	0	3	MME ****	Program Elective – III	3	0	0	3								
	MME ****	Program Elective – I	3	0	0	3	MME ****	Program Elective – IV	3	0	0	3								
	MME ****	Program Elective – II	3	0	0	3	*** ****	Open Elective – II	3	0	0	3								
	MME 3117	Mechanical Lab – II	0	0	3	1	MME 3216	CAD Lab	0	0	6	2								
	MME 3119	Metrology Lab	0	0	3	1	MME 3217	Fluid Mechanics Lab	0	0	3	1								
			<b>18</b>	<b>2</b>	<b>6</b>	<b>22</b>			<b>17</b>	<b>3</b>	<b>9</b>	<b>23</b>								
	<b>IV</b>	<b>SEVENTH SEMESTER</b>																		
HUM 4002		Engg Economics and Financial Management	2	1	0	3	MME 4297	Seminar				1								
MME 4101		Mechanical Vibrations	3	1	0	4	MME 4298	Industrial Training				1								
MME 4102		Finite Element Methods	2	1	0	3	MME 4299	Project Work / Practice School				12								
MME 4103		Production Planning and Control	2	1	0	3														
MME ****		Program Elective – V	3	0	0	3														
MME ****		Program Elective – VI	3	0	0	3														
MME 4116		FEM Lab	0	0	6	2														
MME 4117	Mechanical Lab – III	0	0	3	1															
		<b>15</b>	<b>4</b>	<b>9</b>	<b>22</b>						<b>14</b>									

## Minor Specialisations

### I. Machine Design

1. MME 4001: Design for Manufacture and Assembly
2. MME 4002: Design of Mechanical Systems
3. MME 4003: Fatigue and Fracture
4. MME 4004: Tribology

### II. Manufacturing

1. MME 4005: Composite Materials
2. MME 4006: Heat Treatment of Metals and Alloys
3. MME 4007: Lean Manufacturing
4. MME 4008: Machine Tool Technology

### III. Thermal Engineering

1. MME 4009: Computational Fluid Dynamics
2. MME 4010: Design of Thermal Power Plant Systems
3. MME 4011: Jet Propulsion and Rocket Technology
4. MME 4012: Refrigeration and Air Conditioning Systems

### IV. Business Management

1. HUM 4011: Financial Management
2. HUM 4012: Human Resource Management
3. HUM 4013: Marketing Management
4. HUM 4014: Operations and Systems Management

#### Other Programme Electives

1. MME 4013: Alternative Fuels for Engines
2. MME 4014: Automatic Control Engineering
3. MME 4015: Corrosion Science and Engineering
4. MME 4016: Elements of Mechatronics Systems
5. MME 4017: Fluid Drives and Control
6. MME 4018: Friction and Wear
7. MME 4019: Industrial Robotics
8. MME 4020: Introduction to Combustion
9. MME 4021: Materials Characterization

10. MME 4022: MEMS and Nano Technology
11. MME 4023: Micro Machining
12. MME 4024: Non Destructive Testing
13. MME 4025: Non-Conventional Energy Sources
14. MME 4026: Operations Research
15. MME 4027: Organizational Behavior
16. MME 4028: Personnel Management and Industrial Relations
17. MME 4029: Plant Engineering and Maintenance
18. MME 4030: Plant Layout and Material Handling
19. MME 4031: Power Plant Engineering
20. MME 4032: Project Management
21. MME 4033: Statistical Quality Control
22. MME 4034: Supply Chain and Logistics Management
23. MME 4035: Technology Management
24. MME 4036: Theory of Internal Combustion Engines and Emissions
25. MME 4037: Total Quality Management
26. MME 4038: Work Systems Engineering

#### Open Electives

1. MME 3281: Corrosion Engineering
2. MME 3282: Energy Engineering
3. MME 3283: Industrial Safety Engineering
4. MME 3284: Internal Combustion Engines
5. MME 3285: Introduction to Alternative Fuels and Applications
6. MME 3286: Introduction to Composite Materials
7. MME 3287: Introduction to Nano Technology
8. MME 3288: Introduction to Operations Research
9. MME 3289: Introduction to Quality Control
10. MME 3290: Introduction to Refrigeration and Air Conditioning Systems
11. MME 3291: Introduction to Robotics
12. MME 3292: Personnel Management and Industrial Relations
13. MME 3293: Project Management
14. MME 3294: Thermal Treatment of Metals and Alloys

## THIRD SEMESTER

### MAT 2101: ENGINEERING MATHEMATICS - III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation-Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One-dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

#### References:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", (5e), Wiley Eastern, 1985.
2. Sastry S. S., "Introductory Methods of Numerical Analysis", (2e), Prentice Hall, 1990.
3. Grewal B. S., "Higher Engineering Mathematics", Khanna Publishers, 1989.
4. Murray R. Spiegel, "Vector Analysis", Schaum Publishing Co., 1959

### MME 2101: THERMODYNAMICS - I [2 1 0 3]

Introduction, Basic concept and definitions, Zeroth law of thermodynamics, concept of temperature, temperature scales. Thermodynamic definition of work, heat, comparison between heat and work. Application of first law to various engineering processes, steady flow energy equation and its applications. Limitations of First law, statements of second law and its corollaries, Carnot cycle, Statement of third law, thermodynamic temperature scale. Clausius inequality, entropy - property, principle of increase of entropy, entropy relations to other thermodynamic properties. Introduction to pure substance, dryness fraction and its measurement, different processes involving pure substance. Thermodynamic processes involving ideal and real gases, generalized compressibility chart. Available and unavailable energy, maximum work in a reversible processes, second law efficiency.

#### References:

1. Nag P. K., "Engineering Thermodynamics", McGraw - Hill Education India Pvt. Ltd, 2013.
2. Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach", Tata McGraw Hill Education, 2011.
3. Gordon J. Van Wylen and Richard E. Sonntag, "Fundamentals of Classical Thermodynamics", Wiley, 1986.
4. Rogers G. F. C. and Yon Mayhew, "Engineering Thermodynamics: Work and Heat Transfer", Prentice Hall, 1996.
5. Gupta S. C., "Thermodynamics", Pearson Education, 2009.

### MME 2102: KINEMATICS OF MACHINERY [3 1 0 4]

Kinematic chain, mechanism, mobility of mechanism, inversions, machine. Kinematic chain with three lower pairs, with four lower pairs, four bar chain, single slider crank chain, double slider crank chain and their inversions, Drag link mechanism. Velocity and acceleration of mechanisms by relative velocity method. Instantaneous Centers, Klein's construction for slider crank mechanism. Law of gearing, cycloidal and involute teeth, involutometry, involute function, interference, efficiency of helical gears, worm & worm wheel. Simple, compound, reverted and epicyclic gear trains. Ratio of tensions, Power transmitted, centrifugal tension in a belt. Flat Pivot and Collar friction, Power loss due to friction,

Classification of cams and followers, Cam profile diagrams of disc cam with knife edge follower, roller follower, flat foot mushroom follower and roller oscillating follower.

#### References:

1. Hamilton H. Mabie, Charles F. Reinholtz, "Mechanisms and Dynamics of Machinery", (4e), Wiley's Publication, 1987.
2. Ballaney P. L., "Theory of Machines and Mechanism", Khanna Publications, New-Delhi, 2009.
3. Rattan S. S., "Theory of Machines", Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2009.
4. Singh V. P., "Theory of Machines", Dhanpat Rai & Co. (P) Ltd, New-Delhi, 2010.
5. Rao J.S. and Rao V. Dukkupati, "Mechanism and Machine Theory", New Age International Publishers, 2012.

### MME 2103: STRENGTH OF MATERIALS [2 1 0 3]

Strength, stiffness and stability stresses, Thermal stress, Elastic constants, Strain energy, Stress-strain diagrams, Resilience, Toughness, Hardness, Types of beams, Shear force and bending moment in beams, Stresses in beams, Theory of simple bending, Stress variation along the length and beam section, Shear stresses in beams. Analysis of torsion of circular bars, Shear stress distribution, Bars of solid and hollow circular section, Twist and torsion stiffness, Elastic curve of Neutral axis of the beam under normal loads, Evaluation of beam deflection and slope, Columns, Equivalent length of a column, Euler equation, Slenderness ratio, Rankine formula for columns, Biaxial state of stresses, Thick & thin cylindrical shells and spherical shells.

#### References:

1. Popov E.P., "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, 1997.
2. Beer F. P. and Johnston R, "Mechanics of Materials", (3e), McGraw-Hill Book Co, 2002.
3. Nash W.A., "Theory and Problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York, 1995.
4. Kazimi S.M.A., "Solid Mechanics", Tata McGraw-Hill Publishing Co, New Delhi, 1981.
5. Ryder G.H., "Strength of Materials", (3e), Macmillan India Ltd., 2002.

### MME 2104: MATERIAL SCIENCE AND METALLURGY [3 0 0 3]

Introduction to crystal structure, crystal defects, Solidification-homogeneous and heterogeneous nucleation, crystal growth. Phases in solids - single & multi phase, solid solutions, equilibrium diagrams, Isomorphous and Eutectic systems, equilibrium & non-equilibrium cooling. Invariant reactions, Lever rule. Iron-Carbon systems - Allotropy and Polymorphism, cooling curve for pure iron, Fe-C equilibrium diagrams. Heat treatment processes like Annealing, Normalizing, Hardening, Tempering and Case hardening. Ferrous alloys - alloy steels like plain carbon steels, stainless steels, free machining steels, HSS and Maraging steels, Cast irons. Non-ferrous alloys - Brasses, Bronzes and Al-Cu alloys.

#### References:

1. Avner S.H., "Introduction to Physical Metallurgy", (3e), McGraw Hill, 2004.
2. William D. Callister, "Materials Science and Engineering", John Wiley & Sons, 2007.
3. Lakhtin Yu., "Engineering Physical Metallurgy and Heat Treatment", MIR Publishers, 1985.

- Gupta K.M., "Material Science, Metallurgy and Engineering Materials", Umesh Publication, 2012.
- Raghavan V., "Material Science and Engineering", (4e), Prentice Hall of India, 1989.

#### **MME 2105: MANUFACTURING TECHNOLOGY [4 0 0 4]**

Foundry technology, moulding materials, moulding sand & testing, Casting-Investment casting, Permanent mould casting, Slush casting, Pressure die casting Centrifugal casting and Continuous casting. Advantages, limitations and applications of different types of welding processes. Cold, warm and hot working of metals. Constructions, accessories & attachments, types and operations of Lathes, Drilling, Milling, Planing, Shaping and grinding machines. Drill bits, milling cutters and grinding wheels. Principles, working, equipment, advantages, limitations and applications of different Non-conventional machining processes. Processing of plastics.

#### **References:**

- Rajput R. K., "A Text book of Manufacturing Technology", Laxmi Publications Private Limited, 2011.
- Khanna O.P., "A Text book of Production Technology", Dhanpat Rai Publications, 2011.
- Rao P.N., "Manufacturing Technology", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
- Paul DeGarmo E., Black J. T. and Ronald Kohser A., "Materials and Process in Manufacturing", John Wiley and Sons, Delhi, 2004.
- Benedict G. F., "Non Traditional Machining Techniques", Marcel Decker, New York, 1990.

#### **MME 2116: COMPUTER AIDED MECHANICAL DRAWING [0 0 6 2]**

2D drafting-Intersection of Solids, Threaded Fasteners, square bolts & nuts, foundation bolt, Bearings, Couplings and Joints. 3D part modeling, assembly and sectional/exploded views-Drawings-Vertical stuffing box, Simple eccentric, Drill jig, Square tool post, Non-return valve, Screw jack, Swivel bearing, Strap type connecting rod end and Machine vice.

#### **References:**

- Gopalkrishna K. R., "Machine Drawing", Subhas Publications, Bangalore, 2002.
- Bhat N. D., "Machine Drawing", Charotar Publishing House, Anands, 2002.
- Venugopal K., "Engineering Drawing and Graphics + Auto CAD", Newage International Publishers, Delhi, 2002.
- Narayana K. L. and Kannaiah P., "Text book on Engineering Drawing", Scitech Publications, Chennai, 2002.
- Sham Tickoo, "CATIA for Engineers and Designers", Dreamtech Press New Delhi, 2005

#### **MME 2118: WORKSHOP PRACTICE - I [0 0 3 1]**

Preparation of models using Welding techniques, Lathe and CNC Turning Centre. Acceptance tests on machine tools.

#### **References:**

- Hajra Chaudhury S.K., Hajra Choudhury A. K. and Nirjhar Roy, *Elements of Workshop Technology*, Vol. I, Media Promoters and Publishers Pvt. Ltd., 2003.
- Hajra Chaudhury S.K., Hajra Choudhury A. K. and Nirjhar Roy, *Elements of Workshop Technology*, Vol. II, Media Promoters and Publishers Pvt. Ltd., 2003.

- Peter Smid, *CNC Programming Hand book*, Industrial Press, New York, 2000.

## **FOURTH SEMESTER**

#### **MAT 2210: ENGINEERING MATHEMATICS - IV [2 1 0 3]**

Special Functions-Series solutions of Bessel and Legendre differential equations, Recurrence formulae, generating functions and Orthogonal properties for  $J_n(x)$  and  $P_n(x)$ . Probability, finite sample space, conditional probability and independence, Bayes' theorem, one dimensional random variable: mean and variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least square principle of curve fitting. Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications

#### **References:**

- Kreyzig E., "Advanced Engineering Mathematics", (7e), Wiley Eastern, 1999.
- Meyer P.L., "Introduction to Probability and Statistical applications", (2e), American Publishing Co., 1980.
- Hogg and Craig, "Introduction of Mathematical Statistics", (4e), MacMillan, 1975.
- Grewal B. S., "Higher Engineering Mathematics", Khanna Publishers, 1989.

#### **MME 2201: THERMODYNAMICS - II [2 1 0 3]**

Carnot, Otto, Diesel and Dual cycles, Performance testing of IC Engines, principle of combustion in SI and CI engines. Vapour power cycles like Rankine, Reheat, Regenerative and Binary vapour cycles. Reciprocating air compressor-multistage compression with perfect and imperfect inter cooling. Refrigeration cycles-Bell-Coleman cycle, vapour compression and vapour absorption cycle, Properties of refrigerants. Gas turbine cycles with inter cooling, reheating and regeneration. Nozzles and Diffusers-Isentropic flow, sonic velocity, Mach number, steam nozzles. Stoichiometry-analysis of products of combustion from boiler and engine exhaust.

#### **References:**

- Nag P.K., "Basic and Applied Thermodynamics", Tata McGraw Hill, 2006.
- Mayhew A. and Rogers B., "Engineering Thermodynamics", Longman Green & Co. Ltd. London. E.L.B.S. Edition, 1990.
- Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach", Tata McGraw - Hill Education, 2011.
- Rolle Kurt C., "Thermodynamics and Heat power", Pearson Education, 2005.
- Nijaguna and Samaga, "Thermodynamics data handbook".

#### **MME 2202: FLUID MECHANICS [3 1 0 4]**

Fluid properties, Fluid statics, Intensity of pressure, Pascal's law, pressure variation in static fluid, pressure measurement by manometers, Hydrostatic forces on surfaces, determination of metacentric height, Stability of floating and submerged bodies, Continuity equation for one and three dimensional flow, fluid velocity and acceleration, Energy possessed by fluid, Euler's equation of motion along a stream line, Rayleigh's method and Buckingham's Pi-theorem, similitude, Fluid flow measurement devices, Viscous flow-critical Reynolds number, laminar

flow through circular pipe, laminar flow between fixed parallel plates, Flow through pipes - Darcy and Chezy equation, Flow past immersed bodies - Lift and drag, skin friction drag and form drag, streamlined body, Bluff body, Boundary layer concept, laminar boundary layer thickness, Boundary layer separation.

**References:**

1. Streeter V. L. and Beizamin E., "Fluid Mechanics", Willy Intl., New York, 1998.
2. Modi P. N. and Seth S. M., "Hydraulics and Fluid Mechanics", Standard Book House, 2011.
3. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House, New Delhi, 2000.
4. Bansal R. K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publication, New Delhi, 2006.
5. Yunus A. Cengel and John M. Cimbala, "Fluid Mechanics", Tata McGraw-Hill Publications, 2006.

**MME 2203: DYNAMICS OF MACHINERY [2 1 0 3]**

Static force analysis of Bell Crank Lever, Slider crank mechanisms, Four-bar mechanism, Drag link Mechanism, Toggle mechanism, Stone Crusher mechanism, Mechanisms involving gears and Cams, Plate links. Determination of inertia forces on various links of four bar mechanism and slider crank mechanism. Determination of flywheel size for single cylinder, multi-cylinder IC engine and press work. Balancing of rotating masses in the same and different planes. Balancing of reciprocating masses, Balancing of multi-cylinder in-line engines & V-engines. Centrifugal governors such as Porter, Proell, Hartnell and Wilson Hartnell governors. Gyroscopic effect on the movements of an air-craft, ship and automobiles.

**References:**

1. Ballaney P. L., "Theory of Machines and Mechanism", Khanna Publications, New-Delhi, 2009.
2. Rattan S. S., "Theory of Machines", Tata Mc-Graw Hill Publishers Pvt. Ltd, NewDelhi, 2009.
3. Singh V. P., "Theory of Machines", Dhanpat Rai & Co. (P) Ltd, NewDelhi, 2010.
4. Robert L. Norton, "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines", McGraw-Hill, 2012.
5. Rao J.S. and Rao V. Dukkupati, "Mechanism and Machine Theory", New Age International Publishers Year, 2012.

**MME 2204: AUTOMOBILE ENGINEERING [3 0 0 3]**

Automotive engine classification, Multi cylinder arrangements, engine parts, Valve timing diagram. Fuel supply system-pumps, mixture strength, carburetor, fuel injector, MPFI system. Ignition system, Cooling system and Lubrication system. Clutch-single plate, multi plate, centrifugal and semi centrifugal disc clutch, Fluid flywheel. Gear box-constant mesh gear box, synchromesh gear box, Epicyclic (automatic) gear box and torque converter, Overdrive mechanism. Drive to wheels-torque reaction, driving thrust, braking torque, Universal joint, propeller shaft, differential gear box and rear axle. Tube and tubeless tyres, Steering system, Suspension system. Brakes-drum, disc, hydraulic, servo and air.

**References:**

1. Heinz Heisler, "Vehicle and Engine Technology", (2e), Butterworth-Heinemann Publication, 1998.
2. Kirpal Singh, "Automobile Engineering", Vol. I & II (12e), Standard Publishers Distributors, New Delhi, 2011.

3. Rajput R. K., "Automobile Engineering", (1e), LaxmiPublication (P) Ltd, 2010.
4. Narang G. B. S., "Automobile Engineering", Khanna Publishers, 1990.
5. Giri N. K., "Automotive Technology", Khanna Publication, 2006.

**MME 2217: MECHANICAL LAB - I [0 0 3 1]**

Determination of viscosity, flash & fire point of oil, lower calorific value of gaseous fuel and dryness fraction of steam. Calibration of pressure gauge and determination of compression ratio. Performance test on different single cylinder, low/high speed four/two stroke petrol & diesel engines. Performance test on IC engine with computerized testing facility. Area measurement by Planimeter.

**References:**

1. Ganeshan V., "Internal Combustion Engines", (3e), Tata McGraw Hill, Education Private Limited New Delhi, 2007.
2. Mathur M. L. and Sharma R. P., "Course in Internal Combustion Engines", Dhanpath Raj Publishers, New Delhi, 2001

**MME 2218: WORKSHOP PRACTICE - II [0 0 3 1]**

Exercises on spur gear and helical gear cutting using milling & gear hobbing machines. Practice of shaping operations, Exercises on grinding operations. Machining using CNC Vertical Machining Center and use of Non-conventional machines.

**References:**

1. Hajra Chaudhury S.K., Hajra Choudhury A. K. and Nirjhar Roy, Elements of Workshop Technology, Vol. II, Media Promoters and Publishers Pvt. Ltd., 2003.
2. Peter Smid, CNC Programming Hand book, Industrial Press, New York, 2000.

**MME 2219: STRENGTH OF MATERIALS LAB [0 0 3 1]**

Tension test on mild steel, Compression test on cast iron, Hardness tests Rockwell, Brinell, Vicker's, Charpy Impact test & Izod test on mild steel, Shear test, Torsion test, Fatigue test on mild steel, Test on leaf spring, Test on Helical spring, Bending and compression test on wood, Heat treatment of steel and microstructure study of metals.

**References:**

1. Suryanarayana A.V.K., "Testing of Metallic Materials", PHI, 1990.
2. Khanna and Justo, "Highway Materials Testing", Nemchand, 1989.
3. Technical Teacher's Training Institute, "Laboratory Manual of Strength of Materials", Oxford University Press, 1983.
4. Davis H.E., Troxell G.E., Wiscocil C.T., "The Testing and Inspection of Engineering Materials", McGraw Hill Book Company.

**FIFTH SEMESTER**

**MME 3101: TURBO MACHINES [3 1 0 4]**

Classification, Dimensional analysis & similitude of incompressible and compressible flow turbo machines. Energy transfer- Euler turbine equation, Velocity triangles, physical interpretation of components of energy transfer, degree of reaction, concept of utilization factor for a turbine, theoretical head capacity relationship for pumps and compressors. Thermodynamics of turbomachines-isentropic efficiencies of turbo machines based on stagnation and static conditions, infinitesimal polytropic and finite stage efficiencies for

turbines and compressors, preheat factor for a compressor and reheat factor for a turbine. Analysis of pumps, blowers, fans and compressor-working of radial flow pumps, compressors and blowers, centrifugal compressors and axial flow compressors and fans. Analysis of hydraulic and steam turbines.

**References:**

1. Yahya S.M., “*Turbomachines*”, Satya Prakashana, New Delhi.
2. Yahya S.M., “*Turbines, Compressors and Flans*”, TMH, New Delhi, 2005.
3. Shepherd. D.G., “*Principle of Turbomachinery*”, Macmillan Co. New York, 1956.
4. Sayers.A.T., “*Hydraulic & Compressible flow Turbomachines*”, McGraw Hill, 1990.
5. Dixon S. L., “*Fluid Mechanics, Thermodynamics of Turbomachinery*”, Pergamon, 2006.

**MME 3102: MECHANICAL DESIGN - I [3 1 0 4]**

Ductile and brittle fracture, strain energy, creep & temperature, Hertz contact stresses. Principal stresses, theories of failure, factor of safety, strength under combined axial, bending & torsional loads, stress concentration. Stresses in curved beams. S-N diagram, Low and high cycle fatigue, variables affecting fatigue strength, Goodman & Soderberg equations. Design of shafts subjected to bending in two planes in addition to axial loads. Design of square, rectangular & taper keys. Strength and efficiency of riveted joints, structural joints of lap & butt types, boiler joints, rivets subjected to eccentric loading. Strength of welds, welded joints subjected to eccentric loading, welded pressure vessels. Design of bolts subjected to dynamic and impact and eccentric loading. Stresses in power screw, efficiency of power screw, force & torque requirement in screw jack.

**References:**

1. Bhandari V. B., “*Design of Machine Elements*”, (2e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
2. Norton R. L., “*Machine Design - An Integrated Approach*”, (2e), Prentice Hall Inc. New Jersey, 2004.
3. Juvenile R. C. and Marshek K. M., “*Fundamentals of Machine Component Design*”, (3e), John Wiley and Sons Inc., New York, 2000.
4. Shigley J. E. and Mischke C. R., “*Mechanical Engineering Design*”, (5e), McGraw Hill Inc., New York, 2004.
5. Mahadevan K. and Balaveera Reddy K., “*Machine Design Data Hand Book*”, (4e), CBS Publishers and distributors, New Delhi, 1987.

**MME 3103: CAD-CAM [3 0 0 3]**

Introduction to Computer aided design, need, benefits, applications of CAD, Graphics hardware and Graphics displays. Techniques for geometric modeling, Types and representation of curves, Types and representation of surfaces: Analytic surfaces, Synthetic Types and representation of solids. Numerical control and CNC programming, Computer numerical control, CNC part programming, Advanced features in CNC programming, Adaptive control machining systems. Industrial Robotics, Robot anatomy, Physical configurations, Basic robot motions, Motion systems, Robot programming, End effectors, Work cell design, robotic application. Manufacturing systems CIM, flexible manufacturing and distributed manufacturing.

**References:**

1. Groover Mikell P. and Emory W. Zimmers, “*CAD/CAM: Computer-Aided Design and Manufacturing*”, Prentice Hall of India, New Delhi, 2001.

2. Ibrahim K Zeid, “*CAD/CAM Theory and Practice*”, Tata McGraw Hill, New Delhi, 1998.
3. Groover Mikell P, “*Automation, Production Systems, and Computer Integrated Manufacturing*”, Prentice Hall of India, New Delhi, 2008.
4. Rao P. N., “*CAD/CAM*”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2005.
5. Radhakrishnan P., “*Computer Numerical Control Machines*”, New Central Book Agency (P) Ltd., Kolkata, 2004.

**MME 3104: METROLOGY AND MEASUREMENTS [3 0 0 3]**

Static characteristics of instruments and measurement systems. Methods of pressure measurement by Elastic pressure elements and McLeod gauge. Methods of temperature measurement by pressure thermometer, Electrical resistance thermometer, Thermocouples and Pyrometer. Strain measurement on static and rotary shaft, orientation of strain gauges, gauge factor, strain gauge bridge circuit, calibration circuit, temperature compensation. Measurement of force, torque and shaft power. Grades of tolerances, letter symbols for tolerances, types of fits. Taylor's principle for design of gauges, Gauge Maker's tolerance, types of gauges. Straightness measurement using straight edge and using Autocollimator. Squareness measurement, Surface texture measurement and measurements of screw threads.

**References:**

1. Beckwith Thomas G., “*Mechanical Measurements*”, Pearson Education, Delhi, 2003.
2. Jain R.K., “*Engineering Metrology*”, Khanna Publishers, New Delhi, 1997.
3. Sawhney A.K., “*Mechanical Measurement & Instrumentation*”, Dhanpat Rai & Co, New Delhi, 2002.
4. Nakra B.C. and Chaudry K.K., “*Instrumentation, Measurement & Analysis*”, Tata McGraw Hill, New Delhi, 2002.
5. Gupta I. C., “*Engineering Metrology*”, Dhanpat Rai Publications, New Delhi, 1997

**MME 3117: MECHANICAL LAB - II [0 0 3 1]**

Performance test on rotary air blower, two stage air compressor, refrigeration plant, air conditioning plant, two cylinder 4 Stroke diesel engine and MPFI engine. Valve timing diagram of IC engine, Morse test on multi cylinder petrol engine. Determination of the properties of green sand. Experiments on Gyroscope, Governors and Balancing of rotating and reciprocating unbalance. Measurement using strain gauges.

**References:**

1. Ganeshan V., “*Internal Combustion Engines*”, (3e), Tata McGraw Hill Education Private Limited, New Delhi, 2007.
2. Mathur M. L. and Sharma R. P., “*Course in Internal Combustion Engines*”, Dhanpath Raj Publishers, New Delhi, 2001.
3. Rattan S. S., “*Theory of Machines*”, Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2009.

**MME 3119: METROLOGY LAB [0 0 3 1]**

Study of measuring instruments and gauges, Screw thread measurements, Measurement of effective diameter of external screw threads, Use of Comparators, Measurement of gear dimensions, Radius and angle measurement, Calibration of Micrometer and Vernier caliper, Surface texture and straightness measurement, Use of Profile projector, Coordinate Measuring Machine and Interferometer.

**References:**

1. Jain R. K., “*Engineering Metrology*”, Khanna Publishers, New Delhi, 1997.



- Gupta I. C., "Engineering Metrology", Dhanpat Rai Publications, New Delhi, 1997.
- Raghavendra N. V. and Krishnamurthy L., "Engineering Metrology and Measurements", Oxford University Press, 2013.

## SIXTH SEMESTER

### HUM 4001: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope, The functions of managers, Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, Policies & planning premises, Strategic planning process and tools. Nature & purpose of organising, Span of management, factors determining the span, Basic departmentalization, Line & staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership - leadership behaviour & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA & application of Theory Z. The nature & purpose of international business & multinational corporations, unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections

#### References:

- Koontz D., "Essentials of Management", Mc Graw Hill, New York, 2004.
- Peter Drucker, "Management, Task and Responsibility", Allied Publishers, 2006.
- Peter Drucker, "The practice of management", Butterworth Hein Mann, 2003.

### MME 3201: HEAT TRANSFER [3 1 0 4]

Modes of heat transfer, governing laws and its derivatives, thermal resistance and conductance, overall heat transfer coefficient, initial and boundary conditions. Heat conduction through plane and composite walls, cylinder and composite cylinders, sphere and composite spheres, system with uniform rate of internal heat generation, effect of variable thermal conductivity. Fin analysis, effectiveness and efficiency. Lumped parameter analysis, time constant and response of temperature measuring instruments. Application of dimensional analysis to free and forced convection. Boiling regimes, correlations for boiling, film and dropwise condensation, Nusselt theory. Parallel and counter flow heat exchanger, heat transfer in evaporators and condensers. Thermal radiation, absorption, reflection & transmission of radiation, radiation laws, radiation intensity and total emissive power.

#### References:

- Holman J. P., "Heat Transfer", (10e), Tata McGraw Hill, 2011.
- Ozisik M.N., "Heat Transfer: A Basic Approach", (2e), McGraw Hill, 1985.
- Yunus A. Cengel and Afshin J. Ghajar, "Heat and Mass transfer", (4e), Tata McGraw Hill, 2013.
- ThirumaleswarM., "Fundamentals of Heat and Mass Transfer", (1e), Pearson Education, 2006.
- Rajput R.K. "Heat and Mass Transfer", (4e), S Chand Publishing, 2008.

### MME 3202: MECHANICAL DESIGN - II [3 1 0 4]

Coil springs-helical coil springs, design of springs subjected to steady, fluctuating and impact loads, critical frequency, concentric springs. Leaf springs-semi elliptic carriage springs, stress equalization, combination of leaf & coil springs. Design of spur, helical and bevel gears based on static, dynamic and wear strength considerations. Design of worm gears. Sliding contact bearings-lubricants, mechanism of film lubrication, temperature rise, heat generation & dissipation. Selection of rolling contact bearings. Selection of V belt, timer belt, rope and chain drive. Torque capacity and heat dissipation in different mechanical brakes like block brake, band brake and pivoted shoe brake.

#### References:

- Bhandari V. B., "Design of Machine Elements", (2e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
- Norton R. L., "Machine Design - An Integrated Approach", (2e), Prentice Hall Inc. New Jersey, 2004.
- Juvenile R. C. and Marshek K. M., "Fundamentals of Machine Component Design", (3e), John Wiley and Sons, Inc, New York, 2000.
- Shigley J. E. and Mischke C. R., "Mechanical Engineering Design", (5e), McGraw Hill Inc, New York, 2004.
- Mahadevan K. and Balaveera Reddy K., "Machine Design Data Hand Book", (4e), CBS Publishers and distributors' New Delhi, 1987.

### MME 3216: CAD LAB [ 0 0 6 2]

Solid modelling - Sketching, Extrude, cut, hole, chamfer, round, shell, rib, draft, revolve, pattern, sweep, blend; Datums-Plane, axis, points; Swept blend, variable section sweep, helical sweep; Assembly Drawing-Views, dimensioning, tolerances. Basics of MATLAB.

#### References:

- Ibrahim K Zeid, "CAD/CAM Theory and Practice", Tata McGraw Hill, New Delhi, 1998.
- Sham Tickoo, "Pro/Engineer Wildfire for Designers", CAD/CIM Technologies, 2008.
- Rudra Pratap, "Getting Started with MATLAB", Oxford University Press, 2006.

### MME 3217: FLUID MECHANICS LAB [0 0 3 1]

Measurement of flow using Venturimeter and Orifice meter. Calibration of V notch, rectangular notch and orifice. Measurement of force due to impact of jet on vanes, determination of friction factor of pipes. Performance test on hydraulic ram, centrifugal pump, reciprocating pump, gear pump, impulse turbine and impulse- reaction turbine.

#### References:

- Jagadishlal, "Fluid Mechanics & Hydraulic Machines", Metropolitan Book Co. Pvt. Ltd New Delhi, 1995.
- Bansal R K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publication, New Delhi, 2006.

## SEVENTH SEMESTER

### HUM 4002: ENGG ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash

flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation, Sinking fund and service output methods, Costing and its types Job costing and Process costing, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios

**References:**

1. Blank Leland T. Tarquin Anthony J., "Engineering Economy", McGraw Hill, New Delhi, 2002.
2. Chan S. Park, "Contemporary Engineering Economics", Pearson Education Inc., 2010.
3. Raman B.S., "Advanced accountancy", United Publications, Bangalore, 1993.
4. Ramachandran T., "Accounting and Financial Management", Scitech Publications Pvt. Ltd. India., 2001.
5. Thuesen G. J. and Thuesen H. G., "Engineering Economics", Prentice Hall of India, New Delhi, 2005.

**MME 4101: MECHANICAL VIBRATIONS [3 1 0 4]**

Limits of vibration severity, Natural frequency by Newton's Classical method & Energy method, Longitudinal, lateral & torsional vibration. Viscous damping - different types of viscous damping, Coulomb damping. Steady state forced vibration subjected to harmonic excitation, rotating and reciprocating unbalance, force and displacement transmissibility and whirling of shafts. Vibration measurement- transducers, vibrometer, accelerometer, frequency measuring instruments, exciters, Machine condition monitoring using vibration signals. Two degree of freedom system- Classical method and Lagrange's generalized method, Dynamic vibration absorber, Centrifugal pendulum absorber. Multidegree freedom system- Classical method, Influence coefficient method, Matrix iteration method, Rayleigh's method, Dunkerley's method and Holzer's method. Vibration of continuous system.

**References:**

1. Singirisu Rao S., "Mechanical Vibration", Pearson Education, New Delhi, 2004.
2. Graham Kelly S., "Fundamentals of Mechanical Vibrations", McGraw-Hill, Singapore, 1993.
3. Graham Kelly S., "Schaum's Outline of Mechanical Vibrations (Schaum's Outline Series)", McGraw-Hill Publication, 1996.
4. Ramamurthi V., "Mechanical Vibration", Practice with basic theory, Narosa Publishing House. New Delhi, 2000.
5. Rao J. S. and Gupta K., "Introductory Course on Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd, 1984

**MME 4102: FINITE ELEMENT METHODS [2 1 0 3]**

Review of matrix algebra, Basics of theory of elasticity, Basics concepts of the Finite element method- discretization, types of elements, degrees of freedom, displacement models, convergence, displacement polynomial, Pascal's triangle, higher order elements, Lagrange & Serendipity polynomials, sub-parametric, super-parametric & iso-parametric elements, local and global coordinate systems, shape functions, Finite element formulation by Direct stiffness method-

application of structural, thermal & flow problems. Finite element formulation by iso-parametric approach, Finite Element Formulation by the Weighted residual method, Application of the Finite element method to structural dynamics.

**References:**

1. Daryl L. Logan, "A First course in Finite Element Method", (4e), Thompson Ltd, India, 2007.
2. David V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill. India, 2005.
3. Chandrupatla T. R. and Belegundu A. D., "Introduction to Finite Elements in Engineering", Pearson Education, New York, 2001.
4. Reddy J. N., "An Introduction to Finite Element Method", (3e), McGraw Hill International Edition, New York, 2006.
5. Larry J. Segerlind, "Applied Finite Element Analysis", (2e), John Wiley, New York, 1984.

**MME 4103: PRODUCTION PLANNING AND CONTROL [2 1 0 3]**

Introduction to production, planning & control, functions, types of production activities. Forecasting- importance and techniques, forecast control. Aggregate Planning- pure and mixed strategies using trial & error approach. Job shop scheduling- index method & sequencing techniques. Inventory Control- introduction, classification, inventory control models, quantity discount concept, reorder level, ABC analysis. MRP- introduction and MRP processing logic. Assembly line balancing- meaning and techniques. Plant Location- factors affecting and methods of plant location. Plant Layout- types, factors affecting and techniques of plant layout.

**References:**

1. Monks Joseph G., "Operations Management", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2004.
2. Krajewski Lee J. and Ritzman Larry P, "Operations Management", Pearson Education (Singapore) Pte. Ltd., Delhi, 2005.
3. Adam Everett E. Jr. and Ebert Ronald J., "Production and Operations Management", Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Chase Richard B., Aquilano Nicholas J. and Jacobs F. Roberts, "Production and Operations Management", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1999.
5. Eilon Samuel, "Elements of Production Planning and Control", Universal Publishing Corporation, Mumbai, 1991.

**MME 4116: FEM LAB [0 0 6 2]**

Finite Element Analysis- Truss analysis, Beam analysis, 2D and 3D structural analysis, Thermal analysis, Shell analysis, Modal and Harmonic analysis and Fluid analysis. MATLAB Programming for truss, 2D beams, plane stress and strain problems.

**References:**

1. Daryl L. Logan, "A First Course in Finite Element Method", (4e), Thompson Ltd. India, 2007.
2. ANSYS Classic/Workbench Software Manual.
3. Rudra Pratap, "Getting Started with MATLAB", Oxford University Press, 2006.

**MME 4117: MECHANICAL LAB - III [0 0 3 1]**

Heat transfer from in forced convection and free convection, through composite wall and cylinders. Thermal conductivity of insulating powder and different metals, Study of parallel flow, counter flow and shell & tube heat exchanger, Calibration of thermocouples, Determination of Stephen

Boltzman constant and emissivity. Vibration experiments- Compound pendulum, Bifilar suspension, Torsional vibration, Viscous damping, Forced vibration, Transmissibility ratio, Transverse vibration of beam and Whirling of shaft.

**References:**

1. Holman J. P., "Heat Transfer", (10e), Tata McGraw Hill, 2011.
2. Yunus A. Cenzel and Afshin J. Ghajar, "Heat and Mass Transfer", (4e), Tata McGraw Hill, 2013.
3. Singiresu S. Rao, "Mechanical Vibrations", Pearson Education (Singapore) Pte. Ltd., Delhi, 2004.
4. Ramamurti V. "Mechanical Vibration Practice with Basic Theory", Narosa Publishing House, New Delhi, 2000.

**EIGHTH SEMESTER**

**MME 4297: SEMINAR**

- ▶ Each student has to present a seminar individually, on any technical topic of current interest / latest advancement / topics not covered in the syllabus.
- ▶ The topic has to be approved by the Department and a report of the same has to be submitted a week before the day of the presentation.

**MME 4298: INDUSTRIAL TRAINING**

- ▶ Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester.
- ▶ Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

**MME 4299: PROJECT WORK / PRACTICE SCHOOL**

- ▶ The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions.
- ▶ The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks.
- ▶ A mid-semester evaluation of the project work shall be done after about 8 weeks.
- ▶ An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation.
- ▶ The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form.
- ▶ Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

**MINOR SPECIALISATIONS**

**I. MACHINE DESIGN**

**MME 4001: DESIGN FOR MANUFACTURE AND ASSEMBLY [3 0 0 3]**

Essential factors of product design, morphology of design, producibility requirements in design, DFMA-History, advantages of DFMA in product design, selection of materials and processes. Sand casting-design rules for sand castings, Investment casting-design guidelines. Characteristics of the forging process, design guidelines, Design guidelines for turning, drilling, reaming, shaping, slotting, milling, grinding, and design guidelines for heat treatment. Design for die-casting. Design for sheet metal working, Design for injection molding, Design for powder metal processing, assembly methods, importance of DFA, basic DFA guidelines, product design for manual assembly, design for high-speed

automatic assembly and robot assembly, case studies on DFMA, importance of Fits, tolerance and surface finish in design, production drawings.

**References:**

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for Manufacture and Assembly", CRC Press, 2011.
2. James G. Brala, "Design for Manufacturability Handbook", McGraw Hill, New York, 1999.
3. Kevin Otto and Kristin Wood, "Product Design", Pearson Education, Delhi, 2001.
4. Chitale A. K. and Gupta R. C., "Product Design and Manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. George E. Dieter, "Engineering Design", McGraw Hill Book Co., Singapore, 2000.

**MME 4002: DESIGN OF MECHANICAL SYSTEMS [3 0 0 3]**

Mechanical design process, design factors, design of mechanical systems - Flange coupling, Screw jack, Piston, Connecting rod, Crankshaft- Overhung & Center type, Valve gear mechanism, Single plate clutch, Passenger lift, Concrete mixer, Automobile chassis & suspension. Johnson's method of optimization. Design for manufacture of cast, forged, turned, milled, drilled and ground parts, design for heat treatment, design for assembly.

**References:**

1. Bhandari V.B., "Design of Machine Elements", (3e), Tata McGraw Hill Publishing Company, New Delhi, 2010.
2. Trikha S. N., "Machine Design Exercises", Khanna Publishers, Delhi, 2001.
3. Patil S. P., "Mechanical System Design", Jaico Publishing House, Mumbai, 2004.
4. George E. Dieter, "Engineering Design", McGraw Hill Book Co., Singapore, 2000.
5. Mahadevan K. and Balaveera Reddy K., "Machine Design Data Handbook", (4e), CBS Publishers and distributors, New Delhi, 1987.

**MME 4003: FATIGUE AND FRACTURE [3 0 0 3]**

Structure and deformation of materials, fatigue design philosophies, fatigue mechanisms and microscopic features, macro aspects of fatigue of metals. High cycle fatigue - stress-life (S-N) curves, general S-N behavior, fatigue limits, mean stress effects on S-N behavior, factors influencing S-N behavior, life estimation using S-N approach, concepts of cumulative damage and life prediction. Low cycle fatigue, cyclic stress-strain curve determination, fatigue crack initiation in ductile solids, cyclic deformation and crack initiation in brittle solids. Strain-life approach, notch strain analysis and the strain-life approach. Linear Elastic Fracture Mechanics, Griffith's analysis, stress and displacement field, stress intensity factor(SIF), Plane strain fracture toughness. Fatigue Fracture Mechanics, Crack closure and Fatigue threshold, Effect of over load on fatigue crack growth.

**References:**

1. Dowling N. E., "Mechanical Behavior of Materials", (4e), Pearson Education, 2012
2. Suresh S., "Fatigue of Materials", (2e), Cambridge University Press, 1998
3. Stephens R. I., Fatemi A., Stephens R. R. and Fuchs H. O., "Metal Fatigue in Engineering", (2e), John Wiley & Sons, 2000
4. Bannantine J. A., Comer J. J. and Handrock J. L., "Fundamentals of Metal Fatigue Analysis", Prentice Hall, 1990

- Prashant Kumar, *"Elements of Fracture Mechanics"*, McGraw Hill Education, 2009

#### **MME 4004: TRIBOLOGY [3 0 0 3]**

Introduction to tribology, History of tribology, Interdisciplinary Approach, Economic Benefits. Importance of Lubrication, Types & Properties of Lubricants, Lubricants Additives, Boundary Lubrication, Mixed Lubrication. Equation of Continuity & Motion, Generalized Reynolds Equation with Compressible & Incompressible Lubricant, Hydrodynamic & Hydrostatic lubrication, Elastohydrodynamic lubrication. Causes of Friction, Adhesion Theory, Abrasive Theory, Junction Growth Theory, Laws of Rolling Friction, Friction Instability. Wear Mechanisms and Wear Analysis. Surface engineering, Rolling Contact Bearings, Gears, Journal Bearings - Finite Bearings, Condition Monitoring. Surface topography measurements, electron microscope and friction and wear measurements laser method, bearing performance measurements, bearing vibration measurement.

#### **References:**

- Cameron A., *"Basic Lubrication Theory"*, Ellis Horwood Ltd, Chichester, 1983.
- Majumdar B.C., *"Introduction to Tribology of Bearings"*, A. H. Wheeler & Co. Pvt. Ltd., Allahabad, 1999.
- Williams J.A., *"Engineering Tribology"*, Cambridge University Press, UK, 2005.
- Neale, M.J., *"Tribology Hand Book"*, Butterworth Heinemann, London, 1995.
- Stachowiak G. N., Batchelor A. W. and Stachowick G. B., *"Experimental Methods in Tribology"*, Tribology Series 44, Editor D Dowson, 2004.

## **II. MANUFACTURING**

#### **MME 4005: COMPOSITE MATERIALS [3 0 0 3]**

Introduction: Definition, classification, types of matrices & reinforcements, characteristics & selection. Micro mechanical analysis of a lamina: Introduction, derivation of stress, strain, modulus of elasticity of fiber reinforced composites. Manufacturing of polymer composites: Description of method, advantages, disadvantages and application. Metal matrix composites and ceramic matrix composites: reinforcement, matrix materials, base metal characteristics & selection, manufacturing and applications. Design issues and structural component design process. Application developments in aircrafts, missiles, space, automobile, electrical and electronics, marine, recreational and sports equipment's and construction.

#### **References:**

- Mein Schwartz, *"Composite Materials Handbook"*, McGraw Hill Book Company, 1984.
- Autar K. Kaw, *"Mechanics of Composite Materials"*, CRC Press, 2010.
- Mallik P.C., *"Fiber Reinforced Composites"*, Marcel Decker, 1993.
- Rober M. Jones, *"Mechanics of Composite Materials"*, McGraw Hill Kogakusha Ltd, 2008.
- Michael W, Hyer, *"Stress Analysis of Fiber Reinforced Composite Materials"*, McGraw Hill International, 1998.

#### **MME 4006: HEAT TREATMENT OF METALS AND ALLOYS [3 0 0 3]**

Introduction to Iron-Carbon equilibrium diagram & Fundamentals of heat treatment, decomposition of austenite, TTT diagram, Conventional case and Surface hardening treatments, factors affecting hardening, laser

hardening. Age hardening and Thermo-mechanical treatments for Aluminium and Non-Ferrous alloys, Ausforming, Isoforming, Thermo-mechanical annealing Steel specification, Classification and Application of steels and Cast iron with heat treatments, commercial steel, stainless steel, maraging steel, Malleabilization. Heat treatment and Application of non-ferrous metals and alloys defects, causes and remedies in heat treatment.

#### **References:**

- Rajan T. V., Sharma C P and Sharma Alok, *"Heat treatment principles and techniques"*, PHI Publication, 1999.
- Bolton W., *"Engineering Materials Technology"*, Heinmann Newness, 2001.
- Thelning K.E., *"Steel and its Heat Treatment"*, Butterworth/Heinemann, 2000.
- Romesh C Sharma, *"Principles of Heat Treatment of Steels"*, New Age International (P) Limited, 1996.
- Singh Vijendra, *"Heat Treatment of Metals"*, Standard Publishers Distributors, 2012.

#### **MME 4007: LEAN MANUFACTURING [3 0 0 3]**

Framework of Toyota Production System, Introduction to Value Stream Mapping, Characteristics of lean value stream. Introduction to Kanban, Kanban Team Formation, Data Collection, Determining the Kanban Size, Supplier Kanban, Finished Goods Kanban, EOQ vs Kanban Quantity, Production Smoothing, Shortening Production Lead Time, Multifunction Workers, Shortening Setup Time Concepts And Techniques, Organization Structure for Promoting Setup Time Reduction, Standardization of Operations, Yo-i-Don System, One Shot Setup, Determining The Standard Quantity of Work In Progress, Preparing The Standard Operation Sheet.

#### **References:**

- Monden Y, *"Toyota Production System: An Integrated Approach to Just-In-Time"*, (4e), CRC Press, 2011
- Rother M and Shook J, *"Learning to See: Value Stream Mapping to add Value and Eliminate Muda"*, The Lean Enterprise Institute, 1999
- Gross J M and McInnis K R, *"Kanban Made Simple: Demystifying and Applying Toyota's Legendary Manufacturing Process"*, AMACOM books, 2003
- Feld W M, *"Lean Manufacturing: Tools, Techniques and How to Use Them"*, CRC Press, 2001.
- Dailey K W, Wieckhorst D and Welch B, *"The Lean Manufacturing Pocket Handbook"*, DW Publishing, 2003

#### **MME 4008: MACHINE TOOL TECHNOLOGY [3 0 0 3]**

Working and Auxiliary motions in machine Tools, Parameters defining working motions of a machine tool, Machine tool drives-individual drive, Group drive, Mechanical Drives for providing rotational movements, Selection of range of spindle speeds, Typical layouts for intermediate spindle speeds, Construction of speed diagram, Layout of speeds in GP, Saw diagram of a GP series, Rules for layout of speed boxes having sliding clusters, Flow Diagram, Ray diagram, Types of Feed Gear Boxes, Functions and Requirements of machine tool structures, Profiles, Factors affecting stiffness of machine tool structures & Methods of improving it, Commonly used bed and column sections, Antifriction guide ways, Protecting devices, Spindles, Milling & Drilling machines, Antifriction bearings, Elimination of vibration, Machine tool chatter, Vibration isolated tool holders.

### References:

1. Mehta N K, "Machine Tool Design & Numerical control", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2012.
2. Sen and Bhattacharya, "Principles of Machine Tools", New Central Book Agency, Calcutta, 2001.
3. CMTI., "Machine Tool Design Handbook", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2004.
4. Basu S K, "Design of Machine Tools", Oxford & IBH, Delhi, 1989.
5. George Schlesinger, "Testing Machine Tools", Pergamon Press, Oxford, 1982.

## III. THERMAL ENGINEERING

### MME 4009: COMPUTATIONAL FLUID DYNAMICS [3 0 0 3]

Models of fluid flow: Continuity, Momentum and Energy equations in Cartesian coordinate system, General characteristic of the governing equations: The initial and boundary conditions, The format of the differential equation for the conservation: Discretization Process, Methods of deriving the discretized equations, Explicit Taylor series expansion, Application of the explicit finite difference technique to one dimensional steady state heat transfer in a rectangular fin, Unsteady conduction heat transfer: Explicit, Implicit and Crank Nicholson Methods, Discretization using control volume technique: The Four basic rules in control volume formulation, Discretization of source terms and linearization, The SIMPLE algorithms to solve flow problems: Staggered Grid, the derivation of the pressure correction equation as Poisson's Pressure equation, Implementation of boundary conditions in CFD.

### References:

1. John D Anderson Jr., "Computational Fluid Dynamics - The Basics with Applications", International Edition. McGraw Hill. New York, 1995.
2. Suhas V Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere / McGraw Hill, New York, 1980.
3. Versteeg H K and Malalasekera W, "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Longman Scientific & Technical. England, 1995.
4. Ghoshdastidar, "Computer Simulation of Flow and Heat Transfer", Tata- McGraw-Hill Book Company. New Delhi, 1998.
5. Muralidhar K and Sundararajan T, "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.

### MME 4010: DESIGN OF THERMAL POWER PLANT SYSTEMS [3 0 0 3]

Design of Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger Recuperative Air Pre Heater, Economizer, Boiler furnace design, Estimation of inside heat transfer coefficient using Jens & Lottes equation and Thom's correlation. Estimation of pressure drop in two phase flow using Thom's method, Super heater and Re-heater Design: Estimation of flow in each element of a tube assembly. Estimation of attenuation factor and direct radiation from furnace, Design of Steam Condenser-estimation of tube side velocity, surface area and pressure drop for various tube sizes & Plot the graph) and estimation of shell diameter of steam condenser, Design of Cooling Tower.

### References:

1. Kern D.Q., "Process Heat Transfer", McGraw-Hill Publications, 1965.
2. Ganapathy V., "Applied Heat Transfer", Penn Well Publishing Company, Tulsa, Oklahoma, 1982.

3. Sarit Kumar Das, Balakrishnan A R, "Process Heat Transfer", Alpha Science International, 2005.

### MME 4011: JET PROPULSION AND ROCKET TECHNOLOGY [3 0 0 3]

Jet Propulsion, Thrust equation, Efficiencies: Ram efficiency, thermal efficiency, propulsive efficiency, propeller efficiency. Propulsive Devices: turbo jet, turbo prop engine, turbo shaft engine, Ram jet, pulse jet, Rocket Propulsion, Principle of rocket propulsion, thrust equation, Criteria for Rocket-Motor Performance- specific impulse, total impulse, Chemical Rockets: Solid propellant rockets, types of solid propellant, burning rate, solid propellant grain configurations. Liquid propellant rockets, Feed systems and injectors. Gaseous propellant rockets, Developments in Rocket Technology: nuclear propulsion systems, Electrical propulsion and Hybrid rockets. .

### References:

1. Zucrow, "Aircraft and Missile Propulsion", Vol I and II, John Wiley, New York. 1958.
2. Jain J K, "Gas Turbine Theory and Jet Propulsion", (7e), Khanna Publishers. New Delhi, 1972.
3. Mathur M L and R P Sharma, "Gas Turbines and Jet Propulsion", Standard Publishers Distributors, Delhi, 2000.
4. Yahya S M, "Fundamentals of compressible flow with aircraft and rocket propulsion", New Age International Pvt.Ltd. New Delhi, 2004.
5. Ganesan V, "Gas Turbines", Tata McGraw-Hill, New Delhi. 2005.

### MME 4012: REFRIGERATION AND AIR CONDITIONING SYSTEMS [3 0 0 3]

Basic concepts and Air Refrigeration Cycles, Vapor Compression Refrigeration Systems, Vapor Absorption Refrigeration Systems, Compound vapour compression refrigeration system. Multi-evaporator and cascade systems, Classification of Refrigerants, Comparison of thermodynamic properties of refrigerants, Alternate Cooling Methods: Desiccant Cooling System, Solar Refrigeration, Thermo Electric Refrigeration, Analysis of Steam Jet Ejector Cycle, Refrigeration, Psychrometry, Psychrometric charts, Process involving Air-Vapour Mixtures, Air Conditioning Systems, Types of Air Conditioners, Load Estimation for inside and outside design conditions. Different types of heat loads.

### References:

1. Arora S.C.and Domkundwar S., "Course in Refrigeration and Air-conditioning", Danpath Rai. New Delhi, 1992
2. Cook Norman, "Refrigeration and Air conditioning", Macmillan London, 1995
3. Stocker W.F., "Refrigeration and Air conditioning", Tata McGraw Hill, 1978
4. Prasad Manohar, "Refrigeration and Air conditioning", New Age International Pvt. Limited. New Delhi, 2004
5. Gauger D. C., Shapiro H. N., Pate M. B., "Alternative Technologies for Refrigeration and Air Conditioning Applications", Springfield, Washigton DC, 2008

## IV. BUSINESS MANAGEMENT

### HUM 4011: FINANCIAL MANAGEMENT [2 1 0 3]

Introduction to financial management, Principle of accountancy, Sources of long term finance, Valuation of securities, Leverages, Working capital management, Capital budgeting, Cost of capital, Cash management, and Dividend decisions.

#### References:

1. Prasanna Chandra, "Fundamentals of Financial Management", Tata McGraw Hill, Delhi, 2006.
2. Pandey I M, "Financial Management", Vikas Publishing house, Delhi, 2007.
3. Subir Kumar Banerjee, "Financial Management", Sultan Chand & Co., Delhi, 1999.
4. ICFAI, "Corporate Financial Management", ICFAI, Hyderabad, 2003.
5. Maheshwari S.N, "Financial Management", Sultan Chand & Co., Delhi, 2002.

#### HUM 4012: HUMAN RESOURCE MANAGEMENT [2 1 0 3]

Evolution and development, HRD Organization and responsibilities. Evolution of HRM, Theories of HRM. Human resource planning, Human Resources Inventory, Forecast, Job analysis, Job description, Job specification, Job evaluation, Employment stability. Human Resource Planning and Recruiting, Induction, & socialization, Training and development, Performance management and appraisal.

#### References:

1. Rao T V and Pereira D F, "Recent experiences in Human Resources Development", Oxford and IBH Publishing, 1986.
2. Subba Rao A, "Essentials of Human Resource Management and Industrial Relations", Himalaya Publishing House, 1999.
3. Nair N. G. and Latha Nair, "Personnel Management and Industrial Relations", S. Chand Company, 1999.
4. Virmani B R; Rao Kala, "Economic restructuring technology transfer and human resource development", Response books, 1997.
5. Pareek Udai et al, "Human Resource Development in Asia: Trends and Challenges", Oxford and IBH Publishing, 2002.

#### HUM 4013: MARKETING MANAGEMENT [2 1 0 3]

Understanding marketing management, Assessing market opportunities and customer value, Adapting marketing to the New Economy, Building Customer Satisfaction, Value, and Retention, Market Demand, Scanning the Marketing Environment, Consumer Markets, Business Markets, Dealing with the Competition, Market Segments, Product Life Cycle, New Market Offerings, Designing and Managing Services, Price Strategies, Retailing, Wholesaling, Integrated Marketing Communications.

#### References:

1. Philip Kotler, "Marketing Management Analysis, Planning, Implementation and Control", Prentice Hall of India Private Limited, New Delhi, 2000.
2. ICFAI, "Marketing Management", ICFAI, Hyderabad, 2003.
3. Varshney R L and Gupta S L, "Marketing Management", Sultan Chand & Sons, New Delhi, 2004.
4. Adrian Palmer, "Principles of Marketing", Oxford University Press, New York, 2000.

#### HUM 4014: OPERATIONS AND SYSTEMS MANAGEMENT [2 1 0 3]

Types of production activities, Production consumption cycle, Functions of production and operations management, Importance and uses of forecasting, Product development and design: Product life cycle, Process design, Process charts, Flow diagrams and Man machine charts, Capacity planning, Aggregate planning, Scheduling, Operations strategy, Operation performance Frontier and productivity, Systems thinking, Systems engineering and its management, Systems decision process. Systems thinking, structure, classification, boundaries, visibility, System

life cycle models, System dynamics and its importance in system thinking. System dynamics modeling process.

#### References:

1. Monks Joseph G, "Operations Management", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2004.
2. Krajewski Lee J. and Ritzman Larry P, "Operations Management", Pearson Education (Singapore) Pte. Ltd., Delhi, 2005.
3. Miegheem J, "Operations Strategy: Principles and Practices, Dynamic Ideas", ISBN: 0-9759146-6-9, 2008.
4. Sterman J D, "Business Dynamics - Systems Thinking and Modeling for A Complex World", McGraw Hill, International Edition, 2004.
5. Senge Peter, "The Fifth Discipline, Currency Doubleday", New York, 1990.

### OTHER PROGRAM ELECTIVES

#### MME 4013: ALTERNATIVE FUELS FOR ENGINES [3 0 0 3]

Introduction to alternative fuels, Need for alternative fuels - Availability of different alternative fuels for SI and CI engines. Properties of potential alternative fuels, Liquid Fuels for SI Engines, Requirements of fuels for SI engines-Different Techniques of utilizing alternative liquid fuels Blends, Neat form, Reformed fuels - Manufacturing, Storage and Safety-Performance and emission characteristics of alternative liquid fuels, Liquid Fuels in CI Engines, Requirements of fuels for CI engines- Different techniques for their utilization- Blends, Fuel modifications to suit CI engines, Dual fuelling, Ignition accelerators and other additives, Gaseous Fuels in SI Engines, Gaseous Fuels in CI Engines, Electrical Vehicles.

#### References:

1. Ramadhas A S, "Alternative Fuels for Transportation", CRC Press, Taylor & Francis Group, 2010.
2. Thipse S S, "Alternative Fuels: Concepts, Technologies and Developments", Jaico Book Distributors, 2010.
3. Gajendra Babu M K, "Alternative Transportation Fuels: Utilization in Combustion Engines", CRC Press, Taylor & Francis Group, 2010.
4. Michael F. Hordiski, "Alternative Fuels: The Future of Hydrogen", The Fairmont Press, 2008.
5. James D. Halderman, "Hybrid and Alternative Fuel Vehicles", (2e), Prentice Hall, 2010.

#### MME 4014: AUTOMATIC CONTROL ENGINEERING [3 0 0 3]

The course Automatic control engineering mainly deals with the application of automatic control in various systems like temperature control system, water level control system, flow control system etc. These physical systems can mathematically modelled and many physically different systems have the same mathematical model. The advantage of such mathematical models is that these can be solved easily and system stability can be ascertained using mathematical models. In addition, the selection of proper system parameters for safety of a control system can be demonstrated through various plots like Nyquist and Bode plots. Digital control systems play a very important role in handling multi variate systems which can be modelled using state space representation.

#### References:

1. Harrison H.L. and Bollinger J.G., "Automatic controls", (2e), International Text Book Co. U.S.A, 1968.
2. Raven, "Automatic Control Engineering", McGraw Hill, U.S.A, 1995.

3. Benjamin Kuo, C., "Automatic Control Systems EEE", (7e), Prentice Hall of India Ltd. New Delhi, 1995.
4. Verma S.N., "Automatic Control Systems", Khanna Publishers, Delhi, 1990.
5. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Ltd., New Delhi, 2004.

#### **MME 4015: CORROSION SCIENCE AND ENGINEERING [3 0 0 3]**

Definitions, Corrosive Environments, Consequences of Corrosion, Cost of Corrosion, Corrosion Science and Corrosion Engineering, Fundamental aspects of Corrosion. Corrosion Cell, Cathodic and Anodic Reactions, Types of Corrosion Cells, Reference Electrode, Calomel Electrode, Pourbaix Diagrams. Corrosion Rate Expressions, Electro-Chemical nature of Aqueous Corrosion, Polarization, Factors influencing Corrosion Rate. Types of Corrosion, Measuring Polarization, Anodic Polarization, Cathodic Polarization, Activation Polarization and Concentration Polarization. Corrosion Prevention, Materials Selection, Alteration of Environments, Design, Cathodic and Anodic Protection, Corrosion Inhibitors, Coatings. Methods used to determine Corrosion Rate, Weight Loss Measurements, Linear Polarization, Tafel Extrapolation Techniques.

#### **References:**

1. Ahmed Zaki, "Principles of corrosion Engineering and corrosion control", Elsevier science and technology Books, 2006.
2. Mars G. Fontana, "Corrosion Engineering", (3e), Tata McGraw Hill, 2008.
3. Trethewey K. R. and Longman J. Chamberlain, "Corrosion for Students of Science and Engineering", Scientific and Technical, 1988.
4. Schweitzer A Philip, "Fundamentals of corrosion-Mechanisms, Causes and preventive methods", CRC Press, Taylor and Francis Group, 2010.
5. Uhlig H. H. and Revie R. W., "Corrosion and Corrosion Control", Wiley, 1985.

#### **MME 4016: ELEMENTS OF MECHATRONICS SYSTEMS [3 0 0 3]**

Introduction: Definition, basic concepts and elements of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors, Transducers: Displacement. Piezoelectric actuators, Shape memory alloys. Hydraulic & Pneumatic devices Power supplies, valves, cylinder sequencing. Data acquisition and translation: Signal conditioning Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Pulse width Modulation Counters, decoders, ADC, DAC Signal Analysis - Linearization of data, Compensation, Signal Averaging, Fourier analysis. Data presentation system: Display - Cathode ray oscilloscope, LED, LCD, Printers, Magnetic Recording, Controllers and Algorithms: Microprocessor Applications.

#### **References:**

1. Alciatore David G & Hystand Michael B, "Introduction to Mechatronics and Measurement systems", Tata McGraw Hill, 2003.
2. Boltan W, "Mechatronics", Addison Wesley Longman Ltd, 1999.
3. Devdas Shetty & Richard Kolk, "Mechatronics System Design", PWS Publishing, 2001
4. Dan Nesculescu, "Mechatronics", Pearson Education Pvt. Ltd, 2002.
5. Bradley D A and others, "Mechatronics", Nelson Thornes Chennai, 2004.

#### **MME 4017: FLUID DRIVES AND CONTROL [3 0 0 3]**

Structure and signal flow of pneumatic system, basic components, pneumatic actuators: direction and flow control valves, symbols of pneumatic valves, traverse time diagram. Design of manually operated circuits, control of multiple actuators, structure of electro pneumatics circuits, types of sensors, electrically actuated direction control valves, relay control systems. Design of electro pneumatic circuits, basic concepts of PLC. Structure of hydraulic circuit, Pascal's law, force transmission in hydraulics, power pack and accessories, hydraulic fluids, filters, hydraulic pumps and actuators. Calculation of force, speed, power developed. Pipes and fittings, accumulators, construction and working of direction, pressure and flow control valves, proportional and Servo valves. Applications in regenerative meter in, meter out, bleed off, sequencing, pressure reducing circuits, electro hydraulic circuits.

#### **References:**

1. Peter Croser and Frank Ebel, "Pneumatics Basic Level TP 101", Festo Didactic GMBH & Co, Germany, 2002.
2. Prede G. and Scholz D., "Electropneumatics Basic Level", Festo Didactic GMBH & Co, Germany, 2002.
3. Hasebrink J. P. and Kobler R., "Fundamentals of Pneumatic Control Engineering", Festo Didactic GMBH & Co, Germany, 2002.
4. Peter Rohner, "Industrial Hydraulic Control", John Wiley & Sons, Brisbane, 1989.
5. Majumdar S. R., "Oil Hydraulic Systems Principles and Maintenance", Tata McGraw Hill, New Delhi, 2005.

#### **MME 4018: FRICTION AND WEAR [3 0 0 3]**

Influence of material properties, rolling friction, Measurement of friction, friction coefficient values. Mechanism of adhesive wear, shapes of transferred and loose wear particles, size distribution of wear fragments, quantitative laws of adhesive wear, wear coefficients, Abrasive wear, Corrosive wear, Impact wear, Hydrodynamic, hydrostatic and elasto-hydrodynamic lubrication, solid film lubrication, boundary lubrication single penetration and multiple penetration models. Effectiveness of liquid lubricant and solid lubricant. Rebuilding and surfacing cements, wear tiles, electro spark deposition coatings, fused carbide cloth, thermal/chemical deposited ceramic coatings, centrifugal cast wear coatings, wear sleeves, wear plates.

#### **References:**

1. Rabinowicz E, "Friction and Wear of Materials", John Wiley & Sons, Inc., 1995.
2. Bharat Bhushan, "Principles and applications of Tribology", John Wiley & Sons Inc., 1999.
3. Arnell R D, Davies P B, Halling J & Whomes T L, "Tribology: Principles and design applications", Macmillan Education Ltd, 1991.
4. Kragelsky I V, "Friction Wear Lubrication Tribology hand book", vol 1, 2 & 3, MIR Publishers, 1981.
5. Majumdar B. C., "Tribology of Bearings", Wheeler Publisher, 1990.

#### **MME 4019: INDUSTRIAL ROBOTICS [3 0 0 3]**

Definition of Robots; Types of Robots; Robot Configuration; Selection of Robots; factor affecting the control resolution, Spatial resolution, Accuracy and repeatability, Specification of a robot, Robot arm/manipulator Kinematics, Types of Grippers; Force Analysis of gripper mechanism; Classification of Actuators; Actuators used in Robots - DC motors, Stepper motors, AC motors and Servo motors, Robot Transmission Systems; Sensors; Types and classification of robot sensors, Positional potentiometer, Velocity tachometer, Working

of resolver, Optical encoder, Magneto resistive skin, Hall generator, Electro-magnetic & Adhesive end effectors, proximity sensors; Tactile Sensing; Robot Vision.

**References:**

1. Janakiraman P. A., "Robotics and Image Processing", Tata McGraw Hill, 1995.
2. Groover M.P., "Industrial Robotics", PHI, 2008.
3. Jain K.C., Aggarwal L.N., "Robotics Principles and Practice", Khanna Publishers, 1997.
4. Fu, Gonzalez and Lee, "Robotics: Control, Sensing, Vision and Intelligence", Tata McGrawHill, 2008.
5. Hegde Ganesh S, "A textbook on Industrial Robotics", Laxmi Publications (P) Ltd, 2006.

**MME 4020: INTRODUCTION TO COMBUSTION [3 0 0 3]**

Introduction to combustion deals with the history of combustion modes, flames, types of fuels and their properties. The thermo-chemistry of combustion, property relations, first law of thermodynamics, reactants and product mixtures, stoichiometry, Adiabatic flame temperature, chemical equilibrium, the products of combustion. Basics of mass transfer related law and species conservation. The fundamentals of Chemical kinetics, important chemical mechanisms and Simplified conservation equations for reacting flows, laminar premixed flames, flame velocity thickness of flame, flame stabilization Laminar diffusion flames and turbulent flames. Droplet evaporation and burning, applications and simple models of droplet evaporation burning. The impact on environment due to combustion, emissions from combustion processes.

**References:**

1. Stephen R. Turns, "An Introduction to Combustion, Concepts and Applications", (2e), McGraw- Hill, 2000.
2. Mishra D.P., "Fundamentals of Combustion", PHI Learning Private Limited New Delhi, 2010.
3. Sharma, S.P. and Mohan, C., "Fuels and Combustion", Tata McGraw-Hill, 1987.
4. Sarkar. S., "Fuels and Combustion", Orient Longman, 2005.
5. Mukunda H.S., "Understanding of Combustion", McMillan India Ltd, New Delhi 1989.

**MME 4021: MATERIALS CHARACTERIZATION [3 0 0 3]**

Basic physical and mechanical properties of materials, X-ray Diffraction Methods, X-ray Radiation, Generation of X-rays, Distortions of Diffraction Spectra, Wide Angle X-ray Diffraction and Scattering, Microscopic material characterization, Light Microscopy - Optical Principles, Image Formation, Resolution, Depth of Field, Aberrations, Instrumentation, illumination system. Confocal microscopy, Scanning Electron Microscopy. Contrast formation, electron specimen Interactions, preparation for micro-composition examination, Transmission Electron Microscopy, Selected Area Diffraction Characteristics, Single-Crystal Diffraction, Multi-Crystal Diffraction, Kikuchi Lines. Images of Crystal Defects, Wedge Fringe, Bending Contours, Dislocations. Differential Thermal Analysis and Differential Scanning Calorimetry, Thermogravimetry, interpretation of TG curves.

**References:**

1. Yang Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", John Wiley & Sons (Asia) Pvt. Ltd, Singapore, 2008.
2. Sam Zhang, Lin Li, Ashok Kumar, "Materials Characterization Techniques", CRC Press, 2008.

**MME 4022: MEMS AND NANOTECHNOLOGY [3 0 0 3]**

General methods of preparation of nanoparticles, Carbon nanostructures and their Applications. Nanosized Structures, Physical chemistry of nanosystems, Nanoparticles, Nanowires and Nanorods, Thin films- Self assembled monolayers, Experimental techniques- Temperature measurement techniques, Atomic Force Microscopy, Scanning Tunneling Microscopy, Spectroscopy and Diffraction techniques. Micro Electro Mechanical Systems, MEMS, Micro and Nanoscale Thermal Engineering, Nanofluids preparation and Characterization, Properties of nanofluids, Nanomaterials used in energy and Environmental applications and their Properties. Device applications in hydrogen storage and Production, Fuel cells, Battery, Solar energy conversion, Waste water treatment, Pollution remedies, Nanomaterials in automobiles. Challenges and Scope.

**References:**

1. Charles P Poole, "Introduction to Nanotechnology", Wiley- Interscience Publication, 2003.
2. Guozhong Cao, "Nanostructures & Nanomaterials", Imperial College Press, 2004.
3. Sobhan C B, "Microscale and Nanoscale Heat Transfer", Taylor and Francis Publication, 2008.
4. Mohamed Gad-el-Hak, "The MEMS Handbook", Taylor and Francis Publication, 2005.
5. James J Allen, "MEMS Design", Taylor and Francis Publication, 2005.

**MME 4023: MICRO MACHINING [3 0 0 3]**

Micromachining, Traditional Micromachining Processes, Materials for micromachining, Advanced Micromachining and Nanofinishing, Abrasive Water Jet Micromachining (AWJMM), Ultrasonic Micromachining (USMM), Abrasive Jet Micromachining (AJMM), Thermoelectric Advanced Micromachining, Electric Discharge Micromachining (EDM), Electric Discharge Grinding (EDG) And Electric Discharge Diamond Grinding (EDDG), Wire Electric Discharge Micromachining, Laser Beam Micromachining, Electron Beam Micromachining. Electrochemical and Chemical Advanced Machining, Chemical Micromachining (ChMM). Wafer bonding- Anodic bonding, Fusion bonding, CVD and PVD processes, Spin coating, Evaporation and Epitaxy, Laser ablation technique. Bulk and Surface Micromachining Techniques, Micromachining Tools.

**References:**

1. Jain V. K., "Introduction to Micromachining", Narosa Publishers, New Delhi, 2010.
2. Jain V. K., "Advanced Machining Processes", Allied Publishers Private Limited, New Delhi, 2009.
3. Mojtaba Kahrizi, "Micromachining Techniques for Fabrication of Micro and Nano Structures", Intech, 2012

**MME 4024: NON DESTRUCTIVE TESTING [3 0 0 3]**

NDE in Design, Maintenance and Service, Benefits of NDE, Choosing the NDE technique, Qualifications of NDE personnel, Penetrant Inspections, penetrant testing materials and processes, penetrant testing methods and systems, sensitivity, standards, Magnetic Particle Testing, Ultrasonic Testing, Elastic wave propagation, Ultrasonic Transducers, Criteria for probe selection, Inspection techniques, ultrasonic techniques for stress measurement and material studies, Radiographic Techniques, electromagnetic radiation sources, properties of X- and gamma rays. Radiographic imaging, Radiographic inspection techniques, radiographic inspection systems, Eddy Current



Testing (ECT), 3D or phased array ECT. Acoustic Emission Testing, Thermography, impact echo method of testing, phased array techniques, laser testing methods, vibration testing and analysis methods.

#### References:

1. Don E Bray and Roderic K Stanley, "Nondestructive Evaluation: A Tool in Design, Manufacturing and Service", Taylor and Francis Group, London, 1997.
2. Paul E Mix, "Introduction to Nondestructive Testing-A training Guide", (2e), John Wiley and Sons, Inc, 2005.
3. Davis Joseph R., "ASM Handbook: Volume 17, Nondestructive Evaluation and Quality Control", ASM International Materials Park, OH.
4. ASNT (Edited), "Materials and Processes for NDT Technology", ASNT, USA, 1981.
5. Ensminger Dale, "Ultrasonics: Fundamentals, Technology, Application", (2e), Marcel Dekker, New York, 1988.

#### MME 4025: NON - CONVENTIONAL ENERGY SOURCES [3 0 0 3]

Forms of energy, Energy sources, Need for renewable energy sources, Thermal applications of solar energy, Measurement of solar radiation, Empirical equations for predicting the availability of solar radiation, solar radiations on tilted surface, flat plate collector, Performance analysis, Transmissivity of cover systems, Transmissivity - absorptivity product, Collector efficiency factor and Heat removal factor, Principles of wind power, Total power, maximum power (Betz theory), Actual power, Types of windmill, Ocean energy, Tidal energy, Tidal energy conversion by single pool system and two pool system, Principle of OTEC, Small scale Hydel Plant, Geothermal energy conversion, Biomass energy, Influencing factors for the generation of biogas, Types of biogas plants, Direct energy conversion, Thermo- ionic converters, MHD generators, Types of MHD converters.

#### References:

1. Sukatme S. P., "Solar Energy Principles of Thermal Collection and Storage", Tata Mc Graw Hill, 2005.
2. El-Wakil M M, "Power plant Technology", McGraw Hill International, 1984.
3. Rai G. D., "Non-conventional Energy Sources", Khanna Publications, 1997.
4. Rao S and Dr. Parulekar B. B., "Energy Technology", Khanna Publishers, 2004.
5. Culp A.W., "Principles of Energy Conversion", McGraw Hill International, 2001.

#### MME 4026: OPERATIONS RESEARCH [3 0 0 3]

The subject covers definition, phases, applications, advantages and disadvantages of operations research. Linear programming problems (LPP) are formulated and solved using graphical and simplex methods and post optimality analysis conducted. The special cases of LPP include transportation and assignment problems along with travelling salesman problem. Game theory and various methods, waiting line models and simulation. Poisson arrival rate and Exponential service times, System characteristics, Problems on the models- (M/M/1): (M/M/1) : (N/FIFO), Simulation of queuing models, Network model analysis using Critical Path Method (CPM) and Project Evaluation & Review Technique (PERT). Determination of probability/expectation of project completion.

#### References:

1. Taha H. A., "Operations Research", (7e), Pearson Education, 2002.
2. Winston W.L., "Operations Research", Thomson Asia, 2003.
3. Vohra N. D., "Quantitative Techniques in Management", 2007.

4. Sharma S. D., "Operations Research", (14e), KedarNathRamnath Publications, 2005.
5. Kanthiswaroop, Gupta and Manmohan, "Operations Research", Sultan Chand and Sons, 2003.

#### MME 4027: ORGANIZATIONAL BEHAVIOR [3 0 0 3]

Contributing disciplines to OB, Basic OB Model. Learning, Methods of shaping behavior, Values, Attitudes and Job satisfaction, Personality, Determinants of Personality, Personality theories, Major personality attributes, Perception Attribution Theory, Selective perception, Halo effect, Contrast effect, Stereo-typing. Maslow's hierarchy of needs, Theory X and Theory Y, Frederick Herzberg's Motivation and Hygiene Theory, Contemporary Theories, Group Dynamics, Group Behaviour Model, Quality of a good leader, types and theories of leadership. Conflict, Dimensions of Conflict Handling Intentions, Virtual Organisation, Boundary less Organisation, Mechanistic and Organic Model, Factors influencing organisation structure. Work Design, Organisational Change and Organisational Development, Lewin's Three-Step Model and Action research. Organisational Development.

#### References:

1. Luthans Fred, "Organisational Behaviour", McGraw Hill, New York, 1989.
2. Gupta Rakesh, "Organisational Behaviour", Kitab Mahal, Allahabad, 1998.
3. Davis Keith and Newstrom J.W., "Organisational Behaviour at Work", Tata-McGraw Hill, New Delhi, 1997.
4. Moorhead Gregorey and Griffin Ricky W., "Organisational Behaviour", AITBS, New Delhi, 1999.
5. Carrel Michael R., "Fundamentals of Organisational Behaviour", Prentice Hall, New Jersey, 1997.

#### MME 4028: PERSONNEL MANAGEMENT AND INDUSTRIAL RELATIONS [3 0 0 3]

Objectives of personnel management, Functions of Personnel Management, Process of Human Resource Planning, Steps in recruitment process, Sources of recruitment, methods of recruitment. Promotions, Demotions, Transfers, Separation, Absenteeism and Turn over, Wage and Salary administration, Performance Appraisal, Methods of Performance evaluation. Industrial Relations: Functional Requirements, Employees participation in management. Grievances and Grievance Handling, Act of Indiscipline/ Misconduct, Principles for maintenance of discipline. Industrial Disputes, Procedure for the Settlement of Disputes, Government and Industrial Relations, Organs of Industrial Peace. Trade Unions: Objectives and Functions, Growth of Trade Union Movement, Factors Affecting Growth of Trade Unions, Essentials of a Successful Trade Union.

#### References:

1. Mamoria, C.B., "Personnel Management", Himalaya Publishing House, 2007
2. Megginson, Leon C., "Personnel and Human Resource Administration", 1977
3. Beach, D.S., "Personnel: The Management of People At Work", 1977.
4. Yoder and Dale, "Personnel Management and Industrial Relations", 1972.

#### MME 4029: PLANT ENGINEERING AND MAINTENANCE [3 0 0 3]

Introduction to Industrial Building, Building maintenance and repairs, Hardener/sealers, Floor paints, Functions of coating, Constituents of

paint, Ventilation systems and control, Requirement of water, Building services, Water purification processes, Membrane processes, Effluents. Measurement of noise, Vibration, Noise and Vibration control, Nature of dust and fumes, Legislation on air pollution concern to the plant engineer. Challenges in maintenance, Responsibilities of the maintenance department, Reliability centered maintenance, Total productive maintenance, Planning of maintenance function, Estimation of maintenance work, Maintenance control, Maintenance scheduling, Maintenance cost, Maintenance budgeting and cost control. Condition Monitoring, Condition monitoring levels, Techniques of condition monitoring, Future scope of condition monitoring.

#### References:

1. Mobley K. R., "Plant Engineer's Handbook", Butterworth-Heinemann, Woburn, 2001.
2. Snow A. D., "Plant Engineer's Reference Book", Butterworth-Heinemann, Woburn, 2000.
3. Mobely, Higgins and Wikoff, "Maintenance Engineering Handbook", McGraw-Hill, 2008.
4. Mishra and Pathak, "Maintenance Engineering and Management", PHI Learning Pvt. Ltd., 2012.
5. Jyoti Mehrotra, "Principles and Practice of Total Productive Maintenance", Allied Publishers Ltd., 1998.

#### MME 4030: PLANT LAYOUT AND MATERIAL HANDLING [3 0 0 3]

Principle of plant layout, product, process and combination layout, economics of different types of layout. Factors influencing the layout-manpower, movement, service, material, machinery, waiting, building and change factors, location of storages & delay point. Layout planning-scientific approach, flow process chart, cross chart, string diagram, line balancing, templates evaluation of layout, installation of layout, computerized layout planning. Material handling- principles of material handling, factors in selection of material handling equipment, safety in material handling, types of material handling equipment, modern material handling equipment.

#### References:

1. Buffa E. S. and Rakesh S. K., "Modern Production and Operation Management", John Wiley & Sons, New York, 2003.
2. Richard M., "Practical Plant Layout", McGraw-Hill, New York, 1955.
3. James Apple M., "Plant Layout and Material Handling", John Wiley, New York, 1977.
4. Mathew P. Stephens and Fred E. Meyers, "Manufacturing Facilities Design & Material Handling", (5e), Purdue University Press, 2013.
5. David E. Mulcahy, "Materials Handling Handbook", McGraw Hill Professional, 1998.

#### MME 4031: POWER PLANT ENGINEERING [3 0 0 3]

Choice of site for power station, load estimation, load duration curve, effect of variable load on power plant, Economics of power generation. Hydro-Electric plants, Storage and pondage, flow duration and mass curves, hydrographs, Different types of fuels used for steam generation. Equipments for burning coal in lump form, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace. Coal and ash handling. Dust collection systems-Electrostatic Precipitator. Accessories for the steam generator such as super-heaters, de-super-heaters, control of super-heaters, economizers, Air Pre-heaters and re-heaters. Cooling towers and ponds, General arrangement of Diesel Power Plant. Gas Turbine Power Plant, Principles of release of nuclear energy. Fusion and fission reactions, Waste disposal.

#### References:

1. Rajput R K, "Power Plant Engineering", Laxmi Publication (P) Ltd, 2010
2. Nag P K, "Power Plant Engineering", Tata McGraw Hill Publishing Co. Ltd, 2008.
3. Nagpal G R, "Power Plant Engineering", Khanna Publishers, 2008.
4. Skrotzki and Vopat, 'Power Station Engineering Economy', McGraw Hill Book Co.
5. Wrangham D.A., "Theory and Practice of Heat Engines", ELBS Edition.

#### MME 4032: PROJECT MANAGEMENT [3 0 0 3]

Concept of project, Project life cycle, organizing projects within the functional organization, organizing projects as dedicated teams, organizing projects within a matrix arrangement, Project manager and their attributes. Feasibility study, Pre-feasibility study, Steps of feasibility study. Estimating project times and costs, Factors influencing the quality of estimates, Top-down approaches of estimation, Bottom-up approaches of estimation, Hybrid approach of estimation. Risk management process, Risk Assessment - probability analysis, Contingency planning, Contingency funding and time buffers, Risk response control, Project scheduling, Bar charts and Milestone charts, Development of networks, Work Breakdown Structure, Program Evaluation and Review Technique, Project audit and closure, Audit reporting, Evaluation of project team and members.

#### References:

1. Gray C., Larson E. and Desai G., "Project Management The Managerial Process", Tata McGraw Hill Pvt. Ltd., New Delhi, 2013.
2. Paneerselvam R. and Senthilkumar P., "Project Management", PHI Learning Pvt. Ltd., New Delhi, 2010.
3. Chandra P., "Projects Planning, Analysis, Selection, Financing, Implementation and Review", Tata McGraw Hill Pvt. Ltd., New Delhi, 2009.
4. Choudhry S., "Project Management", Tata McGraw Hill Publishing Co. Ltd. New Delhi., 1997.
5. Punmia B. and Khandelwal K., "Project Planning and Control with PERT and CPM", Laxmi Publications Pvt. Ltd., New Delhi, 2006.

#### MME 4033: STATISTICAL QUALITY CONTROL [3 0 0 3]

Inspection and quality control, Organization for quality, The Normal distribution curve, Tchebyeff's and Camp-Meidells inequality theorems, Shewhart's bowl drawing experiments, Control charts for variables, Interpreting patterns of variation on control charts for variables, Type I and Type II Errors, Process capability analysis, Control charts for attributes, Control chart for number of non-conformities per unit. Acceptance sampling by attributes, Acceptable quality level, Lot tolerance percent defective, AOQ curve, AOQL, Average total Inspection, Average fraction inspected, Producers risk, Consumers risk, Acceptance sampling tables. Specifications and Tolerances, Conventional and Statistical tolerancing, Precision, Accuracy and Reproducibility of method of measurements, Quality costs.

#### References:

1. Grant E. L and Levenworth R., "Statistical Quality Control", McGraw Hill Publications, New York, 2005.
2. Montgomery D.C., "Introduction to Statistical Quality Control", John Wiley and Sons, New York, 2005.
3. Juran J.M. and Gryna F.M., "Quality Planning and Analysis", Tata McGraw Hill Publications, Delhi, 1995.

- Bertrand L. Hansen, "Quality Control- Theory and Applications", Prentice Hall India, Delhi, 1987.
- Duncan, A.J., "Quality Control and Industrial Statistics", Irwin Press, New York, 1970

#### **MME 4034: SUPPLY CHAIN AND LOGISTICS MANAGEMENT [3 0 0 3]**

Objective of a supply chain, Decision phases in a supply chain, Process view of a supply chain, Role of distribution in the supply chain, Design options for a distribution network, Factors influencing network design decisions, Role of IT in network design, Making network design decisions in practice, Transportation infrastructures and policies, Tailored Transportation, Sourcing Decisions, In-house outsource, Third and fourth party logistics providers, Supply scoring and assessment, Supplier selection, Sourcing planning and analysis, Pricing and Revenue management, Pricing and revenue management for multiple customer segments, pricing and revenue management for perishable assets, Information Technology, Customer relationship management, Internal supply chain management, Supplier relationship management, Transaction management foundation.

##### **References:**

- Chopra and Meindl., "Supply Chain Management Strategy, Planning and Operation", (3e), Pearson Education, New Delhi, 2009.
- Raghuram and Rangaraj, "Logistics and Supply Chain Management: Cases and Concepts", Macmillan, New Delhi, 2000.
- Simchi-Levi and Kaminski, "Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies", McGraw-Hill, 2003.
- Shapiro J., "Modelling the Supply Chain", Duxbury Thomson Learning, U.S.A., 2009.

#### **MME 4035: TECHNOLOGY MANAGEMENT [3 0 0 3]**

Management of technology, system model, integrated and holistic model, Timing and innovation, technology and competition, Entrepreneurs and innovation, entrepreneurship in corporations, entrepreneurship, organizational barriers to innovation, venture team. Business plans for new ventures, successful product innovation, sources of venture capital, Growth of new firms, Dynamics of new firms, corporate systems, dynamic factors affecting growth, Innovation Process, Forecasting Technology, Form of technology change, S-curve jumps from radical to system innovation, Technology life cycle, economic long cycles, Kondratieff waves, Technology and marketing, Sources of innovation, market pull and technology push, Corporate research, Project strategy, sales volume and profitability in product life time, R&D projects, production costs, market share, profit margin.

##### **References:**

- Gearard H Gaynor, "Handbook of Technology Management", McGraw Hill International Edition, 1996.
- Betz Frederick, "Managing Technology", John Wiley & Sons, 2011.
- Steele Lowell W and Badaww Michel K., "Managing Technology",
- Narayanan V. K., "Managing Technology and Innovation for Competitive Advantage", Prentice Hall, 2001.
- Rungachari Krishna, Chari C. P., "Technology Management and Business Development".

#### **MME 4036: THEORY OF INTERNAL COMBUSTION ENGINES AND EMISSIONS [3 0 0 3]**

Introduction to IC engines, Idealized cycles, Fuel air cycles and actual cycles, modes of combustion, Stoichiometry, heat of formation, adiabatic flame temperature, chemical equilibrium, ignition limits. IC

engine fuels: conventional and non-conventional fuels and their analysis. Petroleum refining processes and products, Qualities of SI and CI engine fuels and their ratings, alternative fuels: Alcohols, LPG, CNG, Hydrogen, Vegetable oils. Stages of combustion in SI and CI engines: Normal and abnormal combustion, Principle of combustion chamber design for SI and CI engines. Rotary engine, CRDI, MPFI, TBI and GDI systems, Dual fuel engines and stratified charge engines. IC engine pollutant formation, evaporative emissions, cranks case emissions and tail pipe emissions, Exhaust emission control methods- ammonia injection. EGR and positive crank case ventilation.

##### **References:**

- Ganeshan V., "Internal Combustion Engines", (3e), Tata McGraw Hill Education Private Limited, New Delhi, 2007.
- Mathur and Sharma, "A Course in I C Engines", Dhanpath Rai Publishers, New Delhi, 1981.
- John B. Heywood, "Introduction to Internal Combustion Engines", Tata McGraw Hill Education Private Limited, New Delhi, 2011.
- Lichty L.C., "International Combustion Engines", McGraw Hill, New Delhi, 1951.
- Edward F. Obert, "Internal Combustion Engines and Air Pollution", Harper & Row, Publishers. Delhi, 1973.

#### **MME 4037: TOTAL QUALITY MANAGEMENT [3 0 0 3]**

Dimensions of Quality, Quality Planning, Quality costs Analysis, Techniques for Quality Costs, Basic concepts of Total Quality Management. Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation, TQM Principles, Customer satisfaction and Retention, Employee Involvement - Motivation, Empowerment teams, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure, TQM Tools, Benchmarking Process, Quality Function Deployment, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) - Concept of six sigma, ISO 9000:2000 Quality System - Elements, Implementation, Quality Auditing, QS 9000, ISO 14000.

##### **References:**

- Besterfield Dale H., "Total Quality Management", Pearson Education, Delhi, 2006.
- James R. Evans & William M. Lindsay, "The Management and Control of Quality", (5e), South-Western Thomson Learning, 2002.
- Oakland John S., "Total Quality Management text with Cases", Elsevier, New Delhi, 2006.
- Besterfield Dale H., "Total Quality Management", Pearson Education, Delhi, 2012.
- Zeiri, "Total Quality Management for Engineers", Aditya Books, Delhi, 1992.

#### **MME 4038: WORK SYSTEMS ENGINEERING [3 0 0 3]**

Productivity and work study, Productivity in the individual enterprise, Factors tending to reduce productivity, Techniques for reducing excess work content and ineffective time, Work study, Method study, Flow process charts, Flow diagram, Multiple activity chart, Travel chart, String diagram, motion economy, Two handed process chart, Micro motion study, Therbligs, SIMO chart, Cyclegraph and Chronocyclegraph., Use and basic procedure of work measurement, Techniques of work measurement, Time study, Rating, Introduction to Work sampling, Pre-determined time standards (PTS) and Standard Data. Restricted work, Pump diagram, Multiple machine work, Load factor, Machine

interference, Interference allowance, Working environment and Ergonomics, Safety criteria, Lighting, Noise and Vibration, Ventilation, Climatic conditions.

#### References:

1. International Labour Office (ILO), "Introduction to work study", Universal Book Corporation, Geneva, 2001.
2. Niebel B.W. and Frievalds, A., "Methods, Standards, and Work design", McGraw-Hill, New York, 2003.
3. Barnes R.M., "Motion and Time Study-Design and Measurement of work", Willey International, Singapore, 1980.
4. George K., "Work study, Universal Publishing Corporation", Bombay, 1995.
5. Niebel B.W., "Motion and Time Study", (5e), Richard D.IrvinInc, Illinois, 1972

### OPEN ELECTIVES

#### **MME 3281: CORROSION ENGINEERING [3 0 0 3]**

Definitions, corrosive environments, consequences of corrosion, cost of corrosion, corrosion science and corrosion Engineering, fundamental aspects of corrosion. Corrosion cell, cathodic and anodic reactions, types of corrosion cells, reference electrode, calomel electrode, pourbaix diagrams. Corrosion rate expressions, electro-chemical nature of aqueous corrosion, polarization, factors influencing corrosion rate. Types of corrosion, measuring polarization, anodic polarization, cathodic polarization, activation polarization and concentration polarization. Corrosion prevention, materials selection, alteration of environments, design, cathodic and anodic protection, corrosion inhibitors, coatings. Methods used to determine corrosion rate, weight loss measurements, linear polarization, Tafel extrapolation techniques.

#### References:

1. Ahmed Zaki, "Principles of Corrosion Engineering and Corrosion Control", Elsevier science and Technology Books, 2006.
2. Mars G. Fontana, "Corrosion Engineering", (3e), Tata McGraw Hill, 2008.
3. Trethewey K. R. and Longman J. Chamberlain, "Corrosion for Students of Science and Engineering", Scientific & Technical, 1988.
4. Schweitzer A Philip, "Fundamentals of corrosion-Mechanisms, Causes and preventive methods", CRC Press, Tayler and Francis Group, 2010.
5. Uhlig H. H. and Revie R. W., "Corrosion and Corrosion Control", Wiley, 1985.

#### **MME 3282: ENERGY ENGINEERING [3 0 0 3]**

Steam power plant - Different types of fuels used for steam generation, Equipment for burning coal in lump form, Stokers, Diesel Engine power plant - Method of starting diesel engine, Auxiliaries like cooling and lubrication system, Filters, Centrifuges, Oil heaters, Intake and exhaust system, Layout of diesel power plant. Hydro-electric plant: Hydrographs, Flow duration and mass curves, Storage and pondage, Pumped storage plants, Low, medium and high head plants, Penstock, Water hammer, Surge tanks, Gates and valves, Nuclear Power Plant, Solar energy, Biomass energy, Wind energy, Ocean energy, Geothermal energy conversion, tidal energy conversion.

#### References:

1. Nag P K, "Power Plant Engineering", Tata McGraw Hill, 2002.
2. Domkundwar, "Power Plant Engineering", Dhanpat Rai Publications, 2003.

3. Rai G D, "Non-Conventional Energy Sources", Khanna Publishers.
4. Rao S and Parulekar B B, "Energy Technology", Khanna Publishers, 2004.
5. Culp A W, "Principles of Energy Conversion", McGraw Hill International, 2001.

#### **MME 3283: INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]**

Introduction to Safety Engineering, Industrial Accidents, Theories of Accident Causation, Introduction to Health and Toxic Substances, Environmental Control and Noise, Ventilation and its Design Principle, Personal Protection and First Aid, Fire Protection, Machine Guarding, Safeguarding the point of operation, Power presses, Grinding machines, Saws, Belts and Pulleys, Safety consideration regarding material handling and storage. Safety Requirement for Material Handling and Storage, Electrical Hazards, Employee Participation in Promoting Safety, Safety Training, Safety Committees, Teamwork Approach to Promoting Safety.

#### References:

1. Asfahl C R and Rieske D W, "Industrial Safety and Health Management", (6e), Pearson Education, 2011.
2. Spellman F R and Whiting N E, "The Handbook of Safety Engineering: Principles and Applications", Government Institutes, 2009.
3. Gupta A., "Industrial Safety and Environment", (1e), Laxmi Publications Pvt. Ltd., 2006
4. Goetsch D L, "Occupational Safety and Health for Technologists, Engineers and Managers", (8e), Pearson Education Limited, 2014.

#### **MME 3284: INTERNAL COMBUSTION ENGINES [3 0 0 3]**

Introduction to IC engine, Analysis of air standard cycles, fuel air cycles and actual cycles. Modes of combustion, Stages of combustion in SI & CI engines, factors influencing the stages of combustion, normal and abnormal combustion, Control of abnormal combustion in SI and CI engines. Combustion chambers in SI and CI engines. Supercharging & Turbo-charging, Analysis of Modern developments in IC engines like Wankel engine, Electronic injection systems in SI engines. Common Rail Direct Injection (CRDI) engines, Multi point fuel injection. (MPFI) engines, dual-fuel engines and stratified charge engines. Introduction to engine Electronics, typical engine management systems, position, displacement and speed sensing, pressure, temperature and air measurement systems, exhaust oxygen sensors.

#### References:

1. Ganeshan V., "Internal Combustion Engines", Tata McGraw Hill, Education Private Limited New Delhi, 2007.
2. Mathur and Sharma, "A Course in I C Engines", Dhanpath Rai Publisher, New Delhi, 1981.
3. John B. Heywood, "Introduction to Internal Combustion Engines", Tata McGraw Hill, Education Private Limited New Delhi, 2011.
4. Lichty L.C., "International Combustion Engines", McGraw Hill New Delhi, 1951.
5. Edward F. Obert, "Internal Combustion Engines and Air Pollution", Harper & Row, Publishers. Delhi, 1973.

#### **MME 3285: INTRODUCTION TO ALTERNATIVE FUELS AND APPLICATIONS [3 0 0 3]**

Introduction to alternative fuels, Need for alternative fuels - Availability of different alternative fuels for SI and CI engines. Properties of potential alternative fuels, Liquid Fuels for SI Engines, Requirements of fuels for SI engines-Different Techniques of utilizing alternative liquid fuels Blends,

Neat form, Reformed fuels - Manufacturing, Storage and Safety- Performance and emission characteristics of alternative liquid fuels, Liquid Fuels in CI Engines, Requirements of fuels for CI engines- Different techniques for their utilization- Blends, Fuel modifications to suit CI engines, Dual fuelling, Ignition accelerators and other additives, Gaseous Fuels in SI Engines, Gaseous Fuels in CI Engines, Electrical Vehicles.

**References:**

1. Ramadhas A. S., "Alternative Fuels for Transportation", CRC Press, Taylor & Francis Group, 2010.
2. Thipse S. S., "Alternative Fuels: Concepts, Technologies and Developments", Jaico Book Distributors, 2010.
3. GajendraBabu M. K., "Alternative Transportation Fuels: Utilization in Combustion Engines", CRC Press, Taylor & Francis Group. 2010.
4. Michael F. Horddeski, "Alternative Fuels: The Future of Hydrogen", The Fairmont Press, 2008.
5. James D. Halderman, "Hybrid and Alternative Fuel Vehicles", (2e), Prentice Hall, 2010.

**MME 3286: INTRODUCTION TO COMPOSITE MATERIALS [3 0 0 3]**

Introduction to composite materials: definition, classification, types of matrices and reinforcements, characteristics and selection. Micro mechanical analysis of a lamina. Introduction, derivation of stress, strain, modulus of elasticity of fiber reinforced composites. Manufacturing of polymer composites: method, advantages, disadvantages and application. Application developments in aircrafts, missiles, space, automobile, electrical and electronics, marine, recreational, sports equipment's and construction. Potential future applications of composites. Metal matrix composites and ceramic matrix composites, reinforcement, matrix materials, characteristics and selection, base metal selection, applications.

**References:**

1. Mein Schwartz, "Composite Materials Handbook", McGraw Hill Book Company, 1984.
2. Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, 2010.
3. Mallik P.C., "Fiber Reinforced Composites", Marcel Decker, 1993.
4. Rober M. Jones, "Mechanics of Composite Materials", McGraw Hill Kogakusha Ltd, 2008.
5. Michael W, Hyer, "Stress analysis of fiber Reinforced Composite Materials", McGraw Hill International, 1998.

**MME 3287: INTRODUCTION TO NANOTECHNOLOGY [3 0 0 3]**

Introduction to nanotechnology, Bottom-up and Top-down approaches, Physical and Chemical properties, General methods of preparation of nanoparticles, Carbon nanostructures, Characterization of Nanomaterials, Nanomanipulation, Overview of micro electro mechanical devices and Technologies, Microsensors, MEMS Fabrication Bonding, Deposition and Etching techniques, Lithography, LIGA technique, MEMS applications, Scope of nanotechnology as a multidisciplinary subject, Nanomaterials used in energy and Environmental applications Nanomaterials in automobiles, Health hazards and other Challenges.

**References:**

1. Charles P Poole, "Introduction to Nanotechnology", Wiley-Interscience, 2003.
2. Guozhong Cao, "Nanostructures & Nanomaterials", Imperial College Press, 2004.
3. Mohamed Gad-el-Hak, "The MEMS Handbook", Taylor and Francis, 2005.

4. James J Allen, "MEMS Design", Taylor and Francis, 2005.
5. Murthy B S, Shankar P, "Textbook of Nanoscience and Nanotechnology", Universities Press (India) Private Ltd, 2013.

**MME 3288: INTRODUCTION TO OPERATIONS RESEARCH [3 0 0 3]**

Definition, phases, applications, advantages and disadvantages of operations research. Linear programming problems (LPP) are formulated and solved using graphical and simplex methods and post optimality analysis conducted. The special cases of LPP include transportation and assignment problems along with travelling salesman problem. Game theory and various methods, waiting line models and simulation. Poisson arrival rate and Exponential service times, System characteristics, Problems on the models- (M/M/1): (M/M/1): (N/FIFO), Simulation of queuing models, Network model analysis using Critical Path Method (CPM) and Project Evaluation & Review Technique (PERT). Determination of probability/expectation of project completion.

**References:**

1. Taha H. A., "Operations Research", (7e), Pearson Education, 2002.
2. Winston W.L., "Operations Research", Thomson Asia, 2003.
3. Vohra N. D., "Quantitative Techniques in Management", 2007.
4. Sharma S. D., "Operations Research", (14e), KedarNathRamnath Publications, 2005.
5. Kanthiswaroop, Gupta and Manmohan, "Operations Research", Sultan Chand and Sons, 2003.

**MME 3289: INTRODUCTION TO QUALITY CONTROL [3 0 0 3]**

Definitions of quality, Inspection and quality control, Organization for quality ,General quality control engineering fundamentals, Graphic representation methods of frequency distribution, Measures of central tendency and dispersion, Normal distribution curve, Inequality theorems, Shewhart's bowl drawing experiments, Control charts for variables (, R and s charts), Type I and Type II Errors, Process capability analysis, Process capability indexes. Control charts for attributes (p, np, c and u charts). Acceptance sampling by attributes, Single and Double sampling plans, Operating characteristic curve, AQL, LTPD, AOQ curve, AOQL, ATI, AFI, Producer's risk, Consumer's risk, Acceptance sampling tables. Conventional and statistical tolerance, Precision, Accuracy and Reproducibility of method of measurements. Quality costs.

**References:**

1. Grant E L and Leavenworth R S, "Statistical Quality Control", (7e), Tata McGraw Hill Education, 2000.
2. Montgomery D C, "Introduction to Statistical Quality Control", (6e), John Wiley and Sons Inc., 2009.
3. Mahajan M S, "Statistical Quality Control", Dhanpat Rai Publishing Company Pvt. Limited, 2012.
4. Gryna F, Chua R C H, De Feo J A, "Juran's Quality Planning and Analysis for Enterprise Quality", (5e), McGraw Hill Education, 2007.
5. Hansen B L, "Quality Control: Theory and Applications", PHI Learning Education, 1987.

**MME 3290: INTRODUCTION TO REFRIGERATION AND AIR CONDITIONING SYSTEMS [3 0 0 3]**

Basic concepts and Air Refrigeration Cycles, Vapor Compression Refrigeration Systems, Vapor Absorption Refrigeration Systems, Compound vapour compression refrigeration system. Multi-evaporator and cascade systems, Classification of Refrigerants, Comparison of thermodynamic properties of refrigerants, Alternate Cooling Methods: Desiccant Cooling System, Solar Refrigeration, Thermo Electric Refrigeration, Analysis of Steam Jet Ejector Cycle, Refrigeration,

Psychrometry, Psychrometric charts, Process involving Air-Vapour Mixtures, Air Conditioning Systems, Types of Air Conditioners, Load Estimation for inside and outside design conditions. Different types of heat loads.

**References:**

1. Arora S.C. and Domkundwar S., “*Course in Refrigeration and Air-conditioning*”, Danpath Rai. New Delhi, 1992.
2. Cook Norman, “*Refrigeration and Air conditioning*”, Macmillan London, 1995.
3. Stocker. W.F., “*Refrigeration and Air conditioning*”, Tata McGraw Hill, 1978.
4. Prasad Manohar, “*Refrigeration and Air conditioning*”, New Age International Pvt. Limited. New Delhi, 2004.
5. Jordon Richard C, Priester Gayle B, “*Refrigeration and Air conditioning*”, Prentice Hall, 2008

**MME 3291: INTRODUCTION TO ROBOTICS [3 0 0 3]**

Definition of Robot; Types of Robots; Robot Configuration; Selection of Robots; factor affecting the control resolution, Spatial resolution, Accuracy and repeatability, Specification of a robot, Robot arm/manipulator Kinematics, Types of Grippers; Force Analysis of gripper mechanism; Classification of Actuators; Actuators used in Robots - DC motors, Stepper motors, AC motors and Servo motors, Robot Transmission Systems; Sensors; Types and classification of robot sensors, Positional potentiometer, Velocity tachometer, Working of resolver, Optical encoder, Magneto resistive skin, Hall generator, Electromagnetic & Adhesive end effectors, proximity sensors; Tactile Sensing; Robot Vision.

**References:**

1. Janakiraman P.A., “*Robotics and Image Processing*”, Tata McGraw Hill, 1995.
2. Yoram Koren, “*Robotics for Engineers*”, Tata McGraw Hill, 1992.
3. Groover M.P., “*Industrial Robotics*”, PHI, 2008.
4. Yu Kozyrev, “*Industrial Robots Handbook*”, MIR Pub, 1985.
5. Jain K.C., Aggarwal L.N., “*Robotics Principles and Practice*”, Khanna Publishers, 1997.

**MME 3292: PERSONNEL MANAGEMENT AND INDUSTRIAL RELATIONS [3 0 0 3]**

Objectives of personnel management, Functions of Personnel Management, Process of Human Resource Planning, Steps in recruitment process, Sources of recruitment, methods of recruitment. Promotions, Demotions, Transfers, Separation, Absenteeism and Turn over, Wage and Salary administration, Performance Appraisal, Methods of Performance evaluation. Industrial Relations: Functional Requirements, Employees participation in management. Grievances and Grievance Handling, Act of Indiscipline/ Misconduct, Principles for maintenance of discipline. Industrial Disputes, Procedure for the Settlement of Disputes, Government and Industrial Relations, Organs of Industrial Peace. Trade Unions: Objectives and Functions, Growth of Trade Union Movement, Factors Affecting Growth of Trade Unions, Essentials of a Successful Trade Union.

**References:**

1. Mamoria C B and Gankar S V, “*Personnel Management*”, (23e), Himalaya Publishing House, 2003.
2. Megginson L C, “*Personnel and Human Resources Administration*”, (3e), R. D. Irwin, 1977.

3. Beach D S, *Personnel: “The Management of the People at Work”*, (3e), Macmillan, 1975.
4. Yoder D, “*Handbook of Personnel Management and Labor Relations*”, Volume 1, McGraw Hill, 1958.

**MME 3293: PROJECT MANAGEMENT [3 0 0 3]**

Concepts of Project and Project Management, Categories of projects, Project life cycle phases, Tools and techniques for project management, the project manager, Roles and responsibilities of a project manager. Project Cost Estimation: Cost estimation, Capital cost, Operation and Maintenance costs, Cost estimation of a sample project. Feasibility Study: Types of feasibility. Project Network Construction, Critical path method (CPM), Program evaluation review technique (PERT), Crashing of Project Network, Types of crashing. Resource levelling and Allocation Technique, Project Audit: failures and reasons for audit, Phases of project audit, Project check list. Project Management Performance: Performance indicators, Performance improvement, Project management environment. Project Management Software: InstaPlan, Yojana, Prism project manager, Primavera.

**References:**

1. Paneerselvam R and Senthilkumar P, “*Project Management*”, PHI Learning Pvt. Ltd., 2010
2. Choudhury S, “*Project Management*”, (1e), Tata McGraw Hill Education, 2008
3. Lock D, “*Project Management*”, (10e), Ashgate Publishing Limited, 2013

**MME 3294: THERMAL TREATMENT OF METALS AND ALLOYS [3 0 0 3]**

Introduction to phase diagrams, invariant reactions, analysis of phase diagrams, Introduction to Iron-Carbon equilibrium diagram & Fundamentals of heat treatment, decomposition of austenite, TTT diagram, Conventional case and Surface hardening treatments, factors affecting hardening, laser hardening. Age hardening and Thermo-mechanical treatments for Aluminium and Non-Ferrous alloys, Ausforming, Isoforming, Thermo-mechanical annealing Steel specification, Classification and Application of steels and Cast iron with heat treatments, commercial steel, stainless steel, maraging steel, Malleabilization. Heat treatment and Application of non-ferrous metals and alloys defects, causes and remedies in heat treatment.

**References:**

1. Rajan T. V., Sharma C. P. and Sharma Alok, “*Heat Treatment Principles and Techniques*”, PHI Publication, 1999.
2. Bolton W., “*Engineering Materials Technology*”, Heinmann Newness, 2001.
3. Thelning K. E., “*Steel and its Heat Treatment*”, Butterworth/Heinemann, 2000.
4. Singh Vijendra, “*Heat Treatment of Metals*”, Standard Publishers Distributors, 2012.
5. William D. Callister, “*Materials Science and Engineering*”, John Wiley and Sons, 2007.

## B. Tech in INDUSTRIAL AND PRODUCTION ENGINEERING

Year	THIRD SEMESTER							FOURTH SEMESTER						
	Subject Code	Subject Name	L	T	P	C	Subject Code	Subject Name	L	T	P	C		
<b>II</b>	MAT 2101	Engineering Mathematics – III	2	1	0	3	MAT 2209	Engineering Mathematics – IV	2	1	0	3		
	MME 2103	Strength of Materials	2	1	0	3	MME 2204	Automobile Engineering	3	0	0	3		
	MME 2104	Material Science and Metallurgy	3	0	0	3	MME 2212	Non-Conventional Manufacturing Techniques	3	0	0	3		
	MME 2111	Manufacturing Process Engineering	4	0	0	4	MME 2213	Theory of Machines	3	1	0	4		
	MME 2112	Plant Layout and Material Handling	3	0	0	3	MME 2214	Fluid Mechanics and Machinery	3	1	0	4		
	MME 2113	Thermal Engineering	3	1	0	4	*** ****	Open Elective – I	3	0	0	3		
	MME 2117	Strength of Materials Lab	0	0	3	1	MME 2216	Computer Aided Mechanical Drawing	0	0	6	2		
	MME 2118	Workshop Practice – I	0	0	3	1	MME 2218	Workshop Practice – II	0	0	3	1		
			<b>17</b>	<b>3</b>	<b>6</b>	<b>22</b>		<b>17</b>	<b>3</b>	<b>9</b>	<b>23</b>			
<b>III</b>	<b>FIFTH SEMESTER</b>							<b>SIXTH SEMESTER</b>						
	MME 3103	CAD-CAM	3	0	0	3	HUM 4001	Essentials of Management	2	1	0	3		
	MME 3104	Metrology and Measurements	3	0	0	3	MME 3211	Operations Research	3	1	0	4		
	MME 3111	Pneumatics and Hydraulics	3	0	0	3	MME 3212	Quality Control and Reliability Engineering	3	1	0	4		
	MME 3112	Design of Machine Elements	3	1	0	4	MME ****	Program Elective – III	3	0	0	3		
	MME ****	Program Elective – I	3	0	0	3	MME ****	Program Elective – IV	3	0	0	3		
	MME ****	Program Elective – II	3	0	0	3	*** ****	Open Elective – II	3	0	0	3		
	MME 3116	CAD Lab	0	0	6	2	MME 3218	Automation Lab	0	0	3	1		
	MME 3118	Thermo-Fluid Lab	0	0	3	1	MME 3219	Metrology Lab	0	0	3	1		
			<b>18</b>	<b>1</b>	<b>9</b>	<b>22</b>			<b>17</b>	<b>3</b>	<b>6</b>	<b>22</b>		
<b>IV</b>	<b>SEVENTH SEMESTER</b>							<b>EIGHTH SEMESTER</b>						
	HUM 4002	Engg Economics and Financial Management	2	1	0	3	MME 4297	Seminar				1		
	MME 4102	Finite Element Methods	2	1	0	3	MME 4298	Industrial Training				1		
	MME 4111	Tool Engineering and Design	3	1	0	4	MME 4299	Project Work / Practice School				12		
	MME 4112	Production and Operations Management	3	1	0	4								
	MME ****	Program Elective – V	3	0	0	3								
	MME ****	Program Elective – VI	3	0	0	3								
	MME 4116	FEM Lab	0	0	6	2								
MME 4118	Advanced Material Testing Lab	0	0	3	1									
		<b>16</b>	<b>4</b>	<b>9</b>	<b>23</b>						<b>14</b>			

## Minor Specialisations

### I. Machine Design

1. MME 4001: Design for Manufacture and Assembly
2. MME 4002: Design of Mechanical Systems
3. MME 4003: Fatigue and Fracture
4. MME 4004: Tribology

### II. Manufacturing

1. MME 4005: Composite Materials
2. MME 4006: Heat Treatment of Metals and Alloys
3. MME 4007: Lean Manufacturing
4. MME 4008: Machine Tool Technology

### III. Thermal Engineering

1. MME 4009: Computational Fluid Dynamics
2. MME 4010: Design of Thermal Power Plant Systems
3. MME 4011: Jet Propulsion and Rocket Technology
4. MME 4012: Refrigeration and Air Conditioning Systems

### IV. Business Management

1. HUM 4011: Financial Management
2. HUM 4012: Human Resource Management
3. HUM 4013: Marketing Management
4. HUM 4014: Operations and Systems Management

### Other Programme Electives

1. MME 4015: Corrosion Science and Engineering
2. MME 4016: Elements of Mechatronics Systems
3. MME 4018: Friction and Wear
4. MME 4019: Industrial Robotics
5. MME 4021: Materials Characterization
6. MME 4022: MEMS and Nano Technology
7. MME 4023: Micro Machining

8. MME 4024: Non Destructive Testing
9. MME 4027: Organizational Behavior
10. MME 4028: Personnel Management and Industrial Relations
11. MME 4029: Plant Engineering and Maintenance
12. MME 4032: Project Management
13. MME 4034: Supply Chain and Logistics Management
14. MME 4035: Technology Management
15. MME 4036: Theory of Internal Combustion Engines and Emissions
16. MME 4037: Total Quality Management
17. MME 4038: Work Systems Engineering
18. MME 4039: Business Process Re-Engineering
19. MME 4040: Database Management Systems
20. MME 4041: Enterprise Resource Planning
21. MME 4042: Industrial Ergonomics
22. MME 4043: Management Information Systems
23. MME 4044: Materials Management
24. MME 4045: Theory of Metal Forming

### Open Electives

1. MME 3281: Corrosion Engineering
2. MME 3282: Energy Engineering
3. MME 3283: Industrial Safety Engineering
4. MME 3284: Internal Combustion Engines
5. MME 3285: Introduction to Alternative Fuels and Applications
6. MME 3286: Introduction to Composite Materials
7. MME 3287: Introduction to Nano Technology
8. MME 3288: Introduction to Operations Research
9. MME 3289: Introduction to Quality Control
10. MME 3290: Introduction to Refrigeration and Air Conditioning Systems
11. MME 3291: Introduction to Robotics
12. MME 3292: Personnel Management and Industrial Relations
13. MME 3293: Project Management
14. MME 3294: Thermal Treatment of Metals and Alloys





## THIRD SEMESTER

### **MAT 2101: ENGINEERING MATHEMATICS - III [2 1 0 3]**

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation-Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One-dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

#### **References:**

1. Erwin Kreyszig, "Advanced Engineering Mathematics", (5e), Wiley Eastern, 1985.
2. Sastry S. S., "Introductory Methods of Numerical Analysis", (2e), Prentice Hall, 1990.
3. Grewal B. S., "Higher Engineering Mathematics", Khanna Publishers, 1989.
4. Murray R. Spiegel, "Vector Analysis", Schaum Publishing Co., 1959.

### **MME 2103: STRENGTH OF MATERIALS [2 1 0 3]**

Strength, stiffness and stability stresses, Thermal stress, Elastic constants, Strain energy, Stress-strain diagrams, Resilience, Toughness, Hardness, Types of beams, Shear force and bending moment in beams, Stresses in beams, Theory of simple bending, Stress variation along the length and beam section, Shear stresses in beams. Analysis of torsion of circular bars, Shear stress distribution, Bars of solid and hollow circular section, Twist and torsion stiffness, Elastic curve of Neutral axis of the beam under normal loads, Evaluation of beam deflection and slope, Columns, Equivalent length of a column, Euler equation, Slenderness ratio, Rankine formula for columns, Biaxial state of stresses, Thick & thin cylindrical shells and spherical shells.

#### **References:**

1. Popov E. P., "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, 1997.
2. Beer F. P. and Johnston R., "Mechanics of Materials", (3e), McGraw-Hill Book Co, 2002.
3. Nash W. A., "Theory and Problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York, 1995.
4. Kazimi S. M. A., "Solid Mechanics", Tata McGraw-Hill Publishing Co, New Delhi, 1981.
5. Ryder G. H., "Strength of Materials", (3e), Macmillan India Ltd., 2002.

### **MME 2104: MATERIAL SCIENCE AND METALLURGY [3 0 0 3]**

Introduction to crystal structure, crystal defects, Solidification-homogeneous and heterogeneous nucleation, crystal growth. Phases in solids - single & multi phase, solid solutions, equilibrium diagrams, Isomorphous and Eutectic systems, equilibrium & non-equilibrium cooling, Invariant reactions, Lever rule. Iron-Carbon systems - Allotropy and Polymorphism, cooling curve for pure iron, Fe-C equilibrium diagrams. Heat treatment processes like Annealing, Normalizing, Hardening, Tempering and Case hardening. Ferrous alloys - alloy steels like plain carbon steels, stainless steels, free machining steels, HSS and Maraging steels, Cast irons. Non-ferrous alloys - Brasses, Bronzes and Al-Cu alloys.

#### **References:**

1. Avner S.H., "Introduction to Physical Metallurgy", (3e), McGraw Hill, 2004.
2. William D. Callister, "Materials Science and Engineering", John Wiley & Sons, 2007.
3. Lakhtin Yu., "Engineering Physical Metallurgy and Heat Treatment", MIR Publishers, 1985.
4. Gupta K.M., "Material Science, Metallurgy and Engineering Materials", Umesh Publication, 2012.
5. Raghavan V., "Material Science and Engineering", (4e), Prentice Hall of India, 1989.

### **MME 2111: MANUFACTURING PROCESS ENGINEERING [4 0 0 4]**

Foundry Technology, moulding materials, moulding sand & testing, Casting-Investment casting, Permanent mould casting, Slush casting, Pressure die casting Centrifugal casting and Continuous casting. Advantages, limitations and applications of different types of welding processes. Cold, warm and hot working of metals. Metal cutting-orthogonal and oblique cutting, cutting parameters, tool life & wear, Merchant's analysis & Taylor's equation. Constructions, accessories & attachments, types and operations of Lathes, Drilling, Milling, Planing, Shaping and grinding machines. Drill bits, milling cutters and grinding wheels. Advantages, limitations and applications of Rapid prototyping.

#### **References:**

1. Rao P. N., "Manufacturing Technology", Tata McGraw-Hill Publishing Company Limited, 2006.
2. Rajput R. K., "A Text book of Manufacturing Technology", Laxmi Publications Private Limited, 2011.
3. Parmer R. S., "Welding Engineering & Technology", Khanna Publishers, 1999.
4. Jain P. L., "Principles of Foundry Technology", Tata McGraw Hill Publishing company Ltd, 1995.
5. Chua C.K., Leong K.F., and Lim C.S., "Rapid Prototyping: Principles and Applications", World Scientific, 2003.

### **MME 2112: PLANT LAYOUT AND MATERIAL HANDLING [3 0 0 3]**

Principle of plant layout, product, process and combination layout, economics of different types of layout. Factors influencing the layout-manpower, movement, service, material, machinery, waiting, building and change factors, location of storages & delay point. Layout planning-scientific approach, flow process chart, cross chart, string diagram, line balancing, templates evaluation of layout, installation of layout, computerized layout planning. Material handling- principles of material handling, factors in selection of material handling equipment, safety in material handling, types of material handling equipment, modern material handling equipment.

#### **References:**

1. Buffa E. S. and Rakesh S. K., "Modern Production and Operation Management", John Wiley & Sons, New York, 2003.
2. Richard M., "Practical Plant Layout", McGraw-Hill, New York, 1955.
3. James Apple M., "Plant Layout and Material Handling", John Wiley, New York, 1977.
4. Mathew P. Stephens and Fred E. Meyers, "Manufacturing Facilities Design & Material Handling", (5e), Purdue University Press, 2013.
5. David E. Mulcahy, "Materials Handling Handbook", McGraw Hill Professional, 1998.

### **MME 2113: THERMAL ENGINEERING [3 1 0 4]**

Introduction, Zeroth Law, heat and work, First law of thermodynamics, Steady flow energy equation, Second law, Carnot cycle, Carnot theorem, Entropy, Clausius inequality, Vapor power cycle-Rankine cycle, reheat Rankine cycle, Gas power cycles- Otto, Diesel and Dual cycles, air standard efficiency, Air compressors-Multi-stage and single stage, Intercooling, Refrigeration Principle of working, Air refrigeration, vapor compression and absorption systems, coefficient of performance, Elements of Heat transfer - conduction, convection and radiation, Performance testing of IC engines- BP, IP, SFC, Mechanical efficiency, Thermal efficiency, heat balance sheet.

#### **References:**

1. Cengel Yunus and Bole Michael, "Thermodynamics", McGraw Hill, New York, 2010.
2. Estop and McConkey, "Applied Thermodynamics for Engineering Technologies", Pearson Education, Delhi, 2002.
3. Mayhew A. and Rogers B, "Engineering Thermodynamics", E.L.B.S. Longman, London, 1994.
4. Van Wylen. G.J. and Sonntag R.E, "Fundamentals of Classical Thermodynamics", John Wiley, New York, 1985.
5. Cengel, "Thermodynamics and Heat Transfer", McGraw Hills, New York, 1997.

### **MME 2117: STRENGTH OF MATERIALS LAB [0 0 3 1]**

Tension test on mild steel, Compression test on cast iron, Hardness tests Rockwell, Brinell, Vicker's, Charpy Impact test & Izod test on mild steel, Shear test, Torsion test, Fatigue test on mild steel, Test on leaf spring, Test on Helical spring, Bending and compression test on wood, Heat treatment of steel and microstructure study of metals.

#### **References:**

1. Suryanarayana A.V.K., "Testing of Metallic Materials", PHI, 1990.
2. Khanna and Justo, "Highway Materials Testing", Nemchand, 1989.
3. Technical Teacher's Training Institute, "Laboratory Manual of Strength of Materials", Oxford University Press, 1983.
4. Davis H.E., Troxell G.E., Wiscocil C.T., "The Testing and Inspection of Engineering Materials", McGraw Hill Book Company.

### **MME 2118: WORKSHOP PRACTICE - I [0 0 3 1]**

Preparation of models using Welding techniques, Lathe and CNC Turning Centre. Acceptance tests on machine tools.

#### **References:**

1. Hajra Chaudhury S.K., Hajra Choudhury A. K. and Nirjhar Roy, *Elements of Workshop Technology*, Vol. I, Media Promoters and Publishers Pvt. Ltd., 2003.
2. Hajra Chaudhury S.K., Hajra Choudhury A. K. and Nirjhar Roy, *Elements of Workshop Technology*, Vol. II, Media Promoters and Publishers Pvt. Ltd., 2003.
3. Peter Smid, *CNC Programming Hand book*, Industrial Press, New York, 2000.

## **FOURTH SEMESTER**

### **MAT 2209: ENGINEERING MATHEMATICS - IV [2 1 0 3]**

Measures of central tendency, measures of dispersion, mean, median, mode, standard deviation. correlation coefficient Introduction to probability, finite sample space, conditional probability and

independence, Baye's theorem, one dimensional random variable: mean and variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least square principle of curve fitting. Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications.

#### **References:**

1. Kreyzig E., "Advanced Engineering Mathematics", (7e), Wiley Eastern, 1999.
2. Meyer P.L., "Introduction to Probability and Statistical applications", (2e), American Publishing Co., 1980.
3. Hogg and Craig, "Introduction of Mathematical Statistics", (4e), MacMillan, 1975.
4. Grewal B. S., "Higher Engineering Mathematics", Khanna Publishers, 1989.

### **MME 2204: AUTOMOBILE ENGINEERING [3 0 0 3]**

Automotive engine classification, Multi cylinder arrangements, engine parts, Valve timing diagram. Fuel supply system-pumps, mixture strength, carburetor, fuel injector, MPFI system. Ignition system, Cooling system and Lubrication system. Clutch-single plate, multi plate, centrifugal and semi centrifugal disc clutch, Fluid flywheel. Gear box-constant mesh gear box, synchromesh gear box, Epicyclic (automatic) gear box and torque converter, Overdrive mechanism. Drive to wheels-torque reaction, driving thrust, braking torque, Universal joint, propeller shaft, differential gear box and rear axle. Tube and tubeless tyres, Steering system, Suspension system. Brakes-drum, disc, hydraulic, servo and air.

#### **References:**

1. Heinz Heisler, "Vehicle and Engine Technology", (2e), Butterworth-Heinemann Publication, Second Edition, 1998.
2. Kirpal Singh, "Automobile Engineering", Vol. I & II (12e), Standard Publishers Distributors, New Delhi, 2011.
3. Rajput R. K., "Automobile Engineering", (1e), Laxmi Publication (P) Ltd, 2010.
4. Narang G. B. S., "Automobile Engineering", Khanna Publishers, 1990.
5. Giri N. K., "Automotive Technology", Khanna Publication, 2006.

### **MME 2212: NON-CONVENTIONAL MANUFACTURING TECHNIQUES [3 0 0 3]**

Process principles, equipment, applications, advantages and disadvantages of Abrasive Jet Machining (AJM), Water Jet Machining (WJM). Abrasive Water Jet Machining (AWJM), Ultrasonic Machining (USM). Electro Chemical Machining (ECM) Electro Chemical Grinding, Shaped Tube Electrolytic Machining (STEM), Electrical Discharge Machining (EDM), Wire EDM, Electrical Discharge Grinding (EDG), Chemical Machining (CHM), Photo chemical machining. Laser Beam Machining (LBM), Plasma Arc Cutting (PAC), Electron Beam Machining (EBM), Ion Beam Machining (IBM) and Thermal Energy Method (TEM). Processing of polymers/plastics, forming and shaping processes for plastics.

#### **References:**

1. Benedict G. F., "Non Traditional Machining Techniques", Marcel Decker, New York, 1990.
2. Weller E. J., "Non-Traditional Machining", Society of Manufacturing Engineers, Dearborn, 1984.

- Mishra P. K., *"Non-Conventional Machining"*, Narosa Publishing, Delhi.
- Bhattacharya Amitabha, *"New Technology"*, IOE, Calcutta, 1973.
- Paul Degarmo E., Black J. T. and Ronald Kohser A., *"Materials and Process in Manufacturing"*, (8e), Prentice Hall of India, New Delhi, 2003.

#### **MME 2213: THEORY OF MACHINES [3 1 0 4]**

Mechanism and Machine, slider crank and four bar mechanisms, inversions, types of mechanisms. Velocity and acceleration of mechanisms, Relative velocity and instantaneous centre method, Relative acceleration method. Types of Cams and followers, Cam profiles. Balancing of rotating masses in single and different planes. Spur, helical and bevel gear terminology, minimum number of teeth to avoid interference. Types of Gear trains, torque calculations. Belt tensions, power transmitted by a flat and rope belt drive, no. of ropes required. Vibrations- longitudinal, transverse, torsional vibration. displacement, velocity and acceleration, undamped free vibration of spring-mass system.

#### **References:**

- Ballaney P. L., *"Theory of Machines"*, Khanna Publishers, New Delhi, 1998.
- Rattan S. S., *"Theory of Machines"*, Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2009.
- Singh V. P., *"Theory of Machines"*, Khanna Publishers, New Delhi, 1998.
- Rao J. S. and Dukkipati R. V., *"Mechanism and Machine Theory"*, Wiley Eastern Ltd. Delhi, 1992.
- Gosh A., and Mallick A. K., *"Theory of Machines and Mechanisms"*, Affiliated East West Press, Delhi, 1989.

#### **MME 2214: FLUID MECHANICS AND MACHINERY [3 1 0 4]**

Fluid properties, ideal and real fluids, Fluid statics, Pascal's law, Hydrostatic law, pressure measurement by manometers, Total pressure and center of pressure for plane surfaces submerged in liquids, buoyancy, stability conditions for floating and submerged bodies, metacenter and metacentric height, fluid kinematics, continuity equation, Fluid dynamics, Euler's equation, Bernoulli's equation, Linear momentum equation, flow measurement by venturimeter, orifice meter, notches, viscous flow through the circular pipe and between two parallel plates, turbulent flow, major and minor losses, dimensional analysis, similitude, Forces on plane, inclined and curved surfaces. Principle of operation of hydraulic turbines, pumps, gear pump, vane and reciprocating pump.

#### **References:**

- Kumar K.L., *"Fluid Mechanics"*, Eurasia Publishing House, New Delhi, 2000.
- Jagadish Lal, *"Hydraulic Machines"*, Metropolitan Book Company Pvt. Ltd. Delhi, 1971.
- Bansal R. K., *"Fluid Mechanics and Hydraulic Machines"*, Laxmi Publications (P) Ltd. New Delhi, 2006.
- Kumar D.S., *"Fluid Mechanics and Fluid Power Engineering"*, S.K.Kataria Publishers, New Delhi, 2001.
- Cengel Yunus A. and Cimbala John M., *"Fluid Mechanics - Fundamentals & Applications"*, Tata McGraw Hill publications, 2011.

#### **MME 2216: COMPUTER AIDED MECHANICAL DRAWING [0 0 6 2]**

2D drafting-Intersection of Solids, Threaded Fasteners, square bolts & nuts, foundation bolt, Bearings, Couplings and Joints. 3D part modeling, assembly and sectional/exploded views-Drawings-Vertical stuffing box,

Simple eccentric, Drill jig, Square tool post, Non-return valve, Screw jack, Swivel bearing, Strap type connecting rod end and Machine vice.

#### **References:**

- Gopalkrishna K. R., *"Machine Drawing"*, Subhas Publications, Bangalore, 2002.
- Bhat N. D., *"Machine Drawing"*, Charotar Publishing House, Anands, 2002.
- Venugopal K., *"Engineering Drawing and Graphics + Auto CAD"*, Newage International Publishers, Delhi, 2002.
- Narayana K. L. and Kannaiah P., *"Text book on Engineering Drawing"*, Scitech Publications, Chennai, 2002.

#### **MME 2218: WORKSHOP PRACTICE - II [0 0 3 1]**

Exercises on spur gear and helical gear cutting using milling & gear hobbing machines. Practice of shaping operations, Exercises on grinding operations. Machining using CNC Vertical Machining Center and use of Non-conventional machines.

#### **References:**

- Hajra Chaudhury S.K., Hajra Choudhury A. K. and Nirjhar Roy, *Elements of Workshop Technology, Vol. II, Media Promoters and Publishers Pvt. Ltd.*, 2003.
- Peter Smid, *CNC Programming Hand book*, Industrial Press, New York, 2000.

## **FIFTH SEMESTER**

#### **MME 3103: CAD-CAM [3 0 0 3]**

Introduction to Computer aided design, need, benefits, applications of CAD, Graphics hardware and Graphics displays. Techniques for geometric modeling, Types and representation of curves, Types and representation of surfaces: Analytic surfaces, Synthetic Types and representation of solids. Numerical control and CNC programming, Computer numerical control, CNC part programming, Advanced features in CNC programming, Adaptive control machining systems. Industrial Robotics, Robot anatomy, Physical configurations, Basic robot motions, Motion systems, Robot programming, End effectors, Work cell design, robotic application. Manufacturing systems CIM, flexible manufacturing and distributed manufacturing.

#### **References:**

- Groover Mikell P. and Emory W. Zimmers, *"CAD/CAM: Computer-Aided Design and Manufacturing"*, Prentice Hall of India, New Delhi, 2001.
- Ibrahim K Zeid, *"CAD/CAM Theory and Practice"*, Tata McGraw Hill, New Delhi, 1998.
- Groover Mikell P., *"Automation, Production Systems, and Computer Integrated Manufacturing"*, Prentice Hall of India, New Delhi, 2008.
- Rao P.N., *"CAD/CAM"*, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2005.
- Radhakrishnan P., *"Computer Numerical Control Machines"*, New Central Book Agency (P) Ltd., Kolkata, 2004.

#### **MME 3104: METROLOGY AND MEASUREMENTS [3 0 0 3]**

Static characteristics of instruments and measurement systems. Methods of pressure measurement by Elastic pressure elements and McLeod gauge. Methods of temperature measurement by pressure

thermometer, Electrical resistance thermometer, Thermocouples and Pyrometer. Strain measurement on static and rotary shaft, orientation of strain gauges, gauge factor, strain gauge bridge circuit, calibration circuit, temperature compensation. Measurement of force, torque and shaft power. Grades of tolerances, letter symbols for tolerances, types of fits. Taylor's principle for design of gauges, Gauge Maker's tolerance, types of gauges. Straightness measurement using straight edge and using Autocollimator. Squareness measurement, Surface texture measurement and measurements of screw threads.

**References:**

1. Beckwith Thomas G., "Mechanical Measurements", Pearson Education, Delhi, 2003.
2. Jain R. K., "Engineering Metrology", Khanna Publishers, New Delhi, 1997.
3. Sawhney A. K., "Mechanical Measurement & Instrumentation", Dhanpat Rai & Co, New Delhi, 2002.
4. Nakra B. C. and Chaudry K. K., "Instrumentation, Measurement & Analysis", Tata McGraw Hill, New Delhi, 2002.
5. Gupta I. C., "Engineering Metrology", Dhanpat Rai Publications, New Delhi, 1997

**MME 3111: PNEUMATICS AND HYDRAULICS [3 0 0 3]**

Structure and signal flow of pneumatic system, basic components, pneumatic actuators: direction and flow control valves, symbols of pneumatic valves, traverse time diagram. Design of manually operated circuits, control of multiple actuators, structure of electro pneumatics circuits, types of sensors, electrically actuated direction control valves, relay control systems. Design of electro pneumatic circuits, basic concepts of PLC. Structure of hydraulic circuit, Pascal's law, force transmission in hydraulics, power pack and accessories, hydraulic fluids, filters, hydraulic pumps and actuators. Calculation of force, speed, power developed. Pipes and fittings, accumulators, construction and working of direction, pressure and flow control valves, proportional and Servo valves. Applications in regenerative meter in, meter out, bleed off, sequencing, pressure reducing circuits, electro hydraulic circuits.

**References:**

1. Peter Croser and Frank Ebel, "Pneumatics Basic Level TP 101", Festo Didactic GMBH & Co, Germany, 2002.
2. Prede G. and Scholz D., "Electropneumatics Basic Level", Festo Didactic GMBH & Co, Germany, 2002.
3. Hasebrink J.P. and Kobler R., "Fundamentals of Pneumatic Control Engineering", Festo Didactic GMBH & Co, Germany, 2002.
4. Peter Rohner, "Industrial Hydraulic Control", John Wiley & Sons, Brisbane, 1989.
5. Majumdar S.R., "Oil Hydraulic Systems Principles and Maintenance", Tata McGraw Hill, New Delhi, 2005.

**MME 3112: DESIGN OF MACHINE ELEMENTS [3 1 0 4]**

Materials and their properties, principal stresses, theories of failure, factor of safety, strength under combined axial, bending & torsional loads, stress concentration. Fatigue: S-N diagram, Low cycle and high cycle fatigue, variables affecting fatigue strength, Goodman & Soderberg equations, stresses due to combined loading. Design of shafts subjected to bending in two planes in addition to axial loads. Stress in keys, Stresses in bolts, Stresses in power screw, Efficiency of power screw, Force & torque requirement to lift load in power screw jack. Helical coil springs, spring materials, Stress & deflection of springs subjected to steady, fluctuating & impact loads, Energy stored in springs, Critical frequency, Concentric springs. Spur and Helical gears design for static, dynamic and wear load. Selection of Journal bearings and Rolling contact bearing.

**References:**

1. Bhandari V. B., "Design of Machine Elements", (2e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
2. Norton R. L., "Machine Design - An Integrated Approach", (2e), Prentice Hall Inc. New Jersey, 2004.
3. Maleev and Hartman, "Machine Design", (5e) (Revised and edited by Drop Grover), CBS Publishers, New Delhi, 1999.
4. Shigley J. E. and Mischke C. R., "Mechanical Engineering Design", (5e), McGraw Hill Inc., New York, 2004.
5. Mahadevan K. and Balaveera Reddy K., "Machine Design Data Hand Book", (4e), CBS Publishers and distributors, New Delhi, 1987.

**MME 3116: CAD LAB [0 0 6 2]**

Different solid modeling operations, preparation of assembly drawing and sectional views. CNC programming for various turning and machining operations using turning and machining cycles. Modeling in CAM software for plain milling, contouring, pocketing, drilling.

**References:**

1. Ibrahim K Zeid, "CAD/CAM Theory and Practice", Tata McGraw Hill, New Delhi, 1998.
2. Sham Tickoo, "Pro/Engineer Wildfire for Designers", CAD/CIM Technologies, 2008.
3. Pro/E (CREO) software manual.
4. CADEM software manual.

**MME 3118: THERMO-FLUID LAB [0 0 3 1]**

Determination of viscosity, flash & fire point of oil. Performance test on rotary air blower, two stage air compressor, single cylinder four / two stroke petrol and diesel engines. Flow measurement using venturimeter and orifice meter. Calibration of V notch & rectangular notch. Performance test on centrifugal pump, gear pump, impulse turbine and reaction turbine. Measurement of force due to impact of jet on vanes.

**References:**

1. Ganeshan V., "Internal Combustion Engines", (3e), Tata McGraw Hill Education Private Limited, New Delhi, 2007.
2. Mathur M. L. and Sharma R. P., "Course in Internal Combustion Engines", Dhanpath Rai Publishers, New Delhi, 2001.
3. Jagadishlal, "Fluid Mechanics and Hydraulic Machines", Metropolitan Book Co. Pvt. Ltd New Delhi, 1995.
4. Bansal R. K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publication, New Delhi, 2006.

**SIXTH SEMESTER**

**HUM 4001: ESSENTIALS OF MANAGEMENT [2 1 0 3]**

Definition of management and systems approach, Nature & scope, The functions of managers, Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, Policies & planning premises, Strategic planning process and tools. Nature & purpose of organising, Span of management, factors determining the span, Basic departmentalization, Line & staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership - leadership behaviour & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA & application of Theory Z. The

nature & purpose of international business & multinational corporations, unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections.

**References:**

1. Koontz D., "Essentials of Management", Mc Graw Hill, New York, 2004.
2. Peter Drucker, "Management, Task and Responsibility", Allied Publishers, 2006.
3. Peter Drucker, "The Practice of Management", Butterworth Hein Mann, 2003.

**MME 3211: OPERATIONS RESEARCH [3 1 0 4]**

The subject covers definition, phases, applications, advantages and disadvantages of operations research. Linear programming problems (LPP) are formulated and solved using graphical and simplex methods and post optimality analysis conducted. The special cases of LPP include transportation and assignment problems along with travelling salesman problem. Game theory and various methods, waiting line models and simulation. Poisson arrival rate and Exponential service times, System characteristics, Problems on the models- (M/M/1): (M/M/1) : (N/FIFO), Simulation of queuing models, Network model analysis using Critical Path Method (CPM) and Project Evaluation & Review Technique (PERT). Determination of probability/expectation of project completion.

**References:**

1. Taha H. A., "Operations Research", (7e), Pearson Education, 2002.
2. Winston W. L., "Operations Research", Thomson Asia, 2003.
3. Vohra N. D., "Quantitative Techniques in Management", New Delhi, 2007.
4. Sharma S. D., "Operations Research", Kedarnath Ramnath Publications, (14e), 2005.
5. Kanthiswaroop, Gupta and Manmohan, "Operations Research", Sultan Chand and Sons, 2003.

**MME 3212: QUALITY CONTROL AND RELIABILITY ENGINEERING [3 1 0 4]**

Inspection and quality control, Organization for quality, General quality control engineering fundamentals, Graphic representation methods of frequency distribution, Measures of central tendency, and dispersion, Normal distribution curve, Inequality theorems, Shewharts bowl drawing experiments, Control charts for variables, Type I and Type II Errors, Process capability analysis, Process capability indexes. Control charts for attributes. Acceptance sampling by attributes, Single, double and multiple sampling plans, Operating characteristic curve, AQL, LTPD, AOQ curve, AOQL, ATI, AFI, ASN curve, Producer's risk, Consumer risk, Acceptance sampling tables. Conventional and statistical tolerancing, Precision, Accuracy & reproducibility of method of measurements. Equipment failure pattern, Product rule, parallel redundancy, failure rate, MTBF, MTTF, system reliability, Quality costs.

**References:**

1. Grant E. L. and Levenworth R., "Statistical Quality Control", McGraw Hill Publications, New York, 2005.
2. Montgomery D.C., "Introduction to Statistical Quality Control", John Wiley and Sons, New York, 2005.
3. Mahajan M.S., "Statistical Quality Control", Dhanpat Rai and Co. Pvt. Ltd., Delhi, 2012.

4. Juran J.M. and Gryna F.M., "Quality Planning and Analysis", Tata McGraw Hill Publications, Delhi, 1995.
5. Bertrand L. Hansen, "Quality Control- theory and applications", Prentice Hall India, Delhi, 1987.

**MME 3218: AUTOMATION LAB [0 0 3 1]**

Pneumatics - Application of pneumatic cylinders, quick exhaust valve, dual pressure valve, shuttle valve, time delay valve, pressure sequence valve, pneumatic counter, solenoid valves, electrical latching circuit, pressure to electric converter, ON & OFF delay timers, proximity sensors and electrical counters. Hydraulics - Application of variable displacement pump, different types of valves, pressure switch, hydraulic accumulator, inductive sensor and hydraulic motor. Study of different types of PLC and its application.

**References:**

1. Waller D. and Werener H., "Pneumatics Workbook Basic Level", Festo Didactic GMBH & Co. Germany, 1983.
2. Rouff C., Waller D. and Werener H., "Electropneumatics Workbook Basic Level", Festo Didactic GMBH & Co. Germany, 1983.
3. Bosch Rexroth AG., "Project Manual Industrial Hydraulics", RE 00845/04.07.
4. Rexroth AG, "Trainer's Manual Electro Hydraulics", R900071655.

**MME 3219: METROLOGY LAB [0 0 3 1]**

Study of measuring instruments and gauges, Screw thread measurements, Measurement of effective diameter of external screw threads, Use of Comparators, Measurement of gear dimensions, Radius and angle measurement, Calibration of Micrometer and Vernier caliper, Surface texture and straightness measurement, Use of Profile projector, Coordinate Measuring Machine and Interferometer.

**References:**

1. Jain R. K., "Engineering Metrology", Khanna Publishers, New Delhi, 1997.
2. Gupta I. C., "Engineering Metrology", Dhanpat Rai Publications, New Delhi, 1997.
3. Raghavendra N. V. and Krishnamurthy L., "Engineering Metrology and Measurements", Oxford University Press, 2013.

**SEVENTH SEMESTER**

**HUM 4002: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]**

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation, Sinking fund and service output methods, Costing and its types Job costing and Process costing, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios

**References:**

1. Blank Lel and T. Tarquin Anthony J., "Engineering Economy", McGraw Hill, New Delhi, 2002.
2. Chan S. Park, "Contemporary Engineering Economics", Pearson Education Inc., 2010.
3. Raman B. S., "Advanced Accountancy", United Publications, Bangalore, 1993.
4. Ramachandran T., "Accounting and Financial Management", Scitech Publications Pvt. Ltd. India., 2001.
5. Thuesen G. J. and Thuesen H. G., "Engineering Economics", Prentice Hall of India, New Delhi, 2005.

**MME 4102: FINITE ELEMENT METHODS [2 1 0 3]**

Review of matrix algebra, Basics of theory of elasticity, Basics concepts of the Finite element method-discretization, types of elements, degrees of freedom, displacement models, convergence, displacement polynomial, Pascal's triangle, higher order elements, Lagrange & Serendipity polynomials, sub-parametric, super-parametric & iso-parametric elements, local and global coordinate systems, shape functions, Finite element formulation by Direct stiffness method-application of structural, thermal & flow problems. Finite element formulation by iso-parametric approach, Finite Element Formulation by the Weighted residual method, Application of the Finite element method to structural dynamics.

**References:**

1. Daryl L. Logan, "A First course in Finite Element Method", Fourth India Edition, Thompson Ltd, India, 2007.
2. David V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill. India, 2005.
3. Chandrupatta T. R. and Belegundu A. D., "Introduction to Finite Elements in Engineering", Pearson Education. New York, 2001.
4. Reddy J. N., "An Introduction to Finite Element Method", (3e), McGraw Hill International Edition. New York, 2006.
5. Larry J. Segerlind, "Applied Finite Element Analysis", (2e), John Wiley, New York, 1984.

**MME 4111: TOOL ENGINEERING AND DESIGN [3 1 0 4]**

Nomenclature systems of single point cutting tools. Geometry of twist drills and milling cutters. Kinds and mechanism of tool wear, Tool failure criteria, Taylor's tool life equations, Effects of process parameters on tool life. Design of single point cutting tool, form tools, drill bits, milling cutters, broaches. Design of jigs and fixtures- functions and elements of jig and fixtures, design procedure, design of drill jigs, design of milling fixtures. Press tool design-theory of press tool action, methods of reducing cutting forces, design principles, design of different types of dies and punch, die materials, method of punch support, design of elements of press tools, design of forming and drawing dies.

**References:**

1. ASME hand book, "Fundamentals of Tool Design", Society of Manufacturing Engineers, New York, 1991.
2. Juneja B. L. and Sekhon G. S., "Fundamentals of Metal Cutting and Machine Tools", New Age International (P) Ltd. Delhi, 1995.
3. Shaw M. C., "Metal Cutting Principles", Clarendon Press, Oxford, 1996.
4. Nagpal G. R., "Tool Engineering & Design", Khanna Publishers, Delhi.
5. Joshi P. H., "Jigs and Fixture", Wheeler Publishing, Mumbai, 1996.

**MME 4112: PRODUCTION AND OPERATIONS MANAGEMENT [3 1 0 4]**

Introduction to production & operations management, functions, types of production activities and organizational aspects. Plant Location- factors affecting and methods of plant location. Product Development & Design-factors affecting and process analysis. Capacity Planning- factors affecting, decision tree analysis. Forecasting- importance and techniques, forecast control. Aggregate Planning- pure and mixed strategies using trial & error approach. Job shop scheduling- index method & sequencing techniques. Inventory Control- introduction, classification, inventory control models, quantity discount concept, reorder level, ABC analysis. MRP- introduction and MRP processing logic. Assembly line balancing- meaning and techniques.

**References:**

1. Monks Joseph G., "Operations Management", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2004.
2. Krajewski Lee J. and Ritzman Larry P., "Operations Management", Pearson Education (Singapore) Pte. Ltd., Delhi, 2005.
3. Adam Everett E. Jr. and Ebert Ronald J., "Production and Operations Management", Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Chase Richard B., Aquilano Nicholas J. and Jacobs F. Roberts, "Production and Operations Management", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1999.
5. Eilon Samuel, "Elements of Production Planning and Control", Universal Publishing Corporation, Mumbai, 1991.

**MME 4116: FEM LAB [0 0 6 2]**

Finite element analysis-Truss analysis, Beam analysis, 2D and 3D structural analysis, Thermal analysis, Shell analysis, Modal and Harmonic analysis, Fluid analysis. MATLAB programming-Programming for solving plane/space truss, 2D beams and plane stress and plane strain problems.

**References:**

1. Daryl L. Logan, "A First Course in Finite Element Method", (4e), Thompson Ltd. India, 2007.
2. ANSYS Classic/Workbench Software Manual.
3. Rudra Pratap, "Getting Started with MATLAB", Oxford University Press, 2006.

**MME 4118: ADVANCED MATERIAL TESTING LAB [0 0 3 1]**

Heat treatment of steel- Annealing, Normalizing, Hardening and Tempering. Casting of aluminium alloy and deformation study. Estimation of sliding wear properties. Specimen preparation as per ASTM standard and study of tensile properties of heat treated samples. Investigation of fatigue property using rotating beam testing machine, Determination of external flaw using dye penetrant test. Specimen preparation of heat treated and deformed samples and Microstructure study using Metallurgical Microscope, Microhardness study using Vickers Hardness Tester.

**References:**

1. Suryanarayana A. V. K., "Testing of Metallic Materials", PHI, 1990.
2. Khanna and Justo, "Highway Materials Testing", Nemchand, 1989.
3. Technical Teachers' Training Institute, "Laboratory Manual of Strength of Materials", Oxford University Press, 1983.
4. Raghavan V, "Material Science and Engineering", (4e), Prentice Hall of India, Delhi, 1989.

5. Rajan T. V., Sharma C. P. and Alok Sharma, "Heat Treatment Principles and Techniques", PHI Publication, Delhi, 1999.

4. Chitale A. K. and Gupta R. C., "Product Design and Manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi, 2005.

5. George E. Dieter, "Engineering Design", McGraw Hill Book Co., Singapore, 2000.

## EIGHTH SEMESTER

### MME 4297: SEMINAR

- ▶ Each student has to present a seminar individually, on any technical topic of current interest / latest advancement / topics not covered in the syllabus.
- ▶ The topic has to be approved by the Department and a report of the same has to be submitted a week before the day of the presentation.

### MME 4298: INDUSTRIAL TRAINING

- ▶ Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester.
- ▶ Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

### MME 4299: PROJECT WORK / PRACTICE SCHOOL

- ▶ The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions.
- ▶ The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks.
- ▶ A mid-semester evaluation of the project work shall be done after about 8 weeks.
- ▶ An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation.
- ▶ The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form.
- ▶ Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

## MINOR SPECIALISATIONS

### I. MACHINE DESIGN

#### MME 4001: DESIGN FOR MANUFACTURE AND ASSEMBLY [3 0 0 3]

Essential factors of product design, morphology of design, producibility requirements in design, DFMA-History, advantages of DFMA in product design, selection of materials and processes. Sand casting-design rules for sand castings, Investment casting-design guidelines. Characteristics of the forging process, design guidelines, Design guidelines for turning, drilling, reaming, shaping, slotting, milling, grinding, and design guidelines for heat treatment. Design for die-casting. Design for sheet metal working, Design for injection molding, Design for powder metal processing, assembly methods, importance of DFA, basic DFA guidelines, product design for manual assembly, design for high-speed automatic assembly and robot assembly, case studies on DFMA, importance of Fits, tolerance and surface finish in design, production drawings.

#### References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for Manufacture and Assembly", CRC Press, 2011.
2. James G. Brala, "Design for Manufacturability Handbook", McGraw Hill, New York, 1999.
3. Kevin Otto and Kristin Wood, "Product Design", Pearson Education, Delhi, 2001.

#### MME 4002: DESIGN OF MECHANICAL SYSTEMS [3 0 0 3]

Mechanical design process, design factors, design of mechanical systems - Flange coupling, Screw jack, Piston, Connecting rod, Crankshaft- Overhung & Center type, Valve gear mechanism, Single plate clutch, Passenger lift, Concrete mixer, Automobile chassis & suspension. Johnson's method of optimization. Design for manufacture of cast, forged, turned, milled, drilled and ground parts, design for heat treatment, design for assembly.

#### References:

1. Bhandari V.B., "Design of Machine Elements", (3e), Tata McGraw Hill Publishing Company, New Delhi, 2010.
2. Trikha S. N., "Machine Design Exercises", Khanna Publishers, Delhi, 2001.
3. Patil S. P., "Mechanical System Design", Jaico Publishing House, Mumbai, 2004.
4. George E. Dieter, "Engineering Design", McGraw Hill Book Co., Singapore, 2000.
5. Mahadevan K. and Balaveera Reddy K., "Machine Design Data Hand Book", (4e), CBS Publishers and distributors, New Delhi, 1987.

#### MME 4003: FATIGUE AND FRACTURE [3 0 0 3]

Structure and deformation of materials, fatigue design philosophies, fatigue mechanisms and microscopic features, macro aspects of fatigue of metals. High cycle fatigue - stress-life (S-N) curves, general S-N behavior, fatigue limits, mean stress effects on S-N behavior, factors influencing S-N behavior, life estimation using S-N approach, concepts of cumulative damage and life prediction. Low cycle fatigue, cyclic stress-strain curve determination, fatigue crack initiation in ductile solids, cyclic deformation and crack initiation in brittle solids. Strain-life approach, notch strain analysis and the strain-life approach. Linear Elastic Fracture Mechanics, Griffith's analysis, stress and displacement field, stress intensity factor (SIF), Plane strain fracture toughness. Fatigue Fracture Mechanics, Crack closure and Fatigue threshold, Effect of over load on fatigue crack growth.

#### References:

1. Dowling N. E., "Mechanical Behavior of Materials", (4e), Pearson Education, 2012
2. Suresh S., "Fatigue of Materials", (2e), Cambridge University Press, 1998
3. Stephens R. I., Fatemi A., Stephens R. R. and Fuchs H. O., "Metal Fatigue in Engineering", (2e), John Wiley & Sons, 2000
4. Bannantine J. A., Comer J. J. and Handrock J. L., "Fundamentals of Metal Fatigue Analysis", Prentice Hall, 1990
5. Prashant Kumar, "Elements of Fracture Mechanics", McGraw Hill Education, 2009

#### MME 4004: TRIBOLOGY [3 0 0 3]

Introduction to tribology, History of tribology, Interdisciplinary Approach, Economic Benefits, History of Lubrication, Types & Properties of Lubricants, Lubricants Additives, Boundary Lubrication, Mixed Lubrication. Equation of Continuity & Motion, Generalized Reynolds Equation with Compressible & Incompressible Lubricant, Hydrodynamic & Hydrostatic lubrication, Elastohydrodynamic lubrication. Causes of Friction, Adhesion Theory, Abrasive Theory, Junction Growth Theory,

Laws of Rolling Friction, Friction Instability. Wear Mechanisms and Wear Analysis. Surface engineering, Rolling Contact Bearings, Gears, Journal Bearings - Finite Bearings, Condition Monitoring. Surface topography measurements, electron microscope and friction and wear measurements laser method, bearing performance measurements, bearing vibration measurement.

**References:**

1. Cameron A., "Basic Lubrication Theory", Ellis Horwood Ltd, Chichester, 1983.
2. Majumdar B.C., "Introduction to Tribology of Bearings", A. H. Wheeler & Co. Pvt. Ltd., Allahabad, 1999.
3. Williams J.A., "Engineering Tribology", Cambridge University Press, UK, 2005.
4. Neale, M.J., "Tribology Hand Book", Butterworth Heinemann, London, 1995.
5. Stachowiak G. N., Batchelor A. W. and Stachowick G. B., "Experimental methods in Tribology", Tribology Series 44, Editor D Dowson, 2004.

**II. MANUFACTURING**

**MME 4005: COMPOSITE MATERIALS [3 0 0 3]**

Introduction: Definition, classification, types of matrices & reinforcements, characteristics & selection. Micro mechanical analysis of a lamina: Introduction, derivation of stress, strain, modulus of elasticity of fiber reinforced composites. Manufacturing of polymer composites: Description of method, advantages, disadvantages and application. Metal matrix composites and ceramic matrix composites: reinforcement, matrix materials, base metal characteristics & selection, manufacturing and applications. Design issues and structural component design process. Application developments in aircrafts, missiles, space, automobile, electrical and electronics, marine, recreational and sports equipment's and construction.

**References:**

1. Mein Schwartz, *Composite Materials Handbook*, McGraw Hill Book Company, 1984.
2. Autar K. Kaw, *Mechanics of Composite Materials*, CRC Press, 2010.
3. Mallik P.C., *Fiber Reinforced Composites*, Marcel Decker, 1993.
4. Rober M. Jones, *Mechanics of Composite Materials*, McGraw Hill Kogakusha Ltd, 2008.
5. Michael W, Hyer, "Stress Analysis of Fiber Reinforced Composite Materials", McGraw Hill International, 1998.

**MME 4006: HEAT TREATMENT OF METALS AND ALLOYS [3 0 0 3]**

Introduction to Iron-Carbon equilibrium diagram & Fundamentals of heat treatment, decomposition of austenite, TTT diagram, Conventional case and Surface hardening treatments, factors affecting hardening, laser hardening. Age hardening and Thermo-mechanical treatments for Aluminium and Non-Ferrous alloys, Ausforming, Isoforming, Thermo-mechanical annealing Steel specification, Classification and Application of steels and Cast iron with heat treatments, commercial steel, stainless steel, maraging steel, Malleabilization. Heat treatment and Application of non-ferrous metals and alloys defects, causes and remedies in heat treatment.

**References:**

1. Rajan T. V., Sharma C P and Sharma Alok, "Heat Treatment Principles and Techniques", PHI Publication, 1999.

2. Bolton W., "Engineering Materials Technology", Heinmann Newness, 2001.
3. Thelning K. E., "Steel and its Heat Treatment", Butterworth / Heinemann, 2000.
4. Romesh C Sharma, "Principles of Heat Treatment of Steels", New Age International (P) Limited, 1996.
5. Singh Vijendra, "Heat Treatment of Metals", Standard Publishers Distributors, 2012.

**MME 4007: LEAN MANUFACTURING [3 0 0 3]**

Framework of Toyota Production System, Introduction to Value Stream Mapping, Characteristics of lean value stream. Introduction to Kanban, Kanban Team Formation, Data Collection, Determining the Kanban Size, Supplier Kanban, Finished Goods Kanban, EOQ vs Kanban Quantity, Production Smoothing, Shortening Production Lead Time, Multifunction Workers, Shortening Setup Time Concepts And Techniques, Organization Structure for Promoting Setup Time Reduction, Standardization of Operations, Yo-i-Don System, One Shot Setup, Determining The Standard Quantity of Work In Progress, Preparing The Standard Operation Sheet.

**References:**

1. Monden Y, "Toyota Production System: An Integrated Approach to Just-In-Time", (4e), CRC Press, 2011.
2. Rother M and Shook J, "Learning to See: Value Stream Mapping to add Value and Eliminate Muda", The Lean Enterprise Institute, 1999.
3. Gross J M and McInnis K R, "Kanban Made Simple: Demystifying and Applying Toyota's Legendary Manufacturing Process", AMACOM books, 2003.
4. Feld W M, "Lean Manufacturing: Tools, Techniques and How to Use Them", CRC Press, 2001.
5. Dailey K W, Wieckhorst D and Welch B, "The Lean Manufacturing Pocket Handbook", DW Publishing, 2003.

**MME 4008: MACHINE TOOL TECHNOLOGY [3 0 0 3]**

Working and Auxiliary motions in machine Tools, Parameters defining working motions of a machine tool, Machine tool drives-individual drive, Group drive, Mechanical Drives for providing rotational movements, Selection of range of spindle speeds, Typical layouts for intermediate spindle speeds, Construction of speed diagram, Layout of speeds in GP, Saw diagram of a GP series, Rules for layout of speed boxes having sliding clusters, Flow Diagram, Ray diagram, Types of Feed Gear Boxes, Functions and Requirements of machine tool structures, Profiles, Factors affecting stiffness of machine tool structures & Methods of improving it, Commonly used bed and column sections, Antifriction guide ways, Protecting devices, Spindles, Milling & Drilling machines, Antifriction bearings, Elimination of vibration, Machine tool chatter, Vibration isolated tool holders.

**References:**

1. Mehta N K, "Machine Tool Design & Numerical Control", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2012.
2. Sen and Bhattacharya, "Principles of Machine Tools", New Central Book Agency, Calcutta, 2001.
3. CMTI., "Machine Tool Design Handbook", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2004.
4. Basu S K, "Design of Machine Tools", Oxford & IBH, Delhi, 1989.
5. George Schlesinger, "Testing Machine Tools", Pergamon Press, Oxford, 1982.



### III. THERMAL ENGINEERING

#### MME 4009: COMPUTATIONAL FLUID DYNAMICS [3 0 0 3]

Models of fluid flow: Continuity, Momentum and Energy equations in Cartesian coordinate system, General characteristic of the governing equations: The initial and boundary conditions, The format of the differential equation for the conservation: Discretization Process, Methods of deriving the discretized equations, Explicit Taylor series expansion, Application of the explicit finite difference technique to one dimensional steady state heat transfer in a rectangular fin, Unsteady conduction heat transfer: Explicit, Implicit and Crank Nicholson Methods, Discretization using control volume technique: The Four basic rules in control volume formulation, Discretization of source terms and linearization, The SIMPLE algorithms to solve flow problems: Staggered Grid, the derivation of the pressure correction equation as Poisson's Pressure equation, Implementation of boundary conditions in CFD.

#### References:

1. John D Anderson Jr., "Computational Fluid Dynamics- The Basics with Applications", International Edition, McGraw Hill, New York, 1995.
2. Suhas V Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere / McGraw Hill, New York, 1980.
3. Versteeg H K and Malalasekera W, "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Longman Scientific & Technical. England, 1995.
4. Ghoshdastidar, "Computer Simulation of Flow and Heat Transfer", Tata- McGraw-Hill Book Company. New Delhi, 1998.
5. Muralidhar K and Sundararajan T, "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.

#### MME 4010: DESIGN OF THERMAL POWER PLANT SYSTEMS [3 0 0 3]

Design of Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger Recuperative Air Pre Heater, Economizer, Boiler furnace design, Estimation of inside heat transfer coefficient using Jens & Lottes equation and Thom's correlation. Estimation of pressure drop in two phase flow using Thom's method, Super heater and Re-heater Design: Estimation of flow in each element of a tube assembly. Estimation of attenuation factor and direct radiation from furnace, Design of Steam Condenser-estimation of tube side velocity, surface area and pressure drop for various tube sizes & Plot the graph) and estimation of shell diameter of steam condenser, Design of Cooling Tower.

#### References:

1. Kern D.Q., "Process Heat Transfer", McGraw-Hill Publications, 1965.
2. Ganapathy V., "Applied Heat Transfer", Penn Well Publishing Company, Tulsa, Oklahoma, 1982.
3. Sarit Kumar Das, Balakrishnan A R, "Process Heat Transfer", Alpha Science International, 2005.

#### MME 4011: JET PROPULSION AND ROCKET TECHNOLOGY [3 0 0 3]

Jet Propulsion, Thrust equation, Efficiencies: Ram efficiency, thermal efficiency, propulsive efficiency, propeller efficiency. Propulsive Devices: turbo jet, turbo prop engine, turbo shaft engine, Ram jet, pulse jet, Rocket Propulsion, Principle of rocket propulsion, thrust equation, Criteria for Rocket-Motor Performance- specific impulse, total impulse, Chemical Rockets: Solid propellant rockets, types of solid propellant, burning rate, solid propellant grain configurations. Liquid propellant rockets, Feed systems and injectors. Gaseous propellant rockets, Developments in

Rocket Technology: nuclear propulsion systems, Electrical propulsion and Hybrid rockets.

#### References:

1. Zucrow, "Aircraft and Missile Propulsion", Vol I and II, John Wiley, New York. 1958.
2. Jain J K, "Gas Turbine Theory and Jet Propulsion", (7e), Khanna Publishers. New Delhi, 1972.
3. Mathur M L and R P Sharma, "Gas Turbines and Jet Propulsion", Standard Publishers Distributors, Delhi, 2000.
4. Yahya S M, "Fundamentals of compressible flow with aircraft and rocket propulsion", New Age International Pvt.Ltd. New Delhi, 2004.
5. Ganesan V, "Gas Turbines", Tata McGraw-Hill, New Delhi. 2005.

#### MME 4012: REFRIGERATION AND AIR CONDITIONING SYSTEMS [3 0 0 3]

Basic concepts and Air Refrigeration Cycles, Vapor Compression Refrigeration Systems, Vapor Absorption Refrigeration Systems, Compound vapour compression refrigeration system. Multi-evaporator and cascade systems, Classification of Refrigerants, Comparison of thermodynamic properties of refrigerants, Alternate Cooling Methods: Desiccant Cooling System, Solar Refrigeration, Thermo Electric Refrigeration, Analysis of Steam Jet Ejector Cycle, Refrigeration, Psychrometry, Psychrometric charts, Process involving Air-Vapour Mixtures, Air Conditioning Systems, Types of Air Conditioners, Load Estimation for inside and outside design conditions. Different types of heat loads.

#### References:

1. Arora S.C.and Domkundwar S., "Course in Refrigeration and Air-conditioning", Danpath Rai. New Delhi, 1992
2. Cook Norman, "Refrigeration and Air conditioning", Macmillan London, 1995
3. Stocker W.F., "Refrigeration and Air conditioning", Tata McGraw Hill, 1978
4. Prasad Manohar, "Refrigeration and Air conditioning", New Age International Pvt. Limited. New Delhi, 2004
5. Gauger D. C., Shapiro H. N., Pate M. B., "Alternative Technologies for Refrigeration and Air Conditioning Applications", Springfield, Washington DC, 2008

### IV. BUSINESS MANAGEMENT

#### HUM 4011: FINANCIAL MANAGEMENT [2 1 0 3]

Introduction to financial management, Principle of accountancy, Sources of long term finance, Valuation of securities, Leverages, Working capital management, Capital budgeting, Cost of capital, Cash management, and Dividend decisions.

#### References:

1. Prasanna Chandra, "Fundamentals of Financial Management", Tata McGraw Hill, Delhi, 2006.
2. Pandey I M, "Financial Management", Vikas Publishing house, Delhi, 2007.
3. Subir Kumar Banerjee, "Financial Management", Sultan Chand & Co., Delhi, 1999.
4. ICFAI, "Corporate Financial Management", ICFAI, Hyderabad, 2003.
5. Maheshwari S.N., "Financial Management", Sultan Chand & Co., Delhi, 2002.

#### **HUM 4012: HUMAN RESOURCE MANAGEMENT [2 1 0 3]**

Evolution and development, HRD Organization and responsibilities. Evolution of HRM, Theories of HRM. Human resource planning, Human Resources Inventory, Forecast, Job analysis, Job description, Job specification, Job evaluation, Employment stability. Human Resource Planning and Recruiting, Induction, & socialization, Training and development, Performance management and appraisal.

##### **References:**

1. Rao T V and Pereira D F, "*Recent experiences in Human Resources Development*", Oxford and IBH Publishing, 1986.
2. Subba Rao A, "*Essentials of Human Resource Management and industrial Relations*", Himalaya Publishing House, 1999.
3. Nair N G and Latha Nair, "*Personnel Management and Industrial Relations*", S. Chand Company, 1999.
4. Virmani B R; Rao Kala, "*Economic restructuring technology transfer and human resource development*", Response books, 1997.
5. Pareek Udai et al, "*Human Resource Development in Asia: Trends and Challenges*", Oxford and IBH Publishing, 2002.

#### **HUM 4013: MARKETING MANAGEMENT [2 1 0 3]**

Understanding marketing management, Assessing market opportunities and customer value, Adapting marketing to the New Economy, Building Customer Satisfaction, Value, and Retention, Market Demand, Scanning the Marketing Environment, Consumer Markets, Business Markets, Dealing with the Competition, Market Segments, Product Life Cycle, New Market Offerings, Designing and Managing Services, Price Strategies, Retailing, Wholesaling, Integrated Marketing Communications.

##### **References:**

1. Phillip Kotler, "*Marketing Management Analysis, Planning, Implementation and Control*", Prentice Hall of India Private Limited, New Delhi, 2000.
2. ICFAI, "*Marketing Management*", ICFAI, Hyderabad, 2003.
3. Varshney R L and Gupta S L, "*Marketing Management*", Sultan Chand & Sons, New Delhi, 2004.
4. Adrian Palmer, "*Principles of Marketing*", Oxford University Press, New York, 2000.

#### **HUM 4014: OPERATIONS AND SYSTEMS MANAGEMENT [2 1 0 3]**

Types of production activities, Production consumption cycle, Functions of production and operations management, Importance and uses of forecasting, Product development and design: Product life cycle, Process design, Process charts, Flow diagrams and Man machine charts, Capacity planning, Aggregate planning, Scheduling, Operations strategy, Operation performance Frontier and productivity, Systems thinking, Systems engineering and its management, Systems decision process. Systems thinking, structure, classification, boundaries, visibility, System life cycle models, System dynamics and its importance in system thinking. System dynamics modeling process.

##### **References:**

1. Monks Joseph G, "*Operations Management*", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2004.
2. Krajewski Lee J. and Ritzman Larry P, "*Operations Management*", Pearson Education (Singapore) Pte. Ltd., Delhi, 2005.
3. Mieghem J, "*Operations Strategy: Principles and Practices, Dynamic Ideas*", ISBN: 0-9759146-6-9.2008.
4. Stermann J D, "*Business Dynamics - Systems Thinking and Modeling for A Complex World*", McGraw Hill, International Edition, 2004.

5. Senge Peter, *The Fifth Discipline*, Currency Doubleday, New York, 1990.

#### **OTHER PROGRAM ELECTIVES**

#### **MME 4015: CORROSION SCIENCE AND ENGINEERING [3 0 0 3]**

Definitions, Corrosive Environments, Consequences of Corrosion, Cost of Corrosion, Corrosion Science and Corrosion Engineering, Fundamental aspects of Corrosion. Corrosion Cell, Cathodic and Anodic Reactions, Types of Corrosion Cells, Reference Electrode, Calomel Electrode, Pourbaix Diagrams. Corrosion Rate Expressions, Electro-Chemical nature of Aqueous Corrosion, Polarization, Factors influencing Corrosion Rate. Types of Corrosion, Measuring Polarization, Anodic Polarization, Cathodic Polarization, Activation Polarization and Concentration Polarization. Corrosion Prevention, Materials Selection, Alteration of Environments, Design, Cathodic and Anodic Protection, Corrosion Inhibitors, Coatings. Methods used to determine Corrosion Rate, Weight Loss Measurements, Linear Polarization, Tafel Extrapolation Techniques.

##### **References:**

1. Ahmed Zaki, "*Principles of corrosion Engineering and corrosion control*", Elsevier science and technology Books, 2006.
2. Mars G. Fontana, "*Corrosion Engineering*", (3e), Tata McGraw Hill, 2008.
3. Trethewey K. R. and Longman J. Chamberlain, "*Corrosion for students of science and engineering*", Scientific and Technical, 1988.
4. Schweitzer A Philip, "*Fundamentals of corrosion-Mechanisms, Causes and preventive methods*", CRC Press, Taylor and Francis Group, 2010.
5. Uhlig H. H. and Revie R. W., "*Corrosion and Corrosion Control*", Wiley, 1985.

#### **MME 4016: ELEMENTS OF MECHATRONICS SYSTEMS [3 0 0 3]**

Introduction: Definition, basic concepts and elements of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors, Transducers: Displacement. Piezoelectric actuators, Shape memory alloys. Hydraulic & Pneumatic devices Power supplies, valves, cylinder sequencing. Data acquisition and translation: Signal conditioning Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Pulse width Modulation Counters, decoders, ADC, DAC Signal Analysis - Linearization of data, Compensation, Signal Averaging, Fourier analysis. Data presentation system: Display - Cathode ray oscilloscope, LED, LCD, Printers, Magnetic Recording, Controllers and Algorithms: Microprocessor Applications.

##### **References:**

1. Alciatore David G & Hystand Michael B, "*Introduction to Mechatronics and Measurement systems*", Tata McGraw Hill, 2003.
2. Bolton W, "*Mechatronics*", Addison Wesley Longman Ltd, 1999.
3. Devdas Shetty & Richard Kolk, "*Mechatronics System Design*", PWS Publishing, 2001
4. Dan Nesculescu, "*Mechatronics*", Pearson Education Pvt. Ltd, 2002.
5. Bradley D A and others, "*Mechatronics*", Nelson Thornes Chennai, 2004.

### **MME 4018: FRICTION AND WEAR [3 0 0 3]**

Influence of material properties, rolling friction, Measurement of friction, friction coefficient values. Mechanism of adhesive wear, shapes of transferred and loose wear particles, size distribution of wear fragments, quantitative laws of adhesive wear, wear coefficients, Abrasive wear, Corrosive wear, Impact wear, Hydrodynamic, hydrostatic and elasto-hydrodynamic lubrication, solid film lubrication, boundary lubrication single penetration and multiple penetration models. Effectiveness of liquid lubricant and solid lubricant. Rebuilding and surfacing cements, wear tiles, electro spark deposition coatings, fused carbide cloth, thermal/chemical deposited ceramic coatings, centrifugal cast wear coatings, wear sleeves, wear plates.

#### **References:**

1. Rabinowicz E, "*Friction and Wear of Materials*", John Wiley & Sons, Inc., 1995.
2. Bharat Bhushan, "*Principles and applications of Tribology*", John Wiley & Sons Inc., 1999.
3. Arnell R D, Davies P B, Halling J & Whomes T L, "*Tribology: Principles and design applications*", Macmillan Education Ltd, 1991.
4. Kragelsky I V, "*Friction Wear Lubrication Tribology hand book*", Vol 1, 2 & 3, MIR Publishers, 1981.
5. Majumdar B. C., "*Tribology of Bearings*", Wheeler Publisher, 1990.

### **MME 4019: INDUSTRIAL ROBOTICS [3 0 0 3]**

Definition of Robots; Types of Robots; Robot Configuration; Selection of Robots; factor affecting the control resolution, Spatial resolution, Accuracy and repeatability, Specification of a robot, Robot arm/manipulator Kinematics, Types of Grippers; Force Analysis of gripper mechanism; Classification of Actuators; Actuators used in Robots - DC motors, Stepper motors, AC motors and Servo motors, Robot Transmission Systems; Sensors; Types and classification of robot sensors, Positional potentiometer, Velocity tachometer, Working of resolver, Optical encoder, Magneto resistive skin, Hall generator, Electro-magnetic & Adhesive end effectors, proximity sensors; Tactile Sensing; Robot Vision.

#### **References:**

1. Janakiraman P.A., "*Robotics and Image Processing*", Tata McGraw Hill, 1995.
2. Groover M.P., "*Industrial Robotics*", PHI, 2008.
3. Jain K.C., Aggarwal L.N., "*Robotics Principles and Practice*", Khanna Publishers, 1997.
4. Fu, Gonzalez and Lee, "*Robotics: Control, Sensing, Vision and Intelligence*", Tata McGraw Hill, 2008.
5. Hegde Ganesh S, "*A textbook on Industrial Robotics*", Laxmi Publications (P) Ltd, 2006.

### **MME 4021: MATERIALS CHARACTERIZATION [3 0 0 3]**

Basic physical and mechanical properties of materials, X-ray Diffraction Methods, X-ray Radiation, Generation of X-rays, Distortions of Diffraction Spectra, Wide Angle X-ray Diffraction and Scattering, Microscopic material characterization, Light Microscopy - Optical Principles, Image Formation, Resolution, Depth of Field, Aberrations, Instrumentation, illumination system. Confocal microscopy, Scanning Electron Microscopy. Contrast formation, electron specimen Interactions, preparation for micro-composition examination, Transmission Electron Microscopy, Selected Area Diffraction Characteristics, Single-Crystal Diffraction, Multi-Crystal Diffraction, Kikuchi Lines. Images of Crystal Defects, Wedge Fringe, Bending

Contours, Dislocations. Differential Thermal Analysis and Differential Scanning Calorimetry, Thermogravimetry, interpretation of TG curves.

#### **References:**

1. Yang Leng, "*Materials Characterization: Introduction to Microscopic and Spectroscopic Methods*", John Wiley & Sons (Asia) Pvt. Ltd, Singapore, 2008.
2. Sam Zhang, Lin Li, Ashok Kumar, "*Materials Characterization Techniques*", CRC Press, 2008.

### **MME 4022: MEMS AND NANOTECHNOLOGY [3 0 0 3]**

General methods of preparation of nanoparticles, Carbon nanostructures and their Applications. Nanosized Structures, Physical chemistry of nanosystems, Nanoparticles, Nanowires and Nanorods, Thin films- Self assembled monolayers, Experimental techniques- Temperature measurement techniques, Atomic Force Microscopy, Scanning Tunneling Microscopy, Spectroscopy and Diffraction techniques. Micro Electro Mechanical Systems, MEMS, Micro and Nanoscale Thermal Engineering, Nanofluids preparation and Characterization, Properties of nanofluids, Nanomaterials used in energy and Environmental applications and their Properties. Device applications in hydrogen storage and Production, Fuel cells, Battery, Solar energy conversion, Waste water treatment, Pollution remedies, Nanomaterials in automobiles. Challenges and Scope.

#### **References:**

1. Charles P Poole, "*Introduction to Nanotechnology*", Wiley-Interscience Publication, 2003.
2. Guozhong Cao, "*Nanostructures & Nanomaterials*", Imperial College Press, 2004.
3. Sobhan C B, "*Microscale and Nanoscale Heat Transfer*", Taylor and Francis Publication, 2008.
4. Mohamed Gad-el-Hak, "*The MEMS Handbook*", Taylor and Francis Publication, 2005.
5. James J Allen, "*MEMS Design*", Taylor and Francis Publication, 2005.

### **MME 4023: MICRO MACHINING [3 0 0 3]**

Micromachining, Traditional Micromachining Processes, Materials for micromachining, Advanced Micromachining and Nanofinishing, Abrasive Water Jet Micromachining (AWJMM), Ultrasonic Micromachining (USMM), Abrasive Jet Micromachining (AJMM), Thermoelectric Advanced Micromachining, Electric Discharge Micromachining (EDM), Electric Discharge Grinding (EDG) And Electric Discharge Diamond Grinding (EDDG), Wire Electric Discharge Micromachining, Laser Beam Micromachining, Electron Beam Micromachining. Electrochemical and Chemical Advanced Machining, Chemical Micromachining (ChMM). Wafer bonding- Anodic bonding, Fusion bonding, CVD and PVD processes, Spin coating, Evaporation and Epitaxy, Laser ablation technique. Bulk and Surface Micromachining Techniques, Micromachining Tools.

#### **References:**

1. Jain V. K., "*Introduction to Micromachining*", Narosa Publishers, New Delhi, 2010.
2. Jain V. K., "*Advanced Machining Processes*", Allied Publishers Private Limited, New Delhi, 2009.
3. Mojtaba Kahrizi, "*Micromachining Techniques for Fabrication of Micro and Nano Structures*", Intech, 2012.

#### **MME 4024: NON DESTRUCTIVE TESTING [3 0 0 3]**

NDE in Design, Maintenance and Service, Benefits of NDE, Choosing the NDE technique, Qualifications of NDE personnel, Penetrant Inspections, penetrant testing materials and processes, penetrant testing methods and systems, sensitivity, standards, Magnetic Particle Testing, Ultrasonic Testing, Elastic wave propagation, Ultrasonic Transducers, Criteria for probe selection, Inspection techniques, ultrasonic techniques for stress measurement and material studies, Radiographic Techniques, electromagnetic radiation sources, properties of X- and gamma rays. Radiographic imaging, Radiographic inspection techniques, radiographic inspection systems, Eddy Current Testing (ECT), 3D or phased array ECT. Acoustic Emission Testing, Thermography, impact echo method of testing, phased array techniques, laser testing methods, vibration testing and analysis methods.

##### **References:**

1. Don E Bray and Roderic K Stanley, *“Nondestructive Evaluation: A Tool in Design, Manufacturing and Service”*, Taylor and Francis Group, London, 1997.
2. Paul E Mix, *“Introduction to Nondestructive Testing-A training Guide”*, (2e), John Wiley and Sons, Inc., 2005.
3. Davis Joseph R., *“ASM Handbook: Volume 17, Nondestructive Evaluation and Quality Control”*, ASM International Materials Park, OH.
4. ASNT (Edited), *“Materials and Processes for NDT Technology”*, ASNT, USA, 1981.
5. Ensminger Dale, *“Ultrasonics: Fundamentals, Technology, Application”*, (2e), Marcel Dekker, New York, 1988.

#### **MME 4027: ORGANIZATIONAL BEHAVIOR [3 0 0 3]**

Contributing disciplines to OB, Basic OB Model. Learning, Methods of shaping behavior, Values, Attitudes and Job satisfaction, Personality, Determinants of Personality, Personality theories, Major personality attributes, Perception Attribution Theory, Selective perception, Halo effect, Contrast effect, Stereo-typing. Maslow's hierarchy of needs, Theory X and Theory Y, Frederick Herzberg's Motivation and Hygiene Theory, Contemporary Theories, Group Dynamics, Group Behaviour Model, Quality of a good leader, types and theories of leadership. Conflict, Dimensions of Conflict Handling Intentions, Virtual Organisation, Boundary less Organisation, Mechanistic and Organic Model, Factors influencing organisation structure. Work Design, Organisational Change and Organisational Development, Lewin's Three-Step Model and Action research. Organisational Development.

##### **References:**

1. Luthans Fred, *“Organisational Behaviour”*, McGraw Hill, New York, 1989.
2. Gupta Rakesh, *“Organisational Behaviour”*, Kitab Mahal, Allahabad, 1998.
3. Davis Keith and Newstrom J.W., *“Organisational Behaviour at Work”*, Tata-McGraw Hill, New Delhi, 1997.
4. Moorhead Gregory and Griffin Ricky W., *“Organisational Behaviour”*, AITBS, New Delhi, 1999.
5. Carrel Michael R., *“Fundamentals of Organisational Behaviour”*, Prentice Hall, New Jersey, 1997.

#### **MME 4028: PERSONNEL MANAGEMENT AND INDUSTRIAL RELATIONS [3 0 0 3]**

Objectives of personnel management, Functions of Personnel Management, Process of Human Resource Planning, Steps in recruitment process, Sources of recruitment, methods of

recruitment. Promotions, Demotions, Transfers, Separation, Absenteeism and Turn over, Wage and Salary administration, Performance Appraisal, Methods of Performance evaluation. Industrial Relations: Functional Requirements, Employees participation in management. Grievances and Grievance Handling, Act of Indiscipline/ Misconduct, Principles for maintenance of discipline. Industrial Disputes, Procedure for the Settlement of Disputes, Government and Industrial Relations, Organs of Industrial Peace. Trade Unions: Objectives and Functions, Growth of Trade Union Movement, Factors Affecting Growth of Trade Unions, Essentials of a Successful Trade Union.

##### **References:**

1. Mamoria, C.B., *“Personnel Management”*, Himalaya Publishing House, 2007
2. Megginson, Leon C., *“Personnel and Human Resource Administration”*, 1977
3. Beach, D.S., *“Personnel: The Management of People At Work”*, 1977.
4. Yoder and Dale, *“Personnel Management and Industrial Relations”*, 1972.

#### **MME 4029: PLANT ENGINEERING AND MAINTENANCE [3 0 0 3]**

Introduction to Industrial Building, Building maintenance and repairs, Hardener/sealers, Floor paints, Functions of coating, Constituents of paint, Ventilation systems and control, Requirement of water, Building services, Water purification processes, Membrane processes, Effluents. Measurement of noise, Vibration, Noise and Vibration control, Nature of dust and fumes, Legislation on air pollution concern to the plant engineer. Challenges in maintenance, Responsibilities of the maintenance department, Reliability centered maintenance, Total productive maintenance, Planning of maintenance function, Estimation of maintenance work, Maintenance control, Maintenance scheduling, Maintenance cost, Maintenance budgeting and cost control. Condition Monitoring, Condition monitoring levels, Techniques of condition monitoring, Future scope of condition monitoring.

##### **References:**

1. Mobley K. R., *“Plant Engineer's Handbook”*, Butterworth-Heinemann, Woburn, 2001.
2. Snow A. D., *“Plant Engineer's Reference Book”*, Butterworth-Heinemann, Woburn, 2000.
3. Mobely, Higgins and Wikoff, *“Maintenance Engineering Handbook”*, McGraw-Hill, 2008.
4. Mishra and Pathak, *“Maintenance Engineering and Management”*, PHI Learning Pvt. Ltd., 2012.
5. Jyoti Mehrotra, *“Principles and Practice of Total Productive Maintenance”*, Allied Publishers Ltd., 1998.

#### **MME 4032 : PROJECT MANAGEMENT [3 0 0 3]**

Concept of project, Project life cycle, organizing projects within the functional organization, organizing projects as dedicated teams, organizing projects within a matrix arrangement, Project manager and their attributes. Feasibility study, Pre-feasibility study, Steps of feasibility study. Estimating project times and costs, Factors influencing the quality of estimates, Top-down approaches of estimation, Bottom-up approaches of estimation, Hybrid approach of estimation. Risk management process, Risk Assessment - probability analysis, Contingency planning, Contingency funding and time buffers, Risk response control, Project scheduling, Bar charts and Milestone charts, Development of networks, Work Breakdown Structure, Program Evaluation and Review Technique, Project audit and closure, Audit reporting, Evaluation of project team and members.

**References:**

1. Gray C., Larson E. and Desai G., "Project Management The Managerial Process", Tata McGraw Hill Pvt. Ltd., New Delhi, 2013.
2. Paneer Selvam R. and Senthil Kumar P., "Project Management", PHI Learning Pvt. Ltd., New Delhi, 2010.
3. Chandra P., "Projects Planning, Analysis, Selection, Financing, Implementation and Review", Tata McGraw Hill Pvt. Ltd., New Delhi, 2009.
4. Choudhry S., "Project Management", Tata McGraw Hill Publishing Co. Ltd. New Delhi., 1997.
5. Punmia B. and Khandelwal K., "Project Planning and Control with PERT and CPM", Laxmi Publications Pvt. Ltd., New Delhi, 2006.

**MME 4034: SUPPLY CHAIN AND LOGISTICS  
MANAGEMENT [3 0 0 3]**

Objective of a supply chain, Decision phases in a supply chain, Process view of a supply chain, Role of distribution in the supply chain, Design options for a distribution network, Factors influencing network design decisions, Role of IT in network design, Making network design decisions in practice, Transportation infrastructures and policies, Tailored Transportation, Sourcing Decisions, In-house outsource, Third and fourth party logistics providers, Supply scoring and assessment, Supplier selection, Sourcing planning and analysis, Pricing and Revenue management, Pricing and revenue management for multiple customer segments, pricing and revenue management for perishable assets, Information Technology, Customer relationship management, Internal supply chain management, Supplier relationship management, Transaction management foundation.

**References:**

1. Chopra and Meindl., "Supply Chain Management Strategy, Planning and Operation", (3e), Pearson Education, New Delhi, 2009.
2. Raghuram and Rangaraj, "Logistics and Supply Chain Management: Cases and Concepts", Macmillan, New Delhi, 2000.
3. Simchi-Levi and Kaminski, "Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies", McGraw-Hill, 2003.
4. Shapiro J., "Modelling the Supply Chain", Duxbury Thomson Learning, U.S.A., 2009.

**MME 4035: TECHNOLOGY MANAGEMENT [3 0 0 3]**

Management of technology, system model, integrated and holistic model, Timing and innovation, technology and competition, Entrepreneurs and innovation, entrepreneurship in corporations, entrepreneurship, organizational barriers to innovation, venture team. Business plans for new ventures, successful product innovation, sources of venture capital, Growth of new firms, Dynamics of new firms, corporate systems, dynamic factors affecting growth, Innovation Process, Forecasting Technology, Form of technology change, S-curve jumps from radical to system innovation, Technology life cycle, economic long cycles, Kondratieff waves, Technology and marketing, Sources of innovation, market pull and technology push, Corporate research, Project strategy, sales volume and profitability in product life time, R&D projects, production costs, market share, profit margin.

**References:**

1. Gearard H Gaynor, "Handbook of technology management", McGraw Hill International Edition, 1996.
2. Betz Frederick, "Managing Technology", John Wiley & Sons, 2011.
3. Steele Lowell W and Badaww Michel K., "Managing Technology",
4. Narayanan V. K., "Managing Technology and Innovation for

*Competitive Advantage*", Prentice Hall, 2001.

5. Rungachari Krishna, Chari C. P., "Technology Management and Business Development".

**MME 4036: THEORY OF INTERNAL COMBUSTION ENGINES  
AND EMISSIONS [3 0 0 3]**

Introduction to IC engines, Idealized cycles, Fuel air cycles and actual cycles, modes of combustion, Stoichiometry, heat of formation, adiabatic flame temperature, chemical equilibrium, ignition limits. IC engine fuels: conventional and non-conventional fuels and their analysis. Petroleum refining processes and products, Qualities of SI and CI engine fuels and their ratings, alternative fuels: Alcohols, LPG, CNG, Hydrogen, Vegetable oils. Stages of combustion in SI and CI engines: Normal and abnormal combustion, Principle of combustion chamber design for SI and CI engines. Rotary engine, CRDI, MPFI, TBI and GDI systems, Dual fuel engines and stratified charge engines. IC engine pollutant formation, evaporative emissions, cranks case emissions and tail pipe emissions, Exhaust emission control methods- ammonia injection. EGR and positive crank case ventilation.

**References:**

1. Ganeshan V., "Internal Combustion Engines", (3e), Tata McGraw Hill Education Private Limited, New Delhi, 2007.
2. Mathur and Sharma, "A Course in I C Engines", Dhanpath Rai Publishers, New Delhi, 1981.
3. John B. Heywood, "Introduction to Internal Combustion Engines", Tata McGraw Hill Education Private Limited, New Delhi, 2011.
4. Lichty L.C., "International Combustion Engines", McGraw Hill, New Delhi, 1951.
5. Edward F. Obert, "Internal Combustion Engines and Air Pollution", Harper & Row, Publishers. Delhi, 1973.

**MME 4037: TOTAL QUALITY MANAGEMENT [3 0 0 3]**

Dimensions of Quality, Quality Planning, Quality costs Analysis, Techniques for Quality Costs, Basic concepts of Total Quality Management. Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation, TQM Principles, Customer satisfaction and Retention, Employee Involvement - Motivation, Empowerment teams, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure, TQM Tools, Benchmarking Process, Quality Function Deployment, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) - Concept of six sigma, ISO 9000:2000 Quality System - Elements, Implementation, Quality Auditing, QS 9000, ISO 14000.

**References:**

1. Besterfield Dale H., "Total Quality Management", Pearson Education, Delhi, 2006.
2. James R. Evans & William M. Lindsay, "The Management and Control of Quality", (5e), South-Western Thomson Learning, 2002.
3. Oakland John S, "Total Quality Management text with Cases", Elsevier, New Delhi, 2006.
4. Besterfield Dale H, "Total Quality Management", Pearson Education, Delhi, 2012.
5. Zeiri, "Total Quality Management for Engineers", Aditya Books, Delhi, 1992.

### **MME 4038: WORK SYSTEMS ENGINEERING [3 0 0 3]**

Productivity and work study, Productivity in the individual enterprise, Factors tending to reduce productivity, Techniques for reducing excess work content and ineffective time, Work study, Method study, Flow process charts, Flow diagram, Multiple activity chart, Travel chart, String diagram, motion economy, Twohanded process chart, Micromotion study, Therbligs, SIMO chart, Cyclegraph and Chronocyclegraph,. Use and basic procedure of work measurement, Techniques of work measurement, Time study, Rating, Introduction to Work sampling, Pre-determined time standards (PTS) and Standard Data. Restricted work, Pump diagram, Multiple machine work, Load factor, Machine interference, Interference allowance, Working environment and Ergonomics, Safety criteria, Lighting, Noise and Vibration, Ventilation, Climatic conditions.

#### **References:**

1. International Labour Office (ILO), "Introduction to work study", Universal Book Corporation, Geneva, 2001.
2. Niebel B.W. and Frievalds, A., "Methods, Standards, and Work design", McGraw-Hill, New York, 2003.
3. Barnes R.M., "Motion and Time Study-Design and Measurement of work", Willey International, Singapore, 1980.
4. George K., "Work study", Universal Publishing Corporation, Bombay, 1995.
5. Niebel B.W., "Motion and Time Study", (5e), Richard D.IrvinInc, Illinois, 1972.

### **MME 4039: BUSINESS PROCESS RE-ENGINEERING [3 0 0 3]**

Introduction to business processes, common business process in organisations, role of leader and manager, breakthrough re-engineering, BPR and performance improvement, key targets of BPR, business process redesign & improvement, Just-in-time, collaborative manufacturing, intelligence manufacturing, product planning, product design and development, Introduction to BPR, History of BPR, BPR in manufacturing industry, Benefits of BPR, BPR and information technology, BPR implementation methodology, success factors of BPR, barriers of BPR, frame work for barrier management, BPR and relevant technologies.

#### **References:**

1. Radhakrishnan R and Balasubramanian S, "Business process Re-engineering: Text and Cases", (1e), PHI Learning Private Limited, 2008
2. Jayaraman M S, Natarajan G and Rangaramanujan A V, "Business Process Reengineering", Tata McGraw Hill Education, 2007
3. Sethi V and King W R, "Organizational Transformation through Business Process Reengineering", Pearson Education India, 2003
4. Grover V, Markus M L, "Business Process Transformation", PHI Learning Pvt. Limited, 2010.

### **MME 4040: DATABASE MANAGEMENT SYSTEMS [3 0 0 3]**

Databases and Database Users, characteristics of data base approach, Data models, DBMS architecture and data independence, database languages and interfaces, Data Modeling, High level conceptual data models. Weak entity types, ER diagrams and design issues, Record Storage and Primary File Organizations, Secondary storage devices, buffering of blocks, Index Structure of Files, Single-level and multilevel ordered indexes, dynamic multi-level indexes using B-trees and B+ trees, Relational Data Model and Relational Algebra, constraints, and schemas. Structured Query Language (SQL): Basic and complex queries in SQL. Embedded SQL. Database Design.

#### **References:**

1. Elmasri Ramez and Navathe Shamkanth B., "Fundamentals of database Systems", (3e), Addison Wesley Publishing Company, 2011.
2. Raghu Ramakrishnan and Johannes Gehrke, "Database Management System", (3e), Tata McGraw Hill, 2010.
3. McFadden, Hoffer J, Prescott, "Modern Database Management", 2007.
4. Hansen Gary W. and Hansen James V., "Database Management and Design", (2e), PHI Pvt. Ltd, 2002.
5. Das Gupta and Radha Krishna, "Database Management System", Oracle, SQL and PL/SQL, 2<sup>nd</sup> Edition, 2013.

### **MME 4041: ENTERPRISE RESOURCE PLANNING [3 0 0 3]**

Introduction to ERP, ERP and related technologies, integrated management information, business modelling, integrated data model. Executive information system, data warehousing, data mining, online analytical processing, A manufacturing perspective of ERP, CAD/CAM, Materials requirement planning, bill of materials, closed loop MRP, Manufacturing resource planning, distribution requirements planning, ERP modules, Benefits of ERP, ERP implementation life cycle, implementation team training, testing, end user training, Vendors, consultants and users, Future directions in ERP, faster implementation methodologies, business models, ERP case studies.

#### **References:**

1. Alexis Leon, "Enterprise Resource Planning", (2e), Tata McGraw Hill Education, 2008.
2. Monk E and Wagner B, "Concepts in Enterprise Resource Planning", (4e), Cengage Learning, 2012.
3. Garg V K and Venkatakrishnan N K, "Enterprise Resource Planning: Concepts and Practice", (2e), PHI Learning Pvt. Limited., 2003
4. Jaiswal M and Vanapalli G, "Textbook of Enterprise Resource Planning", Macmillan, 2005.

### **MME 4042: INDUSTRIAL ERGONOMICS [3 0 0 3]**

Human factors engineering and design. Man - machine - environment interaction, system approach to human engineering. Systems and types of systems. Human sensorimotor system, biases in decision making, Man-machine-environment interactions. Theory of information and information processing. Visual and auditory displays, quantitative & qualitative displays; auditory displays, Principles of auditory displays. Anthropometry. Biomechanics of motion, functions of controls, factors influencing design of control, design of hand and foot controls. Principles of seat design, Location of component and general place arrangement, Principles of work surface and seat design. Industrial fatigue. Workers and working environment.

#### **References:**

1. Sanders M S, McCormick E J, "Human Factors in Engineering and Design", (7e), McGraw Hill Higher Education, 1993.
2. Pulat B M, "Fundamentals of Industrial Ergonomics", (2e), Waveland Press Inc., 1997.
3. Tillman P and Barry Tillman, "Human Factors Essential: An Ergonomics guide for Designers, Engineers, Scientists and Managers", McGraw Hill Ryerson limited, 1991.
4. Bridger R, "Introduction to Ergonomics", (2e), CRC Press, 2008.

### **MME 4043: MANAGEMENT INFORMATION SYSTEMS [3 0 0 3]**

Concepts of management Information System (MIS), Importance of MIS, Evolution of MIS, Computers and MIS, Typical Management Information Systems. Organizational and Information System Structure, Management and Decision making, Information Support for functional areas of management, Impact of Business on information Systems, Key ingredients of success, Organizing Information Systems, Computer hardware & Software, Telecommunications, Database management, Transaction processing & Reporting-Decision making & decision support system-AI & Expert system-office information system-MIS as technique for programmed decision. Strategic & project planning conceptual design-detailed design-implementation, Evaluation & Maintenance-Controlling of IS. System concept-control-Modelling case study in Hostel, Hospital, Hotel, Stores, Production Industries, etc.

#### **References:**

1. Davis G B and Olson M H, "Management Information Systems", Tata McGraw Hill Education, 2005
2. Laudon K C and Laudon J P, "Essentials of Management Information Systems", (10e), Pearson Education, 2012
3. Sadagopan S, "Management Information Systems", PHI Learning Pvt. Limited, 1997
4. Murdick R G and Ross J E, "Information Systems for Modern Management", (3e), PHI Learning Pvt. Limited, 1995
5. O'Brien J A and Marakas G M, "Management Information Systems", (10e), McGraw Hill/ Irwin, 2011

### **MME 4044: MATERIALS MANAGEMENT [3 0 0 3]**

Concepts, evolution, importance and scope of materials management, organizational structure, man power planning, functions of management, principles of organisation, motivation, factors and techniques of materials planning & budgeting and budgetary control, purchasing, purchasing policy, purchasing parameters and purchasing procedures. Strategic materials planning, JIT production planning, strategic materials planning, Criteria for make or buy decision, spare parts management including equipment selection, codification and standardization. Capital equipment planning and capital equipment decision and purchase of capital equipment's.

#### **References:**

1. Sharma S C, "Materials Management and Materials Handling", Khanna Publishers, 2000
2. Arnold J R T, Chapman S N and Ramakrishnan R V, "Introduction to Materials Management", (5e), Pearson Education India, 2011
3. Gopalakrishnan P and Sundarshan M, "Material Management", PHI Publications, 1999.
4. Datta K, "Materials Management: Procedures, Text and Cases", (2e), PHI Learning, 2008
5. Chitale. A.K, Gupta. R. C, "Materials Management: Text and Cases", PHI Learning, 2013.

### **MME 4045: THEORY OF METAL FORMING [3 0 0 3]**

Fundamentals of Metal Working, Metallurgical aspects of metal forming, Classification of forging processes-Hammer or drop forging, Press forging, Open die forging and Closed die forging. Calculation of forging loads, Effect of forging on microstructure, Residual stresses in forging, Forces and geometry relationships in rolling. Theories of cold rolling and hot rolling, Analysis of the extrusion process, Hydrostatic extrusion, Extrusion of tubing, Rod and Wire drawing, Tube drawing processes, Residual stress in rod, Wire and Tubes. High Energy Rate Forming Processes Comparison of HERF and Conventional methods. Presses-Types and Selection of presses-Formability of sheet metals-Principle,

Process parameters, Equipment and Application of Deep drawing, Spinning, Stretch forming, Plate bending, Press brake forming, Magnetic pulse forming, Super plastic forming, Electro forming, Fine blanking.

#### **References:**

1. Kumar Surender, "Technology of Metal Forming Processes", Prentice-Hall of India, 2008.
2. Narayanasamy. R, "Metalworking Technology, Prentice Hall", 1997.
3. Dieter, "Mechanical metallurgy", McGraw Hill, 1988.
4. Nagpal. G.R., "Metal forming processes", Khanna Publishers, 1998.
5. George E., "Dieter-Engineering Design", McGraw Hill, 2000.

### **OPEN ELECTIVES**

#### **MME 3281: CORROSION ENGINEERING [3 0 0 3]**

Definitions, corrosive environments, consequences of corrosion, cost of corrosion, corrosion science and corrosion Engineering, fundamental aspects of corrosion. Corrosion cell, cathodic and anodic reactions, types of corrosion cells, reference electrode, calomel electrode, pourbaix diagrams. Corrosion rate expressions, electro-chemical nature of aqueous corrosion, polarization, factors influencing corrosion rate. Types of corrosion, measuring polarization, anodic polarization, cathodic polarization, activation polarization and concentration polarization. Corrosion prevention, materials selection, alteration of environments, design, cathodic and anodic protection, corrosion inhibitors, coatings. Methods used to determine corrosion rate, weight loss measurements, linear polarization, Tafel extrapolation techniques.

#### **References:**

1. Ahmed Zaki, "Principles of corrosion Engineering and corrosion control", Elsevier science and Technology Books, 2006.
2. Mars G. Fontana, "Corrosion Engineering", (3e), Tata McGraw Hill, 2008.
3. Trethewey K. R. and Longman J. Chamberlain, "Corrosion for students of science and engineering", Scientific & Technical, 1988.
4. Schweitzer A Philip, "Fundamentals of corrosion-Mechanisms, Causes and preventive methods", CRC Press, Tayler and Francis Group, 2010.
5. Uhlig H. H. and Revie R. W., "Corrosion and Corrosion Control", Wiley, 1985.

#### **MME 3282: ENERGY ENGINEERING [3 0 0 3]**

Steam power plant - Different types of fuels used for steam generation, Equipment for burning coal in lump form, Stokers, Diesel Engine power plant - Method of starting diesel engine, Auxiliaries like cooling and lubrication system, Filters, Centrifuges, Oil heaters, Intake and exhaust system, Layout of diesel power plant. Hydro-electric plant: Hydrographs, Flow duration and mass curves, Storage and pondage, Pumped storage plants, Low, medium and high head plants, Penstock, Water hammer, Surge tanks, Gates and valves, Nuclear Power Plant, Solar energy, Biomass energy, Wind energy, Ocean energy, Geothermal energy conversion, tidal energy conversion.

#### **References:**

1. Nag P K, "Power Plant Engineering", Tata McGraw Hill, 2002.
2. Domkundwar, "Power Plant Engineering", Dhanpat Rai Publications, 2003.
3. Rai G D, "Non-Conventional Energy Sources", Khanna Publishers.
4. Rao S and Parulekar B B, "Energy Technology", Khanna Publishers, 2004.

5. Culp A W, "Principles of Energy Conversion", McGraw Hill International, 2001.

#### **MME 3283: INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]**

Introduction to Safety Engineering, Industrial Accidents, Theories of Accident Causation, Introduction to Health and Toxic Substances, Environmental Control and Noise, Ventilation and its Design Principle, Personal Protection and First Aid, Fire Protection, Machine Guarding, Safeguarding the point of operation, Power presses, Grinding machines, Saws, Belts and Pulleys, Safety consideration regarding material handling and storage. Safety Requirement for Material Handling and Storage, Electrical Hazards, Employee Participation in Promoting Safety, Safety Training, Safety Committees, Teamwork Approach to Promoting Safety.

#### **References:**

1. Asfahl C R and Rieske D W, "Industrial Safety and Health Management", (6e), Pearson Education, 2011.
2. Spellman F R and Whiting N E, "The Handbook of Safety Engineering: Principles and Applications", Government Institutes, 2009.
3. Gupta A., "Industrial Safety and Environment", (1e), Laxmi Publications Pvt. Ltd., 2006
4. Goetsch D L, "Occupational Safety and Health for Technologists", Engineers and Managers, (8e), Pearson Education Limited, 2014.

#### **MME 3284: INTERNAL COMBUSTION ENGINES [3 0 0 3]**

Introduction to IC engine, Analysis of air standard cycles, fuel air cycles and actual cycles. Modes of combustion, Stages of combustion in SI & CI engines, factors influencing the stages of combustion, normal and abnormal combustion, Control of abnormal combustion in SI and CI engines. Combustion chambers in SI and CI engines. Supercharging & Turbo-charging, Analysis of Modern developments in IC engines like Wankel engine, Electronic injection systems in SI engines. Common Rail Direct Injection (CRDI) engines, Multi point fuel injection. (MPFI) engines, dual-fuel engines and stratified charge engines. Introduction to engine Electronics, typical engine management systems, position, displacement and speed sensing, pressure, temperature and air measurement systems, exhaust oxygen sensors.

#### **References:**

1. Ganeshan V., "Internal Combustion Engines", Tata McGraw Hill, Education Private Limited New Delhi, 2007.
2. Mathur and Sharma, "A Course in I C Engines", Dhanpath Rai Publisher, New Delhi, 1981.
3. John B. Heywood, "Introduction to Internal Combustion Engines", Tata McGraw Hill, Education Private Limited New Delhi, 2011.
4. Lichty L.C., "International Combustion Engines", McGraw Hill New Delhi, 1951.
5. Edward F. Obert, "Internal Combustion Engines and Air Pollution", Harper & Row, Publishers. Delhi, 1973.

#### **MME 3285: INTRODUCTION TO ALTERNATIVE FUELS AND APPLICATIONS [3 0 0 3]**

Introduction to alternative fuels, Need for alternative fuels - Availability of different alternative fuels for SI and CI engines. Properties of potential alternative fuels, Liquid Fuels for SI Engines, Requirements of fuels for SI engines-Different Techniques of utilizing alternative liquid fuels Blends, Neat form, Reformed fuels - Manufacturing, Storage and Safety-Performance and emission characteristics of alternative liquid fuels, Liquid Fuels in CI Engines, Requirements of fuels for CI engines- Different techniques for their utilization- Blends, Fuel modifications to suit CI

engines, Dual fuelling, Ignition accelerators and other additives, Gaseous Fuels in SI Engines, Gaseous Fuels in CI Engines, Electrical Vehicles.

#### **References:**

1. Ramadhas A. S., "Alternative Fuels for Transportation", CRC Press, Taylor & Francis Group, 2010.
2. Thipse S. S., "Alternative Fuels: Concepts, Technologies and Developments", Jaico Book Distributors, 2010.
3. GajendraBabu M. K., "Alternative Transportation Fuels: Utilization in Combustion Engines", CRC Press, Taylor & Francis Group. 2010.
4. Michael F. Hordeski, "Alternative Fuels: The Future of Hydrogen", The Fairmont Press, 2008.
5. James D. Halderman, "Hybrid and Alternative Fuel Vehicles", (2e), Prentice Hall, 2010.

#### **MME 3286: INTRODUCTION TO COMPOSITE MATERIALS [3 0 0 3]**

Introduction to composite materials: definition, classification, types of matrices and reinforcements, characteristics and selection. Micro mechanical analysis of a lamina. Introduction, derivation of stress, strain, modulus of elasticity of fiber reinforced composites. Manufacturing of polymer composites: method, advantages, disadvantages and application. Application developments in aircrafts, missiles, space, automobile, electrical and electronics, marine, recreational, sports equipment's and construction. Potential future applications of composites. Metal matrix composites and ceramic matrix composites, reinforcement, matrix materials, characteristics and selection, base metal selection, applications.

#### **References:**

1. Mein Schwartz, "Composite Materials Handbook", McGraw Hill Book Company, 1984.
2. Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, 2010.
3. Mallik P.C., "Fiber Reinforced Composites", Marcel Decker, 1993.
4. Rober M. Jones, "Mechanics of Composite Materials", McGraw Hill Kogakusha Ltd, 2008.
5. Michael W. Hyer, "Stress analysis of fiber Reinforced Composite Materials", McGraw Hill International, 1998.

#### **MME 3287: INTRODUCTION TO NANOTECHNOLOGY [3 0 0 3]**

Introduction to nanotechnology, Bottom-up and Top-down approaches, Physical and Chemical properties, General methods of preparation of nanoparticles, Carbon nanostructures, Characterization of Nanomaterials, Nanomanipulation, Overview of micro electro mechanical devices and Technologies, Microsensors, MEMS Fabrication Bonding, Deposition and Etching techniques, Lithography, LIGA technique, MEMS applications, Scope of nanotechnology as a multidisciplinary subject, Nanomaterials used in energy and Environmental applications Nanomaterials in automobiles, Health hazards and other Challenges.

#### **References:**

1. Charles P Poole, "Introduction to Nanotechnology", Wiley-Interscience, 2003.
2. Guozhong Cao, "Nanostructures & Nanomaterials", Imperial College Press, 2004.
3. Mohamed Gad-el-Hak, "The MEMS Handbook", Taylor and Francis, 2005.
4. James J Allen, "MEMS Design", Taylor and Francis, 2005.
5. Murthy B S, Shankar P, "Textbook of Nanoscience and Nanotechnology", Universities Press (India) Private Ltd, 2013.



**MME 3288: INTRODUCTION TO OPERATIONS RESEARCH [3 0 0 3]**

Definition, phases, applications, advantages and disadvantages of operations research. Linear programming problems (LPP) are formulated and solved using graphical and simplex methods and post optimality analysis conducted. The special cases of LPP include transportation and assignment problems along with travelling salesman problem. Game theory and various methods, waiting line models and simulation. Poisson arrival rate and Exponential service times, System characteristics, Problems on the models- (M/M/1): (M/M/1) : (N/FIFO), Simulation of queuing models, Network model analysis using Critical Path Method (CPM) and Project Evaluation & Review Technique (PERT). Determination of probability/expectation of project completion.

**References:**

1. Taha H. A., "*Operations Research*", (7e), Pearson Education, 2002.
2. Winston W.L., "*Operations Research*", Thomson Asia, 2003.
3. Vohra N. D., "*Quantitative Techniques in Management*", 2007.
4. Sharma S. D., "*Operations Research*", (14e), Kedar Nath Ramnath Publications, 2005.
5. Kanthiswaroop, Gupta and Manmohan, "*Operations Research*", Sultan Chand and Sons, 2003.

**MME 3289: INTRODUCTION TO QUALITY CONTROL [3 0 0 3]**

Definitions of quality, Inspection and quality control, Organization for quality ,General quality control engineering fundamentals, Graphic representation methods of frequency distribution, Measures of central tendency and dispersion, Normal distribution curve, Inequality theorems, Shewhart's bowl drawing experiments, Control charts for variables ( , R and s charts), Type I and Type II Errors, Process capability analysis, Process capability indexes. Control charts for attributes (p, np, c and u charts). Acceptance sampling by attributes, Single and Double sampling plans, Operating characteristic curve, AQL, LTPD, AOQ curve, AOQL, ATI, AFI, Producer's risk, Consumer's risk, Acceptance sampling tables. Conventional and statistical tolerance, Precision, Accuracy and Reproducibility of method of measurements. Quality costs.

**References:**

1. Grant E L and Leavenworth R S, "*Statistical Quality Control*", (7e), Tata McGraw Hill Education, 2000.
2. Montgomery D C, "*Introduction to Statistical Quality Control*", (6e), John Wiley and Sons Inc., 2009.
3. Mahajan M S, "*Statistical Quality Control*", Dhanpat Rai Publishing Company Pvt. Limited, 2012.
4. Gryna F, Chua R C H, De Feo J A, "*Juran's Quality Planning and Analysis for Enterprise Quality*", (5e), McGraw Hill Education, 2007.
5. Hansen B L, "*Quality Control: Theory and Applications*", PHI Learning Education, 1987.

**MME 3290: INTRODUCTION TO REFRIGERATION AND AIR CONDITIONING SYSTEMS [3 0 0 3]**

Basic concepts and Air Refrigeration Cycles, Vapor Compression Refrigeration Systems, Vapor Absorption Refrigeration Systems, Compound vapour compression refrigeration system. Multi-evaporator and cascade systems, Classification of Refrigerants, Comparison of thermodynamic properties of refrigerants, Alternate Cooling Methods: Desiccant Cooling System, Solar Refrigeration, Thermo Electric Refrigeration, Analysis of Steam Jet Ejector Cycle, Refrigeration, Psychrometry, Psychrometric charts, Process involving Air-Vapour Mixtures, Air Conditioning Systems, Types of Air Conditioners, Load Estimation for inside and outside design conditions. Different types of heat loads.

**References:**

1. Arora S.C. and Domkundwar S., "*Course in Refrigeration and Air conditioning*", Danpath Rai. New Delhi, 1992.
2. Cook Norman, "*Refrigeration and Air conditioning*", Macmillan London, 1995.
3. Stocker. W.F., "*Refrigeration and Air conditioning*", Tata McGraw Hill, 1978.
4. Prasad Manohar, "*Refrigeration and Air conditioning*", New Age International Pvt. Limited. New Delhi, 2004.
5. Jordon Richard C, Priester Gayle B, "*Refrigeration and Air conditioning*", Prentice Hall, 2008

**MME 3291: INTRODUCTION TO ROBOTICS [3 0 0 3]**

Definition of Robots; Types of Robots; Robot Configuration; Selection of Robots; factor affecting the control resolution, Spatial resolution, Accuracy and repeatability, Specification of a robot, Robot arm/manipulator Kinematics, Types of Grippers; Force Analysis of gripper mechanism; Classification of Actuators; Actuators used in Robots - DC motors, Stepper motors, AC motors and Servo motors, Robot Transmission Systems; Sensors; Types and classification of robot sensors, Positional potentiometer, Velocity tachometer, Working of resolver, Optical encoder, Magneto resistive skin, Hall generator, Electro-magnetic & Adhesive end effectors, proximity sensors; Tactile Sensing; Robot Vision.

**References:**

1. Janakiraman P. A., "*Robotics and Image Processing*", Tata McGraw Hill, 1995.
2. YoramKoren, "*Robotics for Engineers*", Tata McGraw Hill, 1992.
3. Groover M.P., "*Industrial Robotics*", PHI, 2008.
4. Yu Kozyrev, "*Industrial Robots Handbook*", MIR Pub, 1985.
5. Jain K.C., Aggarwal L.N, "*Robotics Principles and Practice*", Khanna Publishers, 1997.

**MME 3292: PERSONNEL MANAGEMENT AND INDUSTRIAL RELATIONS [3 0 0 3]**

Objectives of personnel management, Functions of Personnel Management, Process of Human Resource Planning, Steps in recruitment process, Sources of recruitment, methods of recruitment.Promotions, Demotions, Transfers, Separation, Absenteeism and Turn over, Wage and Salary administration, Performance Appraisal, Methods of Performance evaluation.Industrial Relations: Functional Requirements, Employees participation in management.Grievances and Grievance Handling, Act of Indiscipline/ Misconduct.Principles for maintenance of discipline.Industrial Disputes, Procedure forthe Settlement of Disputes, Government and Industrial Relations, Organs of IndustrialPeace. Trade Unions: Objectives and Functions, Growth of Trade Union Movement, Factors Affecting Growth of Trade Unions, Essentials of a Successful Trade Union.

**References:**

1. Matoria C B and Gankar S V, "*Personnel Management*", (23e), Himalaya Publishing House, 2003.
2. Megginson L C, "*Personnel and Human Resources Administration*", (3e), R. D. Irwin, 1977.
3. Beach D S, "*Personnel: The Management of the People at Work*", (3e), Macmillan, 1975.
4. Yoder D, "*Handbook of Personnel Management and Labor Relations*", Volume 1, McGraw Hill, 1958.

### MME 3293: PROJECT MANAGEMENT [3 0 0 3]

Concepts of Project and Project Management, Categories of projects, Project life cycle phases, Tools and techniques for project management, the project manager, Roles and responsibilities of a project manager. Project Cost Estimation: Cost estimation, Capital cost, Operation and Maintenance costs, Cost estimation of a sample project. Feasibility Study: Types of feasibility. Project Network Construction, Critical path method (CPM), Program evaluation review technique (PERT), Crashing of Project Network, Types of crashing. Resource levelling and Allocation Technique, Project Audit: failures and reasons for audit, Phases of project audit, Project check list. Project Management Performance: Performance indicators, Performance improvement, Project management environment. Project Management Software: InstaPlan, Yojana, Prism project manager, Primavera.

#### References:

1. Paneerselvam R and Senthilkumar P, "Project Management", PHI Learning Pvt. Ltd., 2010
2. Choudhury S, "Project Management", (1e) Tata McGraw Hill Education, 2008
3. Lock D, "Project Management", (10e), Ashgate Publishing Limited, 2013

### MME 3294: THERMAL TREATMENT OF METALS AND ALLOYS [3 0 0 3]

Introduction to phase diagrams, invariant reactions, analysis of phase diagrams, Introduction to Iron-Carbon equilibrium diagram & Fundamentals of heat treatment, decomposition of austenite, TTT diagram, Conventional case and Surface hardening treatments, factors affecting hardening, laser hardening. Age hardening and Thermo-mechanical treatments for Aluminium and Non-Ferrous alloys, Ausforming, Isoforming, Thermo-mechanical annealing Steel specification, Classification and Application of steels and Cast iron with heat treatments, commercial steel, stainless steel, maraging steel, Malleabilization. Heat treatment and Application of non-ferrous metals and alloys defects, causes and remedies in heat treatment.

#### References:

1. Rajan T. V., Sharma C. P. and Sharma Alok, "Heat treatment principles and techniques", PHI Publication, 1999.
2. Bolton W., "Engineering materials technology", Heinmann Newness, 2001.
3. Thelning K. E., "Steel and its heat treatment", Butterworth /Heinemann, 2000.
4. Singh Vijendra, "Heat Treatment of Metals", Standard Publishers Distributors, 2012.
5. William D. Callister, "Materials Science and Engineering", John Wiley and Sons, 2007.

