COURSE STRUCTURE FOR M. TECH.
(IPED)

SEMESTER – I

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
ME 601	Finite Element Methods	3	0	2	2	100	-	50	150	4
ME 603	Advance Heat transfer	3	0	2	2	100	-	50	150	4
ME 605	Experimental Techniques	3	0	2	2	100	-	50	150	4
ME 681	Theory of Elasticity and stress Analysis	3	0	0	2	100	-	-	100	3
ME 683	Manufacturing Technology-I	3	0	2	2	100	-	50	100	4

SEMESTER – II

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
ME 682	Design of Heat Exchangers	3	0	2	2	100	-	50	150	4
ME 684	Manufacturing Technology-II	3	0	2	2	100	-	50	150	4
ME 686	Design of Pressure Vessel	3	0	2	2	100	-	50	100	4
ME 688	Principles & Design of Process Equipments	3	0	2	2	100	-	50	150	4
	Elective	3	0	0	2	100	-	-	100	3
ME650 **ME660** **ME 672** **ME674**	Optimization Techniques CAD (Computer Aided Design) in Mech. Engg. Modern Manufacturing Processes Piping System Design									

SEMESTER – III

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
ME 801	Dissertation Preliminaries	0	0	16	-	-	-	400	400	8
ME 803	Seminar	0	0	4	-	-	-	100	100	2
ME 805	Professional Practices & Legislation	2	0	0	2	100	-	-	100	2

SEMESTER - IV

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
ME 802	Dissertation	0	0	24	-	-	-	600	600	12

M.Tech. (Mech.) Industrial Process Equipment Design

Semester – I

ME 601	**:**	**Finite Element Methods**	**L**	**T**	**P**	**Credits**
			3	**0**	**2**	**04**

1. Introduction to FEM
2. Formulation Methods – Direct Approach, Variation Approach and Weighted residual Approach.
3. C Deg and C' elements, Isoparametric elements.
4. Interpolation Functions, Element Matrix, Assembly and Boundary Conditions.
5. Condensation and Solution Algorithms.
6. Introduction to non-linear finite element methods
7. Adaptive Finite Analysis, Automatic mech. Generation Estimation , Choice of new Mesh, Transfer Variables.
8. Applications of FEM in Heat Conduction, Fluid Flow, Elastic Plane Stress, Plane Strain and Ax-symmetric problems.

Reference:

1. Huebner, K.H. and Thorton, E.A., "The Finite Element Methods for Engineers" John Wiley & Sons, 1982.
2. Cook, R.D., Malkus, D.S. and Plesha, M.E., "Concepts and Applications of Finite Element Analysis", 3rd Ed., John Wiley & Sons, 1989.
3. Bathe, K.J., "Finite Element Procedures", Prentice Hall of India, New Delhi, 1997.
4. Zienewiccz, O.C. and Taylor, R.L., "The Finite Element Methods", Vol.1 and Vol.2, McGraw Hill, 1991.
5. Belytshko, T., Liu, W.K. and Moran, B., "Non-linear Finite Elements for Continua and Structures", McGraw Hills, 2000.

ME 603 : Advance Heat Transfer	L	T	P	Credits
	3	0	2	04

Factors affecting thermal conductivity of solids, liquids & gasses. General three dimensional heat conduction equation in Cartesian, Cylindrical & Spherical coordinates. Initial condition and various boundary conditions. Heat source systems. Critical thickness of insulation. Different types of ins & their analysis. Two dimensional steady state conduction. Electrical analogy, graphical & numerical methods. Transient heat conduction with & without temperature gradients within the system. Heat flow in semiinifinte solids. Application of Heisler charts.

Free & Forced convection. Similarity & Simulation of convection heat transfer, Boundary layer theory. Turbulent flow heat transfer. Analogy between momentum & heat transfer. Heat transfer with liquid metals. Hea t transfer in high velocity flow. Recent development in theory of turbulent heat transfer. Natural convection under different situations. Empirical relations in convection heat transfer.

Regimes of boiling heat transfer. Heat transfer in condensation. Dro p wise & film condensation. Emperical equations.

Radiation heat transfer peoperties. Laws of thermal radiation. Shape factors. Radiation heat transfer between black, diffuse & gray surface. Electric network method of solving radiation problems. Radiosity approach. Gas emission & absorption, Bulk Radiations.

REFERENCE:

1. S.P.Sukhatme, "Heat Transfer", University Press (India), (1996)
2. J.P.Holamn, " Heat Transfer", McGraw Hill Book. Co., (2002)
3. Eckert and Drake, "Heat and Mass Transfer", McGraw Hill, (1960)
4. Oziski, "Heat Transfer", McGraw Hill, (1986)
5. Incropera & Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley (1996).
6. Mills, "Heat and Mass Transfer", Irwin Publishers(1996).
7. Karlekar, "Heat Transfer", Prentice Hall (1998).

ME 681 : Theory of Elasticity & Stress Analysis	L	T	P	Credits
	3	0	2	04

Plane stress and plane strain, stress and strain at a point. Equilibrium and compatibility equations, Two dimensional problems in rectangular and polar co -ordinates. Three dimensional problems. Torsion and bending of bars.

Principal of Plastic Flow Theory

Stress & Strain relationship & Condition of initiation of plastic deformation.

Failure Criterion

Strain or work hardening.

Large elongations & their components

Experimental strain analysis

Uniaxial tension of a perfect & an imperfect strip.

Plastic Anisotropy

Necking in continuous bar, sheet.

Ductile fracture & reduction of area

Determination of Forming Limit, Strains for an Anisotropic material by growth of Neck.

Methods for testing material properties

Workability Definition

n, Testing & Analysis.

Membrane Stresses

REFERENCE:

1. E.G. Thomsen, C.T. Yang, Kobayashi, "Mechanics of Plastic Deformation in Metal Processing" The McMilan Co., New York.
2. E.M. Mielnik, "Metal Working Science & Engineering", McGr aw – Hill, Inc., New York
3. Z. Marcinialy & J.L. Dancan, "The Mechanics of Sheet Metal Forming", Edward Arnold, London.
4. Timoshenko & Goodier, "Theory of Elasticity", McGraw Hill

ME 605 : Experimental Techniques

L	T	P	Credits
3	0	2	04

- Basic concepts of Measurement
- Statistical Analysis of Experimental Data Method of Least Squares, Uncertainty Analysis.
- Response characteristics of Instruments – 1^{st} & 2^{nd} order instrument.
- Transducers, Vibration & Noise measurements.
- Theory of strain gauges
- Advance & Specific measurements –Stress & Strain Measurement by Photo Elastic Bench, Hotwire & Laser Doppler Anemometry.
- Thermal & Transport property measurement, Thermo gravimetric, Gas Chromatography, Air Pollution & Nuclear radiation measurement.
- NDT, Radiography, Ultrasonography
- Wind Tunnel Testing
- Data Acquisition System
- Advance measurement techniques
- Optical measurement
- Portable coordinate measurement system
- Software analysis
- Mechanical Metallurgy
- Tensile & Bend Testing
- Impact & Hardness Testing
- Fracture Toughness Test
- Corrosion & Creep Test
- Visual Check
- Radiography
- Ultrasonic test
- Magnetic Particle / Dye Penetrant Test
- Other Non Destructive Tests (e.g. Acoustic Emission Current etc.)

Reference:

1. Holman, J.P, "Experimental Methods for Engineers" 5^{th} Ed. McGraw hill International Edition, 1989
2. Doeblin, E.O., "Measurement System – Application and Design – McGraw Hill International Ed., 1990

3. Eckman, D.P. “Industrial Instrumentation”, Wiley Eastern Ltd., New Delhi, 1990
4. Hale, J. and Kocak, H., “Dynamics and Bifurcation s”, Springer-Verlag, N.Y. 1991
5. Strogatz, S.H., “Nonlinear Dynamics and Chaos”, Addison Wesley, Massachusetts, 1995.
6. Helfrack, A.D. and Cooper, W.D., “Modern Electronic Instrumentation & Measurement Techniques”, Prentice Hall of India Pvt. Ltd., New Delhi -2001.

ME 683 : Manufacturing Technology – I	**L**	**T**	**P**	**Credits**
	3	**0**	**2**	**04**

Welding + Distortion control

- Welding Processes
- Welding Equipment + Accessories
- Special Welding Techniques
- Welding Metallurgy
- Welding Defects
- Dissertation & its control
- Metals & their Weldability (C-Mn, LAS, SS & NF)
- Introduction to ASME Section IX

Metallurgy & Heat Treatment:

- Fe-C diagram & Different phases
- Transformation Diagrams for Steel
- Strengthening Mechanism
- Effect of alloying elements
- Metallurgy of steel
- (C-Mn, LAS, SS & QT)
- Non Ferrous Materials
- Different types of heat treatment

Surface Treatment & Painting :

- Blasting & Painting
- Passivation

Reference:

1. Heat Treatment: Principle & Techniques by Rajan T.V. & Sharma C.P., Publisher: Prentice Hall Pvt. Ltd. New Delhi (1988)
2. Engineering Metallurgy by R.A.Higgins, Publisher: Viva Book Pvt. Ltd., New Delhi (2004)
3. Material Science & Metallurgy by O.P. Khanna, Dhanpatrai & Sons, New Delhi (2000)

M.Tech. (Mechanical) Industrial Process Equipment Design

Semester – II

			L	T	P	Credits
ME 686	**:**	**Design of Pressure Vessels**	**3**	**0**	**4**	**05**

Factors influencing the design of vessels – classification of pressure vessels, material selection, loads & types of failures – Stresses in pressure vessels – stresses in circular ring, cylinder & sphere, membrane stresses in vessels under internal pressure, thick cylinders, multilayered cylinders, stress consideration in the selection of flat plate & conical closures, elliptical, torispherical, hemispherical heads, autofretage of thick cylinders, thermal stresses & their significance, fatigue of pressure vessels, tall vertical vessels, support for vertical & horizontal vessels, nozzles & flanges. Discontinuity stresses in pressure vessels. Basic concepts, flow through pipes, Fanno & Reynolds flow, pressure drop in isothermal & non-isothermal flows. Head losses, loss due to contraction & expansion, loss due to fittings, equip-mental length, distribution & mixing losses & designing of piping network. Design for Wind, Sismic and other external loads. Evaluation of vessels for various conditions like hydrotests, upsets and transportation conditions.

ASME Sec II (Materials)
ASME Sec VIII (UG, UW, UCS, UCL, UHA)

Reference:

1. M.V. Joshi & V.V. Mahajani, "Process Equipment Design", Macmillan India, Ltd., 1996
2. J.F. Hanvey, "Pressure Vessels Design", Von Nostrand Co. Inc.
3. ASME code Section 8th div1, div2
4. K.P. Singh & A.L. Soler, "Mechanical Design of Heat Exchangers", Arcturus Pub. Inc. N.J. 08003, USA 1984
5. Demis R. Moss, "Pressure Vessels Design Manual", Gulf Pu blishing Co., Houston, 1987
6. IS 2825
7. Handbook of piping Design
8. ASHRAE fundamentals-1985.

ME 682	**: Design of Heat Exchangers**	**L**	**T**	**P**	**Credits**
		3	**0**	**2**	**04**

Review of Heat Transfer Principles & Convection Correlation.
Introduction to Heat Exchangers and classification
Basic Design Methodologies, -NTU Method AND lmtd method
Design of Double Pipe Heat Exchangers
Shell & Tube Type Heat Exchangers, TEMA, Nomenclature, j -Factors
Conventional Design Methods, Bell -Delware Method
Compact Heat Exchangers, j-Factors, Design Method
Condensers Classification and Design Methods for Surface Condensers
Evaporators – classification and Design Methods
Plate Type – Heat Exchangers
Regenerators
Basic Concepts of Mechanical Design of Heat Exchanger
Fixed and Floating Tube Sheet Design, Design of Expansion Bellows

Reference:

1. Ozisik, M.N., "Heat Transfer-A Basic Approach", McGraw Hill Book Company, N.Y., 1985
2. Saunders, E.A.D., "Heat Exchangers – Selection Design and Construction".
3. Longmann Scientific and Technical, N.Y., 1988
4. Kern, D.O., "Process Heat Transfer", McGraw Hill, 1965.
5. Kays, V.A. and London , A.L., "Compact Heat Exchangers" McGraw Hill, 1964
6. Holger Martin, "Heat Exchangers" Hemisphere Publ. Corp. Washington, 1992.
7. Kuppan, T., "Heat Exchanger Design Handbook", Macel D ekker, Inc., N.Y. 2000
8. Shah R.K. , Subbarao, E.C., Mashelkar, R.A., "Heat Transfer Equipment Design", Hemisphere Publ. Corp., 1988
9. Seikan Ishigai, "Steam Power Engineering-Thermal and Hydraulic Design Principles", Cambridge Univ. Press 1999.
10. Gunn, D. and Horton R., "Industrial Boilers; Longman Scientific & Technical UK Group Ltd. & John Wiley & Sons, N.Y. 1989.

ME 684 : Manufacturing Technology - II	**L**	**T**	**P**	**Credits**
	3	**0**	**2**	**04**

Forming + Cutting

- Cutting (Flame & Plasma)
- Rolling (Hot, Warm, Cold)
- Forging
- Pressing (Die-Punch Spinning)
- Drawing Extrusion & Pipe /Tube Bending

Fabrication :

- Various fabrication operations
- Circular seam set ups
- Nozzle cut-outs and sets-ups, E
- Elevations, Orientations etc.
- Quality aspects – preheat, visual, arc strikes
- Welder trace ability, Documentation
- Good engineering practices (General and SS fabrication)
- Weld repairs -defects marking and repairs
- Machining
- Tube to Tube sheet joints, expansion and welding

Material Handling

- Concepts
- Tools & Tackles
- Safety

Logistics

- Road Transportation
- Marine /Sea Transportation

Reference:

1. William F. Hosford & Robert. M. Caddell, "Metal forming mechanics & metallurgy", Prentice Hall N.Y. 1993.
2. Z. Marciniak & Y.L. Duncan "The mechanics of sheet metal froming", Edaward Arnold, London
3. B. Aritzur, "Metal forming Processes and analysis", Tata McGraw Hill, New Delhi
4. G.E. Diefer, "Mechanical metallurgy", McGraw Hill International edition N.Y.

5. E.G. Thomsion, C.Y. Yang, S Kobayashi, "Mechanics of plastic deformation in metal processing", The Mc Millan Co. N.Y.
6. Advanced welding systems: Fundamentals of fusion welding technology, Vol – 1/Cornu
7. welding handbook, Section 3: Special welding processes and cutting / American Welding Society.
8. Fundamentals of welding metallurgy, Granjon, H.
9. industrial welding procedures: Oxyacetylene, Electric are MIG and TIG, Design and Special Processes, Schell, F.R. and Matlock, B.
10. Arc welding automation, Cary, H.B.
11. Welding and welding technology, Little R.L.

ME 688 : Principles & Design of Process Equipments

L	T	P	Credits
3	0	2	04

Product Focus:

- Basic refinery processes
  Equipment for Distillation column,
  Hydrocracking Hydrotreating, FCC
- Multiphase Ractor Design

  Practical systems and types of Industrial Reactors, Film and Penetration theory analysis of Gas Liquid and Gas Liquid-Solid reactions, Residence time distribution and models for macro mixing in the reactors, Mathematical models for Gas -Liquid-Solid Reactors. Laboratory Reactors. Dynamics of the Co current -down flow fixed-be column. Dynamics of the Co current – up low Fixed-bed column. Dynamics of Countercurrent 110\' fixed-bed column, Dynamics of the Gas – Liquid-Suspended – Solid column.

  Distillation concept Design

  1. Fundamental Concepts Involved in Distillation
  2. Calculations for Bubble point and Dew Point Tempe rature
  3. Vapour Liquid Equilibrium
  4. Material Balance
  5. Enthalpy Balance
  6. Distillation Process Performance

Equilibrium Basic Consideration, K –Factor Hydrocarbon Equilibrium charts, Distillation Operating Pressures, Batch Distillation, Steam Distillation, Multi -component Distillation.

1. Mechanical Design for Tray Performance
   Contacting Trays, Bubble Cap Tray Design, tray layouts, Tray Performance of Bubble Caps, Bubble Cap Tray Design and Evaluation, Sieve Trays with down comers, Perforated plates without down come rs, Tower Specifications.
2. Packed Towers Distillation Column
   Shell Random Packing, Packing Supports, Liquid Distribution, Packing Selection and performance, packing Factors, Recommended Design Capacity and Pressure Drop, Dumped Packing : Gas-Liquid System Below Loading Structured Packing, Mass and Heat Transfer in Packed Towers, Mass Transfer with chemical reactions.

Reference:

1. Yatish T. Shah, "Gas-Liquid Solid Reactors Design", McGraw Hill, New York 1979.
2. P.A.Ramchandanu and R.V.Chowdharry,"Three phase Reactors", 1983
3. J.S.Fogler, "Elements of Chemical Reaction Engineering" , Prentice Hall of India, New Delhi, 1989.
4. Recent Publication in chemical engineering Journals.
5. E.E.Ludwig, "Applied Process Design", Vol.2 III rd Edition, Gulf Publishing Co., Texas, 1994.
6. Holland Charles D., "Multi-Component Distillation", Prentice Hall Inc. Englewood Cliffs N.J.U.S.A. , 1963
7. Coulson J.M. Richardson J.F., "Chemical Engineering", Vol. Ii 3 rd Edition ergamon Press Oxford, 1978.

ELECTIVES

ME 672 : Modern Manufacturing Processes

L	T	P	Credits
3	0	2	04

Introduction, AJM, Mechanics of AJM, Process Criteria & Process parameters, Abrasives etc., USM, Mechanics of USM, Process parameters, effect on machining rate, ECM, Electro chemistry, Kinematics and dynamics of ECM, Effect of Heat and bubble generation, Surface finish, Tool design Electrolytes, EV machines, Grinding, Deburring, Honing, EDM Mechanics of EDM, EDM circuits & operating principles, Surface finish & accuracy, electrodes & Dielectric fluids, EBM -Mechanics of EBM, effect of EBM on material, Generation & control of EBM, Forces in machining, Hydrostatic Pressure on molten metal, Process Capabilities & Limitations, PAM, Non thermal generation of plasma, Mechanism of metal removal parameters, Design of plasma torc h, Types of torches Safety precaution, LBM –Apparatus, Metal removal. Thermal features of laser machining, cutting speed and accuracy, Limitations, Hot machining – heating requirement. Method of heating, Tool Life and production rates. Unconventional formi ng processes (explosive forming magnetic pulse forming, electrohydrolic forming etc.), Laser material Processing,.
Introduction to ASME Section IX

Reference:

1. Production Technology, Tata McGraw Hill Publication New Delhi.
2. A.Ghosh & A.K.Malik, "Manufacturin g Science", Assilated East-West Press Pvt. Ltd. New Delhi. 1985.
3. P.C. Pandey & H.Shan, "Modern machining processes", Tata McGraw Hill New Delhi, 1995
4. P.K.Mishara, "Non Conventional machining" Narosa Pub. House New Delhi 1997.
5. Modern Manufacturing Processes By J.L. Morris.
6. Dr. R.Narayanswami, "Metal forming Technology", Ahuja Book Publisher, New Delhi.

ME 674 : Piping System Design

L	T	P	Credits
3	0	2	04

- Introduction to piping engineering
- Codes & standards for piping engineering & design
- Piping elements viz. pipes, fittings, flanges, gaskets, bolting, valves etc.
- Types of vales
- Piping drawing layout and instruments diagram, Equipment layout
- Basic of flow through pipes
- Pipe sizing & piping hydraulics
- Head sizing & piping hydraulics
- Head losses due to contraction and expansion, other types of losses
- Network analysis, Overall loss estimation through network analysis, optimizing piping network with respect to losses
- Design of liquid handling piping system, sizing for equal velocity, sizing for equal areas, optimal sizing, water hammer
- Steam piping design, stream traps
- Flexibility analysis consideration for cryogenic piping
- Selection of support & expansion joints
- Instrumentation
- Introduction to CAESER

Reference:

1. M.V.Joshi & V.V. Mahajani, "Process Equipmen t Design", MacMillan, India Ltd., 1996.
2. J.F.Hanvey, "Pressure Vessels Design", Von Nostrand Co. Ind., 1963
3. ASME code Section 8th div 1, div 2
4. K.P.Singh & A.L. Soler, "Mechanical Design of Heat Exchangers", Arcturus Pub. Inc. N.J. 08003, USA. 1984
5. Demis R. Moss, Pressure Vessel Design Manual, Gulf Publishing Co., Houston, 1987.
6. IS 2825
7. Sahu G.K., "Hand Book of Piping Design", New Age International (P) Ltd. 1998,
8. ASHRAE fundamentals – 1985.

ME 660 : CAD (Computer Aided Design) in Mech. Engg.

L	T	P	Credits
3	0	2	04

Fundamental of computer graphics, geometrical modeling (solid, surface & wire frame), two & three dimensional transformation (rotation, reflection & sealing), windowing,-clipping, plane curves & space curves, Hidden surfaces removal, awarene ss & application of computer graphics software, object oriented programming. Quadratic, isoparametric & other higher order finite elements, condensation & substructuring, two dimensional axisymmetric problems, application of finite elements to transient problems, various time stepping schemes, incorporation of non linearities. – Application of finite difference & finite element methods to design of process equipments – Awareness & use of standard softwares for equipment design and analysis.

Reference:

1. David F. Rogers & J.Alan Adams, " Mathematical Elements for Computer Graphics", McGraw Hill International Edition, 1990.
2. C.S. Krishnamoorthy and S.Rajeev, "Computer Aided Design", Narosa Publishing House, 1991.
3. M.P. Groover and E.W. Zimmers, "Computer Aided De sign and Manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi, 1997
4. Vera B. Anand, "Computer Graphics and Geometric Modeling for Engineers", John Wiley & Sons Inc. (1993).
5. O.C. Zienkiwicz, "Finite Element Method".

ME 650 : Optimization Techniques

L	T	P	Credits
3	0	2	04

- Single and Multivariable optimization methods, constrained optimization methods, Kuhn-Tucker conditions-Necessary & Sufficiency theorems.
- Linear programming-Traveling salesman problem and Transshipment problems - post optimization analysis.
- Integer programming All integer, Mixed integer and zero -one programming
- Geometric programming – concept – degree of difficulty – solution of unconstrained & constrained non linear problems by geometric programming.
- Dynamic programming.
- Energy System Simulation & optimization/Objectives/constraints, Problems formulation, Unconstrained problems, Constrained Variations, Kuhn -Tucker Conditions.
- Probabilistic Technique – Trade offs between capital & energy using Pinch Analysis.
- Energy-Economy models –Scenario Generation.

Reference:

1. Stocker, W.I. "Design of Thermal System", McGraw Hll, 1987
2. Rao S.S., "Optimization Theory & Applications", Wiley Eastern 1990.
3. New Fville R. "Applied System Analysis", McGraw Hill, Int. Edition 1990
4. K.Deb, "Optimization for Engineering Design", Prentice Hall of India, 1995
5. Reklaitis G.V., Ravindram A., Ragsdell K.M., "Engineering Optimization Methods & Application", Wiley 1983