UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

IV SEMESTER

MECHANICAL - STREAM - INDUSTRIAL ENGINEERING

SCHEME -2013

IV SEMESTER

MECHANICAL - STREAM - INDUSTRIAL ENGINEERING (N)

Course No	Name of subject	Credits	Weekly load, hours			C A Marks	Exam Duration Hrs	U E Max Marks	Total Marks
			L	T	D/P				
13.401	Engineering Mathematics -III (BCHMNPSU)	4	3	1	-	50	3	100	150
13.402	Manufacturing Process (MN)	4	3	1	-	50	3	100	150
13.403	Machine Design (N)	4	3	1	-	50	3	100	150
13.404	Metallurgy & Material Science(MNPU)	4	3	1	-	50	3	100	150
13.405	Operations Management (N)	3	3	-	-	50	3	100	150
13.406	Thermal Engineering (N)	4	3	1	-	50	3	100	150
13.407	Fluid Mechanics and Machines Lab (MN)	3	-	-	3	50	3	100	150
13.408	Thermal Engineering Lab (N)	3	-	-	3	50	3	100	150
	Total	**29**	**18**	**5**	**6**	**400**		**800**	**1200**

13.401 ENGINEERING MATHEMATICS - III (BCHMNPSU)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To introduce the basic notion in complex analysis such as Analytic Functions, Harmonic functions and their applications in fluid mechanics and differentiations and integration of complex functions, transformations and their applications in engineering fields.*
- *Numerical techniques for solving differential equations are also introduced as a part of this course.*

Module – I

Complex Differentiation: Limits, continuity and differentiation of complex functions. Analytic functions – Cauchy Riemann equations in Cartesian form (proof of necessary part only).Properties of analytic functions – harmonic functions. Milne Thomson method.

Conformal mapping: Conformality and properties of the transformations $w = \frac{1}{z}$, w = z^2, $w = z + \frac{1}{z}$, w = sin z , w = e^z - Bilinear transformations.

Module – II

Complex Integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – zeros and singularities – residues and residue theorem.

Evaluation of real definite integrals – $\int_0^{2\pi} f(sinx, cosx)dx$, $\int_{-\infty}^{\infty} f(x)dx$ (with no poles on the real axis). (Proof of theorems not required).

Module – III

Numerical techniques-Solutions of algebraic and transcendental equations-Bisection method – Regula-falsi method – Newton - Raphson method. Solution of system of equations - Gauss elimination, Gauss- Siedel iteration. Interpolation – Newton's Forward and backward formulae - Lagrange's interpolation formula.

Module – IV

Numerical integration-Trapezoidal Rule- Simpson's one third rule.

Numerical solution of ODE –Taylor's series method - Euler's method - Modified Euler's method – Runge-Kutta method of order Four.

Numerical Solution of two-dimensional partial differential equation (Laplace equation)- using finite difference method (five point formula)

References:

1. Bali N. P. and M. Goyal, *Engineering Mathematics*, 7/e, Laxmi Publications, India, 2012.
2. Kreyszig E., *Advanced Engineering Mathematics*, 9/e, Wiley India, 2013.
3. Grewal B. S., *Higher Engineering Mathematics*, 13/e, Khanna Publications, 2012.
4. Koneru S. R., *Engineering Mathematics*, 2/e, Universities Press (India) Pvt. Ltd., 2012.
5. Sastry S. S., *Introductory Methods of Numerical Analysis*, 5/e, PHI Learning, 2012.
6. Babu Ram, *Numerical Methods*, 1/e, Pearson Education, 2010.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Five Short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

After successful completion of this course, the students will be able to use numerical methods to solve problems related to engineering fields. This course helps students to master the basic concepts of complex analysis which they can use later in their career.

13. 402 MANUFACTURING PROCESS (MN)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

- *The subject will enable the students to understand the basic manufacturing process of engineering materials and products including the modern manufacturing methods.*

Module – I

Foundry – basic requirements of casting processes. Patterns – types, materials, allowances. Moulding Sand – Properties, testing, Sand Muller, Types of mould – Green Sand Mould, Dry Sand Mould– Carbon Dioxide Moulding, Shell Moulding, Ceramic Mould Casting, Plaster mould casting.

Cores – Core Sand, Core Types, Core Prints , Core Baking, Principles of gating and risering – Riser location and Direction Solidification, Blind riser, Chills-Internal and External chills and Chaplets. Internal, external chills. Pressurised and Unpressurised Gating systems.

Module – II

Gravity die casting Pressure die casting-Hot and Cold chamber type, Centrifugal casting, Semi centrifugal casting Centrifuging, Continuous Casting. Solidification of Castings – Cleaning and Inspection of castings, Casting defects.

Plastic injection moulding and plastic blow moulding. . Introduction to powder metallurgy process – Compacting and sintering. Forming and shaping of glass. Processing of metal matrix and ceramic matrix.

Module – III

Forming - plastic deformation and yield criteria - relation between tensile and shear yield stress – Rolling - cold, hot rolling - Types of rolling mills-Rolling of channels, I and rail sections. Rolling of tubes, wheels and axles. Defects in rolled products. Forging- open and closed die forging, press forging, roll forging, types of forging presses. Defects in forging. Extrusion-hot and cold extrusion-Wire drawing- Tube drawing, Rotary piercing-Rotary swaging, Cold forming-thread rolling, metal spinning.

Module – IV

Welding- classification, Weldability, Metallurgy of welding, structure of weld, HAZ. Gas welding, types of flames. Arc welding- Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG, MIG. Resistance welding- Spot welding, Seam welding, Projection welding, Butt welding, Flash butt welding, Percussion welding. Solid phase welding-forge welding, friction welding, explosive welding, ultrasonic welding. Thermit welding, Atomic hydrogen welding, Electron beam welding. Weld defects and inspection.

References

1. Kalpakjian S. and S. R Schmid, *Manufacturing Engineering and Technology*, 4/e, Pearson Education, 2001.
2. Ghosh A. and A. Mallik, *Manufacturing Science*, Affiliated East West Press Ltd., New Delhi, 2002.
3. Taylor H. F., M. C. Flemings and J. Wulff, *Foundry Engineering*, Wiley Eastern, 1973.
4. Campbell J. S., *Principles of Manufacturing Materials and Processes*, Tata McGraw Hill, 1999.
5. DeGramo E. P., J. T. Black and R. A. Kosher, *Materials and Process in Manufacturing*, 9/e, Prentice Hall, 2003.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *The students will understand the various aspects of moulding, casting, forming and welding.*
- *The students will be able to identify the features of different manufacturing processes and to select suitable process for a specific material.*

13.403 MACHINE DESIGN (N)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

To develop an ability to design a system to meet the desired needs by choosing proper machine elements and mechanisms within the realistic constraints.

Module – I

Introduction to design - steps in design process - design factors - tolerances and fits - principles of standardisation.

Materials and their properties - Elastic and plastic behaviour of metals - ductile and brittle behaviour. True stress and true strain - stress - strain curves - Selection of materials - stresses in machine parts - tension, compression, shear, bending and torsional stresses, combined stress. Stress concentration, stress intensity factor.

Fracture toughness -factor of safety, margin of safety - variable stress - endurance limit - fatigue factor - theories of failure - combined steady and variable stress - Gerber, Goodman, Soderberg method - impact load - fatigue loading - consideration of creep and thermal stresses in design.

Module – II

Riveted joints - Types of rivets, strength of rivets, Joints for pressure vessels - Structural joints, eccentric loading.

Welded joints - types of joints, strength of welds, fillet welds, stress concentration in welded joints - eccentric loading.

Thin and Thick cylinder design - Stresses due to internal and external pressures.

Module – III

Springs - classification and use of springs - spring materials stresses in helical springs - deflection of helical springs - extension, compression and torsion springs - design of helical springs for static and fatigue loading - design of leaf springs.

Bearing and Lubrication - Journal bearing -Introduction to lubrication - Hydrodynamic bearings - Sommerfield Number, Petroff’s number, L/D ratio, Clearance ratio - minimum film thickness - bearing materials.

Rolling contact bearings - bearing types - Ball & roller bearings - Static and dynamic load capacity - Equivalent dynamic load - Bearing life - Selection of bearing.

Module – IV

Shafts - torsion and bending of shafts, Hollow shafts, design of shafts for strength and stiffness - Effect of key ways. Design of gears - spur, helical, and bevel gears - Design for static and dynamic loading and wear - Lewis and Buckingham equations for design.

Design Data Hand Books:

1. Lingaiah K., *Machine Design Databook*, 2/e, Tata McGraw Hill, 2010.
2. PSG College of Technology, *Machine Design Data Book*, 2011.
3. Mahadevan K. and B. Reddy, *Design Data Handbook for Mechanical Engineering*, 4/e, C.B.S Publishers, 2013.

References:

1. Shigley J.E., *Mechanical Engineering Design*, 8/e, McGraw Hill, 2008.
2. Siegel M. J., V. L. Maleev and J. B. Hartman, *Mechanical Design of Machines*, 4/e, Inter-national Textbook Co., 1965.
3. Phelan R. M., *Fundamentals of Mechanical Design*, Tata McGraw Hill, 1975.
4. Doughtie V. L. and Vallance A., *Design of Machine Members*, 4/e, McGraw Hill, 1964.
5. Juvinall R. C. and Marshek K.M., *Fundamentals of Machine Component Design*, 4/e, John Wiley & Sons, 2012.
6. Norton R. L., *Machine Design*, Prentice Hall, 2013.
7. Spotts M.F., T. E. Shoup and L E Hornberger, *Design of Machine Elements, 8/e,* Pearson Education, 2004.
8. Wentzell T. H., *Machine Design*, Thomson Delmar Learning, 2004.
9. Kulkarni S. G., *Machine Design*, Tata McGraw Hill, 2008.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two question from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Note: *If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course Outcome:

After completion of this course, students are expected to have an understanding of the design of various machine elements. They will be able to select appropriate mechanisms.

13.404 METALLURGY AND MATERIAL SCIENCE (MNPU)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

To impart knowledge on engineering materials, deformation of materials, equilibrium diagrams of selected alloy systems, heat treatment of steels, properties of steels, cast iron and other alloys and their applications.

Module – I

Introduction to material science and engineering, Classification of engineering materials, Crystal structure of metallic materials. Imperfections in crystals: point defects, line defects, surface defects.

Mechanical behaviour of materials: Elastic, visco elastic, anelastic behaviour.

Mechanisms of plastic deformation: role of dislocation, slip and twinning; Schmid's law. Strengthening mechanisms: Grain size reduction, solid solution strengthening, work hardening, Precipitation hardening. Recovery, recrystallisation and grain growth.

Specimen preparation for microstructural examination: Etching. Grain size determination by comparison with standard chart, Hall-Petch equation.

Module – II

Fracture: ductile fracture, brittle fracture, Griffith's theory of brittle fracture, ductile to brittle transition , fracture toughness.

Fatigue: mechanism of fatigue, S-N curve. Creep: creep curve, mechanism of creep.

Diffusion: Fick's laws of diffusion, Mechanisms of diffusion, applications. Solidification of metals and alloys. Solid solution, Hume Rothery's rules.

Phase diagrams: Phase rule, Lever Rule, Relationship between micro structure and properties, Isomorphous systems: Cu-Ni phase diagram, Eutectic systems: Pb-Sn phase diagram. Eutectoid and peritectic reactions.

Module – III

Iron- Carbon equilibrium diagram Development of microstructure in Iron Carbon alloys, Phase transformations in steel. Detailed discussion on Iron-Iron Carbide phase diagram with reference to micro constituents like austenite, ferrite, cementite, pearlite and ledeburite.

TTT diagram for eutectoid steel, CCT diagram, critical cooling rate. Transformation of austenite to pearlite, bainite, martensite spheroidite etc.

Heat treatment of steel: Annealing, normalizing, hardening, tempering, austempering, martempering, Hardenability, Jominy end quench test. Surface treatments: Case Hardening, Carburising, Nitriding, Cyaniding, CVD, PVD, Thermal spraying.

Module – IV

Applications of ferrous and non ferrous alloys: Steel- low, medium, high carbon steels, Alloy steels: effect of various alloying elements in steel.

Stainless steels -ferritic, austenitic, martensitic, duplex steels. Tool steels. Cast iron- gray, white, ductile cast irons. Copper and its alloys. Aluminium and its alloys, Magnesium and alloys, Titanium and its alloys.

Composite materials for mechanical engg applications: classification, fabrication methods: stir casting, powder metallurgy and filament winding. Introduction to Smart materials, Nano materials, Bio materials, Bioplastics. Selection of materials based on properties, service, economic and environmental considerations.

References:

1. Callister W. D. and D. G. Rethwisch, *Material Science and Engineering*, 8/e, John & Wiley Sons, 2010.
2. Raghavan V., *Material Science and Engineering*, PHI Learning Pvt. Ltd., 2004.
3. Jose S. and Mathew E. V., *Metallurgy and Materials Science,* Pentagon Educational Services, 2011.
4. Shackelford J., *Introduction to Materials Science for Engineers*, 7/e, Pearson, 2009.
5. Van Vlack L. H., *Elements of Materials Science and Engineering*, Addison-Wesley, 1989.
6. Lakhtin Y., *Engineering Physical Metallurgy*, Gordon and Breach Science Publishers, 1965.
7. Dieter G. E., *Mechanical Metallurgy*, McGraw-Hill, 1976.
8. Reed-Hill R. E., *Physical Metallurgy*, PWS-Kent Publishing Company, 1992.
9. Avner S. H*., Introduction to Physical Metallurgy*, McGraw-Hill, 1974.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

After successful completion of the course, the students will possess knowledge on:

- *The property classifications of materials that determine their applicability.*
- *The mechanisms of elastic and plastic deformations and thereby be able to modify the mechanical properties of materials.*
- *Heat treatment processes and how to select suitable heat treatments for specific applications.*
- *Different failure mechanisms and thereby how to decide steps to avoid failures.*
- *Different alloy systems and their applications, so that proper selection of material can be made.*
- *Newer engineering materials like Composites, smart materials, nanomaterials.*

13.405 OPERATIONS MANAGEMENT (N)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits:** 3

Course Objectives:

- *To understand the importance of various factors of production.*
- *To learn the methods and techniques to effectively manage inventory of an organisation.*
- *To understand the methods to manage supply chain of materials and information in an organisation to make decisions in dynamic environment.*

Module – I

Demand forecasting: methods-causal and time series models, moving average, exponential smoothing methods. Trend, cycle and seasonality components, Winter's complete model. Analysis of forecast error, comparison of forecasting methods based on errors. Basic inventory models: assumptions and performance measures. Inventory systems under risk, service levels, safety stock, joint determination of Q and R, time varying demands – Selective Inventory Control.

Module – II

Aggregate inventory management: Exchange curves, stock out situations, safety stock policies, distribution inventory systems. Aggregate planning: definition, value of decision rules, aggregate planning strategies, methods – Master production schedule - bill of material, structuring BOM, disaggregation techniques, managing and maintenance of MPS. Material Requirements Planning (MRP): concepts, advantages, and implementation, MRP II.

Module – III

Plant layout: Types of layouts, Comparison of layouts, Systematic Layout Planning (SLP), Design procedures and methods, Software packages for SLP. Models for assembly line balancing. Capacity planning and control, controlling continuous production, batch processing technique. Just-in time, KANBAN system, Lean manufacturing, Agile manufacturing.

Module – IV

Job Shop production activity planning, scheduling, shop loading, sequencing, priority rules for dispatching jobs. Introduction to Business Process Re-engineering, Enterprise Resource Planning.

References:

1. Krajewski L. J. and L. P. Ritzman, *Operations Management: Strategy and Analysis*, Pearson Education, 2002.
2. Panneerselvam R., *Production and Operations Management*, 2/e, Prentice Hall, 2005.

3. Buffa S., *Modern Production /Operations Management* ,8/e, John Wiley & Sons, 1987.
4. Narasimhan S. L., D. W. McLeavy, and P. J. Billington*, Production Planning and Inventory Control*, 2/e, Prentice Hall, 1995.
5. Riggs J. L., *Production Systems: Planning, Analysis and Control*, John Wiley & Sons, 1976.
6. Silver E. A., D. F. Pyke and R. Peterson, *Inventory Management and Production Planning and Scheduling*, 3/e, John Wiley & Sons, 1998.
7. Hopp W. J. and M. L. Spearman, *Factory Physics*: *Foundations of Manufacturing Management*, 3/e, McGraw Hill, 2008.
8. Gaither N. and G. Frazier, *Operations Management*, Thomson learning, 2002.
9. Mahadevan B., *Operations Management*, Pearson Education, 2010.
10. Heizer J. and B. Render, *Operations Management*, 11/e, Pearson Education, 2013.
11. Samson D. and P. J. Singh, *Operations Management: An Integrated Approach*, Cambridge University Press, 2010.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Note: *If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course Outcome:

After completion of this programme, students are expected to have knowledge about various techniques and methods for optimising resources used for production and also to solve operational problems in industries.

13.406 THERMAL ENGINEERING (N)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To get the basic knowledge of the properties of steam and its application.*
- *To familiarize IC Engine Technology.*
- *To get knowledge on the analysis of air compressors and gas turbines.*
- *To acquire knowledge on heat transfer phenomena and design of heat exchangers.*
- *To demonstrate the basic knowledge of refrigeration and air conditioning.*

Module – I

Steam Engineering - Entropy of steam - temperature - entropy diagram - Mollier chart - Rankine cycle, modified Rankine cycle - binary vapour cycle. Steam boilers, High - pressure boilers, steam condensers. Steam nozzles - flow through steam nozzles, effect of friction, super saturated flow.

Steam turbines - Impulse and Reaction turbines, Velocity diagrams, condition for maximum efficiency. Cycles with reheating and regenerating heating - reheat factor, degree of reaction, governing of turbines.

Module – II

Air cycles - Otto and diesel cycles, air standard efficiency. IC engine parts. Working and comparison of two stroke and four stroke cycle engines. Systems of IC engines - Introduction to CRDI, MPFI, GDI and hybrid vehicles.

Fuels and combustion - Stochiometry, calculation of A/F ratio and equivalence ratios, volumetric and gravimetric analysis, fuel properties. Normal and abnormal combustion in SI and CI engines - auto ignition - pre ignition and detonation - factors affecting detonation. Knocking in CI engines.

Module – III

Compressors - reciprocating air compressors - work done and efficiency, volumetric efficiency- effect of clearance, Rotary compressors - roots blowers, vane type compressor, centrifugal and axial flow compressors, work done and efficiency.

Gas turbines - open, closed and semi closed cycles - ideal gas turbine cycle. Compressor and turbine efficiencies, simple cycle, simple cycle with regeneration, intercooling and reheating - cycle efficiency and work output.

Module – IV

Introduction to heat transfer - Different Modes of heat transfer, derivation of heat transfer equations for all modes of heat transfer from basic assumptions (Fourier law, Newton's law of cooling, Planks law, Kirchoff's law, Wiens displacement law and Stefan Boltzmann's law).

Heat exchangers - Different types- LMTD and effectiveness.

Refrigeration & Air conditioning - Vapor compression refrigeration system - simple cycle - TS and PH diagrams - COP. Refrigerants and their properties - Eco friendly refrigerants. Application of refrigeration - Domestic refrigerators, Water coolers and ice plants.

Comfort and Industrial air conditioning. Room air conditioner - split and packaged system.

References:-

1. Ballaney P. L., *Thermal Engineering*, Khanna Publishers, 2007.
2. Rajput R. K., *Thermal Engineering*, 9/e, Laxmi Publications (P) Ltd., 2013.
3. Kearton W. J., *Steam Turbine Theory and Practice - A Textbook for Engineering Students*, Aristophanes Press, 2011.
4. Heywood J. B., *I.C Engine Fundamentals,* McGraw-Hill, 1988.
5. Cohen H., G. F. C. Rogers and H. I. H. Saravanamuttoo, *Gas Turbine Theory*, Longman, 1996.
6. Gill P. W., J. H. Smith and E. J Ziurys, *Fundamentals of Internal Combustion Engines*,. Oxford and IBH Publishing Co., 1972.
7. Sachdeva R. C., *Fundamentals of Engineering Heat and Mass Transfer*, New Age Science, 2009.
8. Nag P. K, *Heat and Mass Transfer*, 3/e, Tata McGraw Hill, 2011.
9. Ballaney P. L., *Refrigeration and Air Conditioning*, Khanna Publishers, 2005.
10. Stoecker W. F. and J.W. Jones, *Refrigeration and Air Conditioning*, McGraw Hill, 1982.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Tests (minimum 2)
40% - Class work.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Five short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Note: *Use of approved Steam Tables and Heat & Mass Transfer Tables shall be permitted for the university examination and hence are permitted for the university examination for this course, proper direction in this regard (or use of any other tables and charts if required) should be provided on the facing sheet of the question paper.*

Course Outcome:

After the completion of the course, students are expected to design, analyze and performance evaluation of thermal energy conversion systems.

13.407 FLUID MECHANICS & MACHINES LAB (MN)

Teaching Scheme: 0(L) - 0(T) - 3(P) **Credits**: 3

Course Objective :

- *To demonstrate the applications of the basic fluid mechanics and hydraulic machines and to provide a more intuitive and physical understanding of the theory.*

Preliminary study:

1. Study of flow measuring equipments - water meters, venturimeter, orifice meter, current meter.
2. Study of gauges - pressure gauge, vacuum gauge, manometers.
3. Study of valves - stop valve, gate valve and foot valve.
4. Study of pumps – Centrifugal, Reciprocating, Rotary, Jet.
5. Study of Turbines - Impulse and reaction types.
6. Study of Hydraulic ram, accumulator etc.

List of Experiments:

1. Determination of Coefficient of discharge and calibration of Notches, Orifice meter, Nozzle and Venturimeter.
2. Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus
3. Determination of Hydraulic coefficients of orifices
4. Determination of Metacentric Height and Radius of gyration of floating bodies.
5. Performance test on Rotodynamic and Positive displacement pumps
6. Performance test on Impulse and Reaction turbines
7. Speed variation test on Impulse turbine
8. Determination of best guide vane opening for Reaction turbine.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test

40% - Class work and Record

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

Questions based on the list of experiments prescribed in Part II.

75% - Theory, Procedure and tabular column (30%);

Conducting experiment, Observation, Tabulation with Sample calculation (30%)

Graphs, Results and inference (15%)

25% - Viva voce (Based on Part I and Part II)

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

At the end of this course the student is expected to:

- *gain a fundamental physical and mathematical understanding of the topic rather than memorizing the equations and situations.*
- *understand physical basis of Bernoulli's equation, and apply it in flow measurement (orifice, Nozzle and Venturimeter), and to a variety of problems.*
- *determine the efficiency and plot the characteristic curves of different types of pumps and turbines.*

13.408 THERMAL ENGINEERING LAB (N)

Teaching Scheme: 0(L) - 0(T) - 3(P) **Credits**: 3

Course Objective :

- *To study the parts and systems of different types of IC engines, compressors, blowers and heat exchangers and their features and characteristics.*
- *To acquire knowledge on the working performance of different types of IC engines, compressors, blowers and heat exchangers under varying conditions.*
- *To get knowledge on the determination of flash and fire points, viscosity, calorific value etc. of different fuels.*

List of Experiments:

1. Study of IC engines :
   a) Diesel engines - all systems and parts
   b) Petrol engines - all systems and parts.
2. Experiment on IC Engines
   a) Performance test on IC Engines (Petrol and Diesel)
   b) Valve timing diagram
   c) Economic speed test
   d) Best cooling water Temperature test
   e) Retardation test
   f) Volumetric efficiency and Air-fuel ratio test
3. Study and Performance Analysis of
   a) Reciprocating compressor
   b) Rotary compressor
   c) Blowers
4. Determination of thermal Conductivity of metals, experiments on convection and radiation heat transfer.
5. Performance analysis of Parallel flow and Counter flow heat exchangers.
6. Determination of flash and fire points of petroleum products
7. Determination of viscosity of lubricating oil using Redwood Viscometer.
8. Determination of calorific value of solid, liquid and gaseous fuels using Bomb

Calorimeter and Gas Calorimeter.

9. Study of pollution testing equipment and flue gas analyser.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test
40% - Class work, Record, homework, assignments etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

Questions based on the list of experiments prescribed. The university exam question paper shall be prepared with or without different parts/sections. The evaluation should be based on appropriate spilt of marks suitable to the question, within the ranges given below.

75% - Theory, Procedure and tabular column (15% - 25%);

Conducting experiment, Observation, Tabulation, Sample calculation (35% - 45%)

Graphs, Results and inference (10% – 20%)

25% - Viva voce

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

At the end of this course the student is expected to:

- *Have knowledge on the parts and systems of different types of IC engines, compressors, blowers and heat exchangers and their features and characteristics.*
- *Have knowledge on the working performance of different types of IC engines, compressors, blowers and heat exchangers under varying conditions.*
- *Have knowledge on the determination of flash and fire points, viscosity, calorific value etc. of different fuels.*