Sri Vasavi Engineering College (Autonomous)

(Sponsored by Sri Vasavi Educational Society)

(Approved by AICTE, New Delhi & Permanently affiliated to JNTUK, Kakinada)

(Accredited by NBA & NAAC with 'A' Grade, Recognized by UGC Under Section 2(f) & 12(B))

Pedatadepalli, Tadepalligudem, W.G.Dt, A.P-534101

Department of Mechanical Engineering

Agenda of the 5th BOS meeting of the department on 28-08-2021

Item No.1

Approval of course structure and syllabi for VII & VIII semesters of B.Tech under V18 Regulations.

Item No.2

Approval of list of courses offering under Open Electives - II & III in VII & VIII semesters of B.Tech respectively and their syllabi under V18 Regulations for all other branches.

Item No.3

Approval of course structure & syllabi for the courses offered in III & IV semesters B.Tech under V20 Regulation.

Item No.4

Approval of Course Structure & syllabi of M.Tech-Thermal Engineering programme under V21 regulations.

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Department of Mechanical Engineering

Date:28-08-2021

Fifth meeting of BOS in Mechanical Engineering Department along with external members is held on 28/08/2021 at 02.00 PM in online mode through ZOOM meeting app in view of COVID-19 pandemic.

The following members are present.

S. No	Name of the BOS Members
1.	Dr.N. Mohan Rao, Professor &CE, JNTUK,Kakinada
2.	Dr. R.V. Chalam, Professor,NIT,Warangal
3.	Dr. A. Krishnaiah, Professor, Osmania University, Hyderabad
4.	Sri S.S. SubramanyaSastry, Head of Practice QMS Veave Technologies, Banglore, India.
5.	Sri A.Sai Krishna, Alumni,Maruthi Design and Engg. Pvt. Ltd ,Bangalore
6.	Dr. Ch.Rambabu, Professor & I/C Principal, SVEC
7.	Dr. M.V. Ramesh, Chairman & HOD, SVEC
8.	All the BOS internal members

Minutes of meeting

Chairman welcomed all the BOS members and introduced to all the BOS internal members.

Item No. 1: Approval of course structure and syllabi for VII & VIII semesters of B.Tech under V18 Regulations.

- Lab course named Production Drawing Lab (course code. **V18MEL13**), MNC course was changed to credit course and 1.5 credits were given in VII semester.
- The course code of Project Work –PART-A(V18MRL14) has been changed to V18MEP01 in VII semester and Project Work – PART-B (V18MEL15) has been changed to V18MEP02 in VIII semester.
- The approved course structure and their syllabi is attached in **Annexure-I.**

Item No. Approval of list of courses offering under Open Electives - II & III in VII & VIII semesters of B.Tech respectively and their syllabi under V18 Regulations for all other branches.

- The approved courses offering under Open Electives are attached in **Annexure-II.**

Item No. 3: Approval of course structure & syllabi for the courses offered in III & IV semesters B.Tech under V20 Regulation.

- The approved course structure & their syllabi is attached in **Annexure-III.**

Item No. 4: Approval of Course Structure & syllabi of M.Tech-Thermal Engineering programme under V21 regulations.

- Approved by the BOS members **Annexure-IV**.

Chairman (Head –ME)
Head of the Department
Mechanical Engineering
Sri Vasavi Engineering College
TADEPALLIGUDEM-534101

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Department of Mechanical Engineering

Annexure I

Course structure Approved in previous BOS under V18 Regulations

IV B.Tech.

VII Semester						
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**Credits**
1	**V18MET20**	Automation in manufacturing	3	0	0	3
2	**V18MET21**	Operation Research	3	0	0	3
3		Professional Elective – II	3	0	0	3
4		Professional Elective – III	3	0	0	3
5		Open Elective – II	3	0	0	3
6	**V18MEL12**	Simulation Lab	0	0	3	1.5
7	**V18MEL13**	Production Drawing Lab	0	0	3	1.5
8	**V18MEP01**	Project Work –PART-A	0	0	9	3
			15	**0**	**15**	**21**

Contact hours: 30 Total Credits: 21

VIII Semester						
S.No.	**Course Code**	**Course**	**L**	**T**	**P**	**Credits**
	V18MET28	Automobile Engineering	3	0	0	3
1		Open Elective – III	3	0	0	3
2		Professional Elective - IV	3	0	0	3
3		Professional Elective –V	3	0	0	3
4	**V18MEP02**	Project Work – PART-B	0	0	18	9
			12	**0**	**18**	**21**

Contact hours : 30 Total Credits : 21

Professional Elective –II **V18MET22 -** Industrial Engineering and Management **V18MET23 -** Composite Materials **V18MET24 -** Refrigeration & Air Conditioning	**Professional Elective –III** **V18MET25 -**Total Quality Management **V18MET26 -** Finite Element Methods **V18MET27 -** Micro Electro Mechanical Systems (MEMS)
Professional Elective –IV **V18MET31 –** Process Planning & Cost Estimation **V18MET32 -** Non Destructive Evaluation **V18MET33 -** Industrial Hydraulics and Pneumatics	**Professional Elective –V** **V18MET34 -** Computational Fluid Dynamics **V18MET35-** Production Planning and Control **V18MET36 -** Energy Conservation and Management

Open Elective –II **V18MEOE4-** Computer Aided Design **V18MEOE5-** Condition Monitoring & Machine learning	**Open Elective –III** **V18MEOE6-** Power Plant Engineering **V18MEOE7 -** Mechatronics

Detailed syllabi of VII & VIII sem B.Tech., for approval in 5th BOS
Syllabi for the courses offered in VII semester B. Tech under V18 Regulation for the Academic Year 2021-2022
VII Semester

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET20
Name of the Course	Automation in Manufacturing					
Branch	Mechanical Engineering					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Understand the basic types, levels, strategies of automation.	K2
CO2	Identify the basic components and their functions of automated production line system.	K2
CO3	Differentiate various automated assembly systems.	K4
CO4	Compute various storage system and transportation requirements of automated systems.	K3
CO5	Apply appropriate process control strategy to an automated system.	K3
CO6	Illustrate the concepts of CIM..	K3

UNIT – I

INTRODUCTION : Facilities — Manual work systems, worker-machine systems and automated systems. Manufacturing support systems, Automation in Production systems — Automated Manufacturing systems, Computerized manufacturing support systems, Manual labour in Production systems, Automation principles and strategies.

UNIT – II

AUTOMATED PRODUCTION LINES : Fundamentals- System configurations, work part transfer mechanisms, Storage buffers, and Control of the production line. Applications — Machining systems and System Design Considerations. Analysis of Transfer lines — Transfer lines with No internal parts storage, Transfer lines with internal storage buffers.

UNIT – III

AUTOMATED ASSEMBLY SYSTEMS : System configurations, Parts delivery at workstations, and applications, quantitative analysis of assembly systems-Parts Delivery System at Workstations, Multi-Station Assembly Machines, Single Station Assembly Machines, Partial Automation.

UNIT – IV

AUTOMATED MATERIAL TRANSPORT & STORAGE SYSTEMS : Automated Material Transport & Storage systems: Automated Guided Vehicle (AGV) Systems, Types and applications, Vehicle Guidance Technology, Vehicle Management and Vehicle safety. Automated Storage/Retrieval Systems (ASRS) and Carousel Storage Systems.

UNIT – V

AUTOMATED INSPECTION SYSTEMS : Quality in Design and manufacturing, inspection principles and strategies, automated inspection, contact Vison-contact, CMM. Manufacturing support systems. Quality function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.

UNIT – VI

COMPUTER INTEGRATED MANUFACTURING : The Scope of CAD/CAM and CIM, Computerized elements of a CIM System, Components of CIM, Database for CIM, Planning , Scheduling and Analysis of CIM Systems.

TEXT BOOKS:

1. Nagrath and Mittel, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Mikell P Groover, " Automation, production Systems and Computer Integrated Manufacturing," 3rd Edition, Prentice Hall Inc., New Delhi, 2007.
3. Nanua Singh, "System Approach to Computer Integrated Manufacturing," Wiley & Sons Inc.,
4. CAD CAM: Principles, Practice and Manufacturing Management by Chris Mc Mohan, JimmieBrowne, Pearson edu. (LPE).
5. Automation by Buckinghsm W, Haper& Row Publishers, New York, 1961
6. Automation for Productivity by Luke H.D, John Wiley & Sons, New York, 1972.

REFERENCE BOOKS:

1. P. Radhakrishnan, S, Subrarnanyan and V, Raju, 'CAD/CAM/CIM', New Age International (P) Ltd., New Delhi, 2009.
2. S.R.Deb and Sankha Deb, 'Robotics Technology and Flexible Automation', Tata McGraw Hill,Seconcl Edition, New Delhi, 2010.
3. Peter Corke, 'Robotics, Vision and Control' Fundamental Algorithms in MATLAB', Springer, 2011.
4. Nicholas Odrey, MikellGroover, Roger Nagel, Ashish Dutta, 'Industrial Robotics (SIE): Technology, Programming and Applications', McGraw Hill, 2012.

WEB REFERENCES:

1. https://nptel_acinicourses/108/105/108105063/
2. https://www.automationmag.com/
3. https://www.springer.com/gp/book/9783319771786.
4. https://library.automationdirect.com/industrial-automation-top-10-trends/
5. https://nptel.ac.inicourses/112/102/112102011

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET21
Name of the Course	Operation Research					
Branch	Mechanical Engineering					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Understand the formulating of LPP and solve LPP by Simplex methods, artificial variables techniques.	K2
CO2	Solve Transportation and assignment problems.	K3
CO3	Explain the concept of Sequencing and replacement of item.	K2
CO4	Understand the concept of queues with single server, solution of games with and without saddle points.	K2
CO5	Apply the concept of inventory models in solving EOQ problems.	K3
CO6	Solve the issues of dynamic programming and simulation.	K3

UNIT – I

HISTORICAL OVERVIEW – Definition and scope– types of operation research models – applications.

LINEAR PROGRAMMING: Problem formulation – graphical solution – simplex method – artificial variables techniques - big-M method, two–phase method.

UNIT – II

TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy

ASSIGNMENT PROBLEM: Introduction, optimal solution, Traveling Salesman problem.

UNIT – III

SEQUENCING – Introduction – flow –shop sequencing – *n* jobs through two machines – *n* jobs through three machines

REPLACEMENT: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

UNIT – IV

THEORY OF GAMES: Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

WAITING LINES: Introduction – single channel – poison arrivals – exponential service times – with infinite population and finite population models

UNIT – V

INVENTORY : Introduction – single item – deterministic models – purchase inventory models with one price break– shortages are not allowed – stochastic models – demand may be discrete variable or continuous variable – instantaneous production. Instantaneous demand and continuous demand and no set up cost.

UNIT – VI

DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming- capital budgeting problem – shortest path problem .

SIMULATION: Definition – types of simulation models – phases of simulation– applications of simulation – inventory and queuing problems – advantages and disadvantages – simulation languages.

TEXT BOOKS:

1. Operations Research / S.D.Sharma-Kedarnath
2. Operations Research by R. Pannerselvam; Publisher: Prentice Hall International.

REFERENCES:

1. Introduction to O.R/Hiller & Libermann (TMH).
2. Operations Research / A.M.Natarajan, P. Balasubramani, A. Tamilarasi / Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, Arhur Yaspan & Lawrence Friedman.

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET22
Name of the Course	**Industrial Engineering and Management** Professional Elective –II					
Branch	**Mechanical Engineering**					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Design and conduct experiments, analyze, interpret data and synthesize valid conclusions	K4
CO2	Design a system, component, or process, and synthesize solutions to achieve desired needs	K4
CO3	Use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints	K3
CO4	Examine effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management	K3
CO5	Understand quality and quality management	K2
CO6	Understand concepts on recourse management	K2

UNIT – I

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

UNIT – II

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and breakdown maintenance.

UNIT – III

WORK STUDY: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs

UNIT – IV

STATISTICAL QUALITY CONTROL: Quality control, Queuing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – and R – charts and *S* charts and their applications, numerical examples.

UNIT – V

TOTAL QUALITY MANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. six sigma – definition, basic concepts

VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

UNIT – VI

RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.

PROJECT MANAGEMENT (PERT/CPM): Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing. (simple problems).

TEXT BOOKS:

1. Industrial Engineering and management / O.P Khanna/Khanna Publishers.

2. Industrial Engineering and Production Management/Martand Telsang/S.Chand & Company Ltd. New Delhi

REFERENCE BOOKS:

1. Industrial Management / Bhattacharya DK/Vikas publishers
2. Operations Management / J.G Monks/McGrawHill Publishers.
3. Industrial Engineering and Management Science/T.R. Banga,S.C.Sharma, N. K. Agarwal/Khanna Publishers
4. Principles of Management /Koontz O' Donnel/McGraw Hill Publishers.
5. Statistical Quality Control /Gupta/Khanna Publishers
6. Industrial Engineering and Management /NVS Raju/Cengage Publishers

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET23
Name of the Course	**Composite Materials** Professional Elective –II					
Branch	**Mechanical Engineering**					

Course Outcomes:

After Successful completion of this course the student will be able to

CO1	Explain the required properties, reinforcements and uses of various composites.	K2
CO2	Explain how common fibers are produced and how the properties of the fibers are related to the internal structure and the interfaces obtained.	K2
CO3	Illustrate the processing techniques for polymer matrix, ceramic matrix and metal matrix composites and list out their properties and applications	K3
CO4	Analyze different ceramic composite materials	K4
CO5	Examine the processing of ceramic matrix composites	K3
CO6	Evaluate mechanical properties of composite materials	K5

UNIT-I

Introduction, Classification of Composite materials based on structure and matrix and reinforcements, Advantages and applications of composites, Functional requirements of reinforcement and matrix materials. Difference between composites and metals &alloys, Properties of composites in comparison with standard materials

UNIT-II

TYPES OF REINFORCEMENTS AND THEIR PROPERTIES: Glass, Carbon, Boron, Aramid, Al_2O_3 and SiC fibers. Nature and manufacture of glass, carbon and aramid fibers, Comparison of fibers. Role of interfaces: Wettability and Bonding, the interface in Composites, Interactions and Types of bonding at the Interface.

UNIT-III

Fabrication of Polymeric Matrix Composites, Structure and properties of Polymeric Matrix Composites, Interface in Polymeric Matrix Composites, Applications,Recycling of PMCs

UNIT-IV

FABRICATION OF METAL MATRIX COMPOSITES (MMC): Solid state fabrication, Liquid state fabrication and In-situ fabrication techniques. Interface in Metal Matrix Composites. Mechanical bonding, Chemical bonding and Interfaces in In-situ Composites. MMC: Properties and Applications.

UNIT -V

FABRICATION OF CERAMIC MATRIX COMPOSITES (CMC): Processing of CMCs: Cold Pressing and Sintering, Hot Pressing, Reaction Bonding Processes, Infiltration, Sol–Gel process. Interface in CMCs. Properties of CMCs, Applications of CMCs.

UNIT -VI

MECHANICAL TESTING OF COMPOSITES AND THEIR CONSTITUENTS: Measurement of Constituent Material Properties Fiber Tests, Neat Resin Matrix Tests, Constituent Volume Fraction Measurement. Measurement of Basic Composite Properties: Tensile Tests, Compressive Tests, Shear Tests, Flexure Tests, Fiber/Matrix Interface Tests.

TEXT BOOKS:

1. Composite Materials – Science & Engineering, K.K. Chawla, Springer-Verlag, New York, 1987.
2. Principles of Composite Material Mechanics, Ronald F. Gibson
3. An Introduction to Composite Materials, Hull, Cambridge, 2nd Edt.1997.

REFERENCE BOOKS:

1. Composites, Engineered Materials Handbook, Vol.1, ASM International, Ohio, 1988.
2. Structure and Properties of Composites, Materials Science and Technology, Vol. 13, VCH, Weinheim, Germany, 1993
3. Composite Materials: Engineering and Science, F.L. Matthews and R.D. Rawlings, Chapman & Hall, London, 1994.

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET24
Name of the Course	**Refrigeration & Air Conditioning** Professional Elective –II					
Branch	**Mechanical Engineering**					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Apply the concept of refrigeration to various systems.	K3
CO2	Employ the methods to improve performance of vapor compression systems.	K3
CO3	Identify eco-friendly refrigerants and understanding various VCR System Components.	K2
CO4	Describe vapour absorption systems.	K2
CO5	Analyze cooling and heating loads in an air conditioning system.	K4
CO6	Explain various air conditioning systems.	K2

UNIT – I

INTRODUCTION TO REFRIGERATION: Necessity and applications – Unit of refrigeration and C.O.P. –Mechanical refrigeration – Types of ideal cycles of refrigeration.

Air refrigeration: Bell Coleman cycle - Open and Dense air systems – Refrigeration needs of Air crafts- Refrigeration systems used in air crafts and Problems.

UNIT – II

VAPOUR COMPRESSION REFRIGERATION: Working principle and essential components of the plant –simple vapour compression refrigeration cycle – COP – Representation of cycle on T-S and p-h charts – Effect of sub cooling and super heating – Cycle analysis – Actual cycle influence of various parameters on system performance – Use of p-h charts – Problems.

UNIT – III

Refrigerants – Classification – Desirable properties of an ideal refrigerant – Common refrigerants used – Nomenclature of refrigerants .

VCR System Components: Compressors – General classification – comparison – Advantages and Disadvantages. Condensers – Classification – Working Principles. Evaporators – Classification – Working Principles. Expansion devices – Types – Working Principles.

UNIT – IV

VAPOR ABSORPTION SYSTEM: Calculation of maximum COP – description and working of Water-Ammonia Systems, Water-Lithium Bromide System. Principle of operation three fluid absorption system, salient features.

UNIT – V

INTRODUCTION TO AIR CONDITIONING: Psychometric properties & Processes – Characterization of sensible and latent heat loads — Need for ventilation, Consideration of infiltration – Load concepts of RSHF, GSHF- Problems, concept of ESHF and ADP temperature.

Requirements of industrial air conditioning, Air conditioning load calculations.

UNIT – VI

AIR CONDITIONING SYSTEMS: Classification of equipment, Components related to Air- Conditioning Systems- filters, grills and registers, fans and blowers.

TEXT BOOKS:

1. A Course in Refrigeration and Air conditioning , SC Arora & Domkundwar, Dhanpatrai
2. Refrigeration and Air Conditioning , CP Arora, TMH.
3. Refrigeration and Air Conditioning / Manohar Prasad / New Age

REFERENCE BOOKS:

1. Principles of Refrigeration /Dossat / Pearson Education.
2. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH
3. Stoecker, W. F., and Jones, J. W., Refrigeration and Air-Conditioning, McGraw - Hill, New Delhi.
4. Data Book: Refrigerant and Psychrometric Properties - Tables and Charts [SI Units], MathurM. L., and Mehta F. S., Jain Brothers.

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET25
Name of the Course	**Total Quality Management** Professional Elective –III					
Branch	**Mechanical Engineering**					

Course Outcomes:

After the completion of this course, the students will be able to

CO1	Understand the importance of significance of quality & to understand the concept of Quality.	K2
CO2	Develop quality improvement teams & to implement Quality Implementation Programs.	K3
CO3	Identify requirements of quality improvement programs & bench marketing	K2
CO4	Apply the tools and techniques of quality management to manufacturing and services processes.	K3
CO5	Apply the concepts of comprehensive quality management and the challenges of putting them into practice.	K3
CO6	Apply the quality management methods for analysing and solving problems of organization.	K3

UNIT – I

INTRODUCTION: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT – II

CUSTOMER FOCUS AND SATISFACTION: The importance of customer satisfaction and loyalty-Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. .

UNIT – III

BENCH MARKETING: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT – IV

ORGANIZING FOR TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering:

UNIT – V

THE COST OF QUALITY: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT – VI

QUALITY MANAGEMENT SYSTEM (QMS): Introduction to QMS. Universal Standards of Quality: ISO around the world, The ISO9001 ANSI/ASQCQ-Series Standards, benefits of ISO9001 certification, the third party audit, Documentation ISO9001 and services, the cost of certification implementing the system.

TEXT BOOKS:

1. Total Quality Management / Joel E.Ross/Taylor and Franscis Limited
2. Total Quality Management/P.N.Mukherjee/PHI
3. Total Quality Management Paperback / R Kesavan, C Elanchezhian, B Vijaya Ramnath / I K International Publishing House

REFERENCE BOOKS:

1. Beyond TQM / Robert L.Flood
2. Statistical Quality Control / E.L. Grant / McGraw Hill.
3. Total Quality Management- A Practical Approach/H. Lal
4. Quality Management/Kanishka Bedi/Oxford University Press/2011
5. Total Engineering Quality Management/Sunil Sharma/Macmillan

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET26
Name of the Course	**Finite Element Methods** Professional Elective – III					
Branch	**Mechanical Engineering**					

Course Outcomes:

After the completion of this course, the students will be able to

CO1	Use the concepts of variational methods and weighted residual methods in FEM.	K3
CO2	Use Finite Element Formulation for solving the problems.	K3
CO3	Solve the problems of Truss elements by FEM.	K3
CO4	Solve the problems of Beam s elements by FEM.	K3
CO5	Use FEM to solve 2D CST problems.	K3
CO6	Analyze finite element method for problems involving dynamics and heat transfer.	K4

UNIT-I

INTRODUCTION TO FINITE ELEMENT METHOD: stress and equilibrium, strain – displacement relations, stress-strain relations, plane stress and plane strain conditions, variational and weighted residual methods, the concept of potential energy, one-dimensional problems.

UNIT – II

FINITE ELEMENT FORMULATION: Discretization of the domain, element shapes, discretization procedures, assembly of stiffness matrix, bandwidth, node numbering, mesh generation, interpolation functions, convergence requirements, Treatment of Boundary conditions, Derivation of element stiffness matrix for Bar elements and problems

UNIT – III

ANALYSIS OF TRUSSES: Finite element modelling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

UNIT – IV

ANALYSIS OF BEAMS: Derivation of Element stiffness matrix for beam element, derivation of load vector for concentrated and UDL, Problems on Cantilever, simply supported beams with point and uniformly distributed loads.

UNIT-V

CST AND AXISYMMETRIC ELEMENTS: Finite element modelling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems,

HIGHER ORDER AND ISOPARAMETRIC ELEMENTS: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements, numerical integration.

UNIT – VI

STEADY STATE HEAT TRANSFER ANALYSIS: one dimensional analysis of a fin and two dimensional analysis of thin plate, analysis of a uniform shaft subjected to torsion.

DYNAMIC ANALYSIS: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

TEXT BOOKS:

1. The Finite Element Methods in Engineering / S. S Rao / Pergamon.

REFERENCE BOOKS:

1. Finite Element Method with applications in Engineering / YM Desai, Eldho& Shah /Pearson publishers
2. An introduction to Finite Element Method / JN Reddy / McGraw Hill
3. The Finite Element Method for Engineers – Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smithand Ted G. Byrom / John Wiley &Sons (ASIA) Pte Ltd.
4. Finite Element Analysis/ P.Seshu
5. Finite Element Methods: Basic Concepts and Applications ByChennakesava R. Alavala
6. Finite Element Analysis: for students & Practicing Engineers / G.LakshmiNarasaiah / BSP Books Pvt. Ltd.

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET27
Name of the Course	Micro Electro Mechanical Systems (MEMS) Professional Elective – III					
Branch	Mechanical Engineering					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Understand about the basics of MEMS, Methods of Micro machining.	K2
CO2	Interpret various Mechanical sensors & Actuators	K3
CO3	Illustrate the working principles of various Thermal sensors and Actuators & its applications.	K3
CO4	Differentiate between different types of MOEMS devices	K2
CO5	Illustrate and explain various Magnetic sensors and Actuators & its applications	K3
CO6	Illustrate and explain various micro-fluidic devices & its applications	K3

UNIT – I

INTRODUCTION: Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA.

UNIT – II

MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.

UNIT – III

THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermisters, thermo devices, thermo couple, micro machined thermo couple probe, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA).

UNIT – IV

MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch.

UNIT – V

MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator.

UNIT – VI

MICRO FLUIDIC SYSTEMS: Applications, considerations on micro scale fluid, fluid actuation methods, dielectro phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), micro fluid dispenser, micro needle, micro pumps.

TEXT BOOKS:

1. MEMS, Nitaigour Premchand Mahalik, TMH Publishing co.

REFERENCE BOOKS:

1. Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2. MEMS and NEMS, Sergey Edwrd Lyshevski, CRC Press, Indian Edition.
3. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.
4. Introductory MEMS, Thomas M Adams, Richard A Layton, Springer International Publishers.

Semester	VII	L	T	P	C	Course Code
Regulation	V18	0	0	3	1.5	V18MEL12
Name of the Course	Simulation Lab					
Branch	Mechanical Engineering					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Apply the tools like ANSYS or FLUENT in solving real time problems and day to day problems.	K3
CO2	Develop drawings for various components.	K3
CO3	Practice programming on CNC Machines.	K3

List of experiments:

1. **DRAFTING:** Development of part drawings for various components in the form of orthographic and isometric representation of dimensioning and tolerances scanning and plotting. study of script, DXE and IGES files.

2. **PART MODELING:** Generation of various 3D models through protrusion, revolve, shell sweep. creation of various features. study of parent child relation. feature based and boolean based modelling surface and assembly modelling. study of various standard translators. Design simple components.

3. a) Determinationofdeflectionandstressesin2Dand3Dtrussesandbeams.
   b) Determination of deflections component and principal and Von-mises stresses in plane stress, plane strain and Axisymmetric components.
   c) Determination of stresses in 3D and shell structures (at least one example in each case)
   d) Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
   e) Steady state heat transfer Analysis of plane and Axisymmetriccomponents.

4. a) Study of various post processors used in NC Machines.
   b) Machining of simple components on NC lathe and Mill by transferring NC Code / from a CAM package. Through RS 232.
   c) Practice on CNC Sinutrain Turning
   d) Practice on CNC Sinutrain Milling
   e) CNC programming forturned components using FANUC Controller
   f) CNC programming for milled components using FANUC Controller
   g) Automated CNC Tool path & G-Code generation using

   Pro/E/MasterCAM**Packages to be provided to cater to drafting, modeling & analysis from the following:**CATIA, Pro-E, I-DEAS, ANSYS, NISA, CAEFEM, Gibbs CAM, Master CAM etc.

Semester	VII	L	T	P	C	Course Code
Regulation	V18	0	0	3	1.5	V18MEL13
Name of the Course	Production Drawing Lab					
Branch	Mechanical Engineering					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Recognise the need of limits, fits and tolerances, and apply the same on part drawings for manufacturing.	K2
CO2	Illusttrate the Geometric Dimensioning and tolerancing, able to apply GD&T to a part drawing.	K3
CO3	Indicate various surface roughness symbols on part drawings for manufacturing.	K2
CO4	Assess the raw material requirements, final cost of the component and heat treatment process.	K3
CO5	Develop skill to produce detailed drawings from assembly drawings.	K3
CO6	Construct press tools, die-casting dies and jigs and fixtures using computer aided design software.	K3

PART-A

LIMITS, FITS AND TOLERANCES: Types of fits, exercises involving selection and interpretation of fits and estimation of limits from tables.

GEOMETRIC DIMENSIONING AND TOLERANCING: Introduction to GD&T ,terminology & basic rules, features and material conditions, maximum material condition, least material condition, regardless of feature's size, datums, datum reference frame, **form tolerances, orientation tolerances, profile tolerances, runout tolerances.**

ADDING GD&T TO A DRAWING/DESIGN – size, location, orientation & form, choosing datums, indication of form and position tolerances on drawings, preparation of bill of material

SURFACE ROUGHNESS AND ITS INDICATIONS: Definition, types of surface roughness indication-Surface roughness obtained from various manufacturing process, recommended surface roughness on mechanical components, heat treatment and surface treatment symbols used on drawings.

PART-B

Drawing of parts from assembly of stuffing box, piercing and blanking die, Die casting die, Box jig, machining fixture with indication of size, tolerance, roughness, form and position tolerances using Computer aided design software.

TEXT BOOKS:

1. Production and Drawing – K.L. Narayana& P. Kannaiah/New Age Publication
2. Tool Engineering & Design_G.R.Nagpal/Khannapublishers,1st edition, Khanna Publishers, 2009
3. MachineDrawingwithAutoCAD-PohitandGhosh,1st edition, Pearso, 2017
4. Geometric dimensioning and tolerancing- James D. Meadows/B.S Publications.

REFERENCE BOOKS:

1. MachineDrawingbyNagpal,1st edition, khanna publishers,2009
2. Machinedrawing,AjeetSingh,2nd edition,TMH,2016
3. Engineering Metrology, R.K. Jain, Khanna Publications.

Syllabi for the courses offered in VIII semester B. Tech under V18 Regulation for the Academic Year 2021-2022

VIII Semester

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET28
Name of the Course	Automobile Engineering					
Branch	Mechanical Engineering					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Understand various components in four wheel automobile.	K2
CO2	Differentiate between different types of transmission systems used in automobile.	K4
CO3	Examine steering geometry and steering systems used in automobile.	K3
CO4	Interpret suspension, breaking and electrical systems in automobile.	K3
CO5	Understand various safety systems used in automobile.	K2
CO6	Practice engine service for different components in automobile.	K3

UNIT – I

INTRODUCTION: Components of four wheeler automobile – chassis and body – power unit – power transmission – rear wheel drive, front wheel drive, 4 wheel drive – types of automobile engines, engine construction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation – engine service, reboring, decarbonisation, Nitriding of crank shaft.

UNIT – II

TRANSMISSION SYSTEM: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, construct mesh, synchromesh gear boxes, epicyclic gear box, over drive torque converter. propeller shaft – Hotch – Kiss drive, Torquetube drive, universal joint, differential rear axles – types – wheels and tyres.

UNIT – III

STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle toein, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears– types, steering linkages.

UNIT – IV

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

BRAKING SYSTEM: Mechanical brake system, hydraulic brake system, master cylinder, wheel cylinder tandem master cylinder requirement of brake fluid, pneumatic and vacuum brakes.

ELECTRICAL SYSTEM: Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.

UNIT – V

ENGINE SPECIFICATION AND SAFETY SYSTEMS: Introduction- engine specifications with regard to power, speed, torque, no. of cylinders and arrangement, lubrication and cooling etc.

Safety: Introduction, safety systems - seat belt, air bags, bumper, anti lock brake system (ABS), wind shield, suspension sensors, traction control, mirrors, central locking and electric windows, speed control.

UNIT – VI

ENGINE SERVICE: Introduction, service details of engine cylinder head, valves and valve mechanism, piston connecting rod assembly, cylinder block, crank shaft and main bearings, engine reassembly-precautions.

TEXT BOOKS:

1. Automotive Mechanics – Vol. 1 & Vol. 2 / Kirpal Singh/standard publishers
2. Automobile Engineering / William Crouse/TMH Distributors
3. Automobile Engineering/P.S Gill/S.K. Kataria & Sons/New Delhi.

REFERENCE BOOKS:

1. Automotive Engines Theory and Servicing/James D. Halderman and Chase D. Mitchell Jr.,/ Pearson education inc.
2. Automotive Engineering / K Newton, W.Steeds & TK Garrett/SAE
3. Automotive Mechanics: Principles and Practices/ Joseph Heitner/Van Nostrand Reinhold
4. Automobile Engineering / C Srinivasan / Mc Graw Hill

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET31
Name of the Course	**Process Planning & Cost Estimation** Professional Elective – IV					
Branch	**Mechanical Engineering**					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Understand the basic concepts of production, steps involved in types of process planning.	K2
CO2	Calculate the process parameters for various production processes.	K3
CO3	Prepare the types of estimates.	K3
CO4	Calculate depreciation cost and explain about different costs.	K3
CO5	Estimate production cost in forging, welding and foundry.	K2
CO6	Determine the machining time of different machining operations.	K4

UNIT – I

INTRODUCTION: Types of production, standardization, simplification, product design and selection-process planning-methods, selection and analysis-steps involved in manual and computer aided process planning-Break even analysis.

UNIT – II

PROCESS PLANNING ACTIVITIES: Calculation of process parameters for various production processes-Selection of jigs & fixtures-Selection quality assurance methods-Set of documents for process planning.

UNIT – III

ESTIMATION AND COSTING: Aim and objective of cost estimation – Functions of estimation – Costing – Importance and aims of costing – Difference between costing and estimation. Types of estimates – Estimation procedure.

UNIT – IV

COST ELEMENTS: Material cost – Determination of material cost, labour cost, Expenses — Analysis of overhead expenses – Factory expenses, Administrative expenses – Selling and Distributing expenses – Allocation of over head expenses. Cost of product – Illustrative examples Depreciation: Depreciation – Causes of Depreciation – Methods of Depreciation calculation.

UNIT – V

ESTIMATION OF PRODUCTION COST : Estimation in forging shop – Losses in forging – forging cost – Illustrative examples. Estimation in welding shop – Gas cutting – Electric welding - Illustrative examples. Estimation in foundry shop – Estimation of pattern cost and casting cost - Illustrative examples.

UNIT – VI

MACHINING TIME ESTIMATION: Estimation of Machining Time for Lathe operations – Estimation of Machining Time for Drilling, Boring, Shaping, Planning, Milling and Grinding operations - Illustrative examples.

TEXT BOOKS:

1. M.Adithian and B.S. Pabla, Estimation and Costing, Konark publishers Pvt. Ltd., 1989.
2. A.K.Chitale and R.C.Gupta, Product Design and Manufacturing, Prentice Hall Pvt. Ltd.., 2005

REFERENCE BOOKS :

1. Namua Singh, System Approach to computer integrated Design and Manufacturing, John Wiley & Sons,Inc.,1996.
2. Joseph G Monks, Operation Management, Theory & Problems, McGraw Hill Book Company, 1987.
3. T.R.Banga and S.C.Sharma, Estimations and Costing, Khanna Publishers,1988.
4. G.B.S.Narang and V.Kumar, Production and Costing, Khanna Publishers, 1995.
5. Sinha B.P – Mechanical estimating & costing – Tata McGrawhill publishing co.,1995

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET32
Name of the Course	Non Destructive Evaluation Professional Elective – IV					
Branch	Mechanical Engineering					

Course Outcomes:

After Successful completion of this course the student will be able to

CO1	Identify the flaws in manufacturing process through radiographic inspection	K2
CO2	Explain the theory of wave propagation and inspect the components using ultrasonic test	K2
CO3	Identify various surface, subsurface flaws with LPT and ECT	K2
CO4	Explain the principle of eddy current test system, flaw detection and evolution	K2
CO5	Demonstrate the flaw detection using IRT test	K2
CO6	Find the industrial applications in railways, nuclear, aerospace etc	K3

UNIT – I

Introduction to non-destructive testing, Radiographic test, Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography.

UNIT – II

ULTRASONIC TEST: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection, Effectiveness and Limitations of Ultrasonic Testing.

UNIT – III

LIQUID PENETRANT TEST: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and Limitations of Liquid Penetrant Testing.

EDDY CURRENT TEST: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing.

UNIT – IV

MAGNETIC PARTICLE TEST: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials,Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test.

UNIT – V

INFRARED AND THERMAL TESTING: Introduction and fundamentals to infrared and thermal testing, Heat transfer –Active and passive techniques, Lock in and pulse thermography, Contact and non contact thermal inspection methods, Heat sensitive paints and papers, thermally quenched phosphors liquid crystals, techniques for applying liquid crystals, other temperature sensitive coatings, Inspection methods, Infrared radiation and infrared detectors, thermo mechanical behavior of materials, IR imaging in aerospace applications,electronic components, Honey comb and sandwich structures–Case studies.

UNIT – VI

INDUSTRIAL APPLICATIONS OF NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions.

TEXT BOOKS:

1. Non destructive test and evaluation of Materials/J Prasad, GCK Nair/TMH Publishers
2. Ultrasonic testing of materials/ H Krautkramer/Springer
3. Non destructive testing/Warren, J Mc Gonnagle / Godan and Breach Science publishers
4. Nondestructive evaluation of materials by infrared thermography / X. P. V. Maldague, Springer-Verlag, 1st edition, (1993)

REFERENCE BOOKS:

1. Ultrasonic inspection training for NDT/ E. A. Gingel/Prometheus Press,
2. ASTM Standards, Vol 3.01, Metals and alloys
3. Non-destructive, Hand Book – R. Hamchand

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET33
Name of the Course	**Industrial Hydraulics and Pneumatics** Professional Elective – IV					
Branch	**Mechanical Engineering**					

Course Outcomes:

After Successful completion of this course the student will be able to

CO1	Understand the fundamentals of Fluid Power Systems	K2
CO2	Develop general concepts associated with Hydraulic actuators and cylinders.	K3
CO3	Identify Hydraulic elements in the design of circuits	K2
CO4	Illustrate various accumulators & intensifiers	K3
CO5	Develop the operation of pnuematics circuits andcomponents typically used in industry.	K3
CO6	Examine the applications of Industrial Hydraulics and Pneumatics.	K3

UNIT – I

FUNDAMENTALS OF FLUID POWER SYSTEMS-INTRODUCTION – types advantages, disadvantages & applications-fluid characteristics-terminologies used in fluid power-hydraulic symbols-hydraulic systems and components-sources- pumping theory-gear, vane & piston pumps.

UNIT-II

FLUID POWER ACTUATORS : Introduction-hydraulic actuators-hydraulic cylinders-types, construction, specifications and special types. hydraulic motors- working principle-selection criteria for various types-hydraulic motors in circuits- formulae-numerical problems

UNIT-III

HYDRAULIC ELEMENTS IN THE DESIGN OF CIRCUITS- Introduction-control elements- direction control valve-check valve-pressure control valve-relief valve- throttle valve-temperature & pressure compensation-locations of flow controlvalve

UNIT-IV

ACCUMULATORS & INTENSIFIERS-types, size &function of accumulators- application & circuits of accumulators- intensifiers-circuit & applications.

UNIT-V

PNEUMATIC SYSTEMS-INTRODUCTION-symbols used-concepts & components- comparison-types & specifications of compressors-arrangement of a complete pneumatic system-compressed air behaviour-understandingpneumatic circuits-direction control valves

UNIT-VI

APPLICATIONS- Servo systems-introduction-closed loop, hydro-mechanical and electro hydraulic – conventional and proportional valves-characteristics of proportional and servo valves- PLC applications in fluid power – selected pneumatic / electro pneumatic circuit problems – failure and trouble shooting in fluid power systems.

TEXT BOOKS:

1. Introduction to Hydraulics and Pneumatics by S. Ilango and V.Soundararajan, PHI , New Delhi
2. Applied hydraulics and pneumatics-T. Sunder Selwyn & R.Jayendiran, Anuradha Publications.

REFERENCE BOOKS:

1. Oil Hydraulic Systems, S.R .Majumdar, McGrawHill Companies
2. Pneumatic Systems: Principles and Maintenance, Majumdar,McGrawHill

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET34
Name of the Course	**Computational Fluid Dynamics** Professional Elective – V					
Branch	**Mechanical Engineering**					

Course Outcomes:

After Successful completion of this course the student will be able to

CO1	Apply techniques in the numerical solution of fluid equations	K3
CO2	Apply numerical modeling and its role in the field of heat transfer and fluid flow.	K3
CO3	Develop methodologies used in CFD	K3
CO4	Comapre various discretization methods and solving methodologies.	K4
CO5	Apply skills in the actual implementation of CFD methods (e.g. boundary conditions, different numerical schemes etc.	K3
CO6	Apply the finite element methods in the application of CFD analysis to real life engineering designs.	K3

UNIT – I

ELEMENTARY DETAILS IN NUMERICAL TECHNIQUES: Number system and errors, representation of integers, fractions, floating point arithmetic, loss of significance and error propagation, condition and instability, computational methods for error estimation, convergence of sequences.

UNIT – II

APPLIED NUMERICAL METHODS: Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices.

EQUATIONS GOVERNING FLUID FLOW AND HEAT TRANSFER: Introduction, conservation of mass, Newton's second law of motion, expanded forms of navier-stokes equations, conservation of energy principle, special forms of the navier-stokes equations.

UNIT – III

Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function - vorticity formulation. Finite difference applications in heat conduction and convention – heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure.

UNIT – IV

Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modeling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

UNIT – V

Introduction to first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modeling, conservative property, the upwind scheme

UNIT – VI

FINITE VOLUME METHOD: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

TEXT BOOKS:

1. Numerical heat transfer and fluid flow / Suhas V. Patankar- Butter-worth Publishers.
2. Computational fluid dynamics - Basics with applications - John. D. Anderson / McGraw Hill.

REFERENCE BOOKS:

1. Computational Fluid Flow and Heat Transfer/ Niyogi, Pearson Publications.
2. Fundamentals of Computational Fluid Dynamics – Tapan K. Sengupta / Universities Press.
3. Computational fluid dynamics, 3rd edition/Wendt/Springer publishers

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET35
Name of the Course	**Production Planning and Control** Professional Elective – V					
Branch	**Mechanical Engineering**					

Course Outcomes:

After Successful completion of this course the student will be able to

CO1	Generalise structure, elements and functions of Production planning and Control.	K2
CO2	Apply the principles of different forecasting methods.	K3
CO3	Analyze principles of different inventory control systems.	K4
CO4	Generalise Routing, its procedure, factors affecting Routing procedure.	K2
CO5	Explain Scheduling methods, Planning and controlling aspects.	K2
CO6	Understand Dispatching procedure, types of follow up, applications of computers in production planning and control.	K2

UNIT – I

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

UNIT – II

Forecasting– importance of forecasting – types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitive methods.

UNIT – III

Inventory management– functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems.

Introduction to MRP I, MRP II, ERP, JIT systems.

UNIT – IV

Routing– definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition – difference with loading.

UNIT – V

Scheduling policies– techniques, standard scheduling methods. Line Balancing, aggregate planning, chase planning, expediting.

UNIT – VI

Dispatching– activities of dispatcher – dispatching procedure – follow up – definition – reasons for existence of functions – applications of computers in production planning and control.

TEXT BOOKS:

1. Elements of Production Planning and Control / Samuel Eilon.
2. Manufacturing, Planning and Control, Partik Jonsson Stig-Arne Mattsson, Tata Mc Graw Hill

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MET36
Name of the Course	**Energy Conservation and Management** Professional Elective – V					
Branch	**Mechanical Engineering**					

Course Outcomes:

After Successful completion of this course the student will be able to

CO1	Understand the principles of Energy.	K2
CO2	Evaluate thermal Performance.	K5
CO3	Illustrate Energy Conservation Program.	K3
CO4	Predict the Energy Conservation Options	K2
CO5	Recognise the Strategies for Electricity and Management	K2
CO6	Express the Importance and Role of Energy Management	K2

UNIT-I

Energy scenario, Principles of energy conservation, Energy consumption pattern, Resource availability.

UNIT-II

Calculation of thermal performance, calculation of heat loss – heat gain, estimation of annual heating & cooling load factors that influence thermal performance, analysis of existing buildings.

UNIT-III

Organizing for energy conservation program, the energy audit and energy information system, technology for energy conservation, co-generation of process, steam & electricity, computer controlled energy.

UNIT-IV

Commercial options in waste heat recovery equipment, cases of energy studies, energy conservation opportunity, Energy conservation in I. C. Engine.

UNIT-V

Strategies for electricity and management, setting up an energy management programme, electricity saving technique by category of end use, Electrical end use in industries, energy & power management in industry, energy management strategies for industry, demand management.

UNIT-VI

Importance and role of energy management, Energy economics, Payback period, Internal rate of return, life cycle costing.

TEXT BOOKS:

1. Hamies, Energy Auditing and Conservation, Methods, Measurements, Management and Case Study, Hemisphere,
   Washington, 1980
2. W.F.Kenny, Energy Conservation in Process Industry.
3. Trivedi, P.R, Jolka K.R., Energy Management, Commonwealth Publication, New Delhi, 1997.
4. C.B.Smith, Energy Management Principles, Pergamon Press, New York, 1981.

REFERENCE BOOKS:

1. W.C. Turner, Energy Management, Hand Book.
2. Kreith, Economics of Solar Energy and Conservation Systems, Vol -3.
3. Witte, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washinton, 1988.

Annexure II

Course offered in OPEN ELECTIVE - II & III in VII & VIII sem B.Tech., under V18 Regulations
VII SEMESTER

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MEOE4
Name of the Course	**Computer Aided Design** Open Elective – II					
Branch	**Mechanical Engineering**					

Course Outcomes:
After successful completion of the course, the student will be able to

CO1	Explain the basic fundamentals of CAD tools	K2
CO2	Find the characteristics of curves, Representation and continuity requirements	K3
CO3	Illustrate the Geometric Transformations.	K3
CO4	Demonstrate various types of surfaces and Representation.	K3
CO5	Differentiate between the methods of representing Solid Modelling**.**	K4
CO6	Apply the local and global properties for product development	K3

UNIT – I
CAD Introduction: Need of machine design, use of computer, computer fundamentals, computer aided design process, CAD configuration, and CAD tools, positive and negative points of CAD, CAD and CAM integration.

UNIT – II
DESIGN OF CURVES: Fundamental of Curve Design, Parametric Space of a Curve, Representation, Parametric cubic curve, Blending functions, Truncation, extension, and subdivision, composite curve: continuity requirements .

UNIT – III
GEOMETRIC TRANSFORMATIONS: Translation, Rotation, Scaling Symmetry and Reflection, Homogeneous Transformations. Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation.

UNIT – IV
DESIGN OF SURFACES: Fundamental of Surface Design, Parametric Space of a Surface, Representation of a Surface patch, sixteen point form, Four Curve Form, Plane.

UNIT – V
SOLID MODELLING: Solid Modelling fundamentals, topology and geometry. Geometric Modelling Method, Constructive Solid Geometry (CSG), Boundary Representation (Brep), Introduction to Wireframe, surface and solid modelling techniques. Introduction CAD data exchange format IGES, STEP

UNIT – VI
GEOMETRIC PROPERTIES: Local and global properties of a curve, Local and global properties of a surface, Global properties of complex solids, Relational properties, intersections. Applications in Product Development and other areas.

REFERENCE BOOKS:

1. Geometric Modeling: Michael E. Mortenson, Third Edition, Industrial Press Inc.2006.
2. Mathematical Elements of Computer Graphics, Rogers and Adams, McGraw Hill. 1994
3. CAD CAM Theory and Prectice: I. Zeid, Tata-McGraw Hill, 2006
4. Computer-Aided Engineering Design, B Sahay and ASaxena, Springer, 2005.
5. Differential Geometry of Curves and Surfaces, Thomas F. Banchoff and Stephen T. Lovett, Thomas Banchoff-Stephen Lovett, 2010.
6. Computational Geometry for Design and Manufacture, I.D. Faux and M.J. Pratt, John Wiley, 1980.
7. Lectures on Classical Differential Geometry, Dirk J. Struick, Addison Wesley, 1980.

Semester	VII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MEOE5
Name of the Course	**Condition Monitoring and Machine Learning** Open Elective – II					
Branch	**Mechanical Engineering**					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Understand various condition monitoring techniques	K2
CO2	Demonstrate the construction and principle of working of sensors for condition monitoring.	K3
CO3	Interpret the concepts of signal processing analysis	K3
CO4	Assess various failure analysis and maintenance.	K3
CO5	Examine the elements of Machine condition monitoring	K3
CO6	Examine the concepts of machine learning systems for signal analysis and fault detection systems	K3

UNIT – I

CONDITION MONITORING TECHNIQUES: Introduction, Condition Monitoring in manufacturing industries; Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques - Case studies.

UNIT – II

SENSORS FOR CONDITION MONITORING: Accelerometers, strain gauges, eddy current probes, LVDT for measurement of displacement, velocity and acceleration; Temperature transducers, radiation pyrometers and thermal imaging devices.

UNIT – III

SIGNAL PROCESSING: Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions.

SIGNAL ANALYSIS: Time domain and Frequency domain and Time-frequency domain analysis

UNIT – IV

FAILURE ANALYSIS AND MAINTENANCE: Maintenance Principles, Failure mode analysis - Equipment down time analysis – Breakdown analysis - condition based maintenance.

UNIT – V

MACHINE CONDITION MONITORING: Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies.

UNIT – VI

MACHINE LEARNING: Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system, Case studies.

TEXT BOOKS:

1. EthemAlpaydin, Introduction to Machine Learning (2010), The MIT Press, Cambridge, London.

REFERENCE BOOKS:

1. K. P. Soman, Data mining theory and practice (2006), Prentice-Hall of India.
2. Amiya RanjanMohanty, Machinery Condition Monitoring: Principles and Practices (2015), CRC Press
3. Mishra, R.C., Pathak, K., Maintenance Engineering and Management (2012), Prentice Hall of India.
4. Clarence W. De Silva, Sensors and Actuators: Control System Instrumentation (2007), CRC Press – Taylor and Francis Group.
5. Boualem Boashash, Time Frequency Signal Analysis and Processing: A Comprehensive Reference (2015), Elsevier.

Course offered in OPEN ELECTIVE - III for other departments in VIII sem B.Tech., under V18 Regulations

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MEOE6
Name of the Course	**Power Plant Engineering** Open Elective – III					
Branch	**Mechanical Engineering**					

Course Outcomes:
After successful completion of the course, the student will be able to

CO1	Explain the working and layout of steam power plant and the different systems comprising the plant.	K2
CO2	Outline the working principle of diesel power plant and its layout.	K2
CO3	Illustrate the working and layout of gas turbine power plant and various auxiliaries comprising the plant.	K3
CO4	Construct the working principle and basic components of the hydro electric plants.	K3
CO5	Describe the and basic components and working principle of different reactors of nuclear power plant.	K2
CO6	Outline the power plant economics .	K4

UNIT – I
Introduction to the Sources of Energy.
Steam Power Plant: Plant layout, working of different circuits, coal handling equipment, ash handling systems, overfeed and underfeed fuel beds, types of stokers, dust collectors, cooling towers and feed water treatment.

UNIT – II
Diesel power Plant: IC Engines, types, Plant layout with auxiliaries – fuel supply system, air starting equipment, lubrication and cooling system, super charging.

UNIT – III
Gas Turbine Plant: Introduction, classification, construction, Layout with auxiliaries, Principles ofworking of closed and open cycle gas turbines, combined cycle power plants and comparison.

UNIT – IV
Hydro Electric Power Plant: Water power , hydrological cycle, hydrographs, classification of dams and spill ways.
Hydro Projects and Plant: Classification – typical layouts – plant auxiliaries – plant operation pumped storage plants.

UNIT – V
Nuclear Power Station: Nuclear fuel – breeding and fertile materials, nuclear reactor – reactor operation. Types of reactors and their operation - Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor. Radiation hazards and shielding, radioactive waste disposal.

UNIT – VI

Power Plant Economics: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor – related exercises.

TEXT BOOKS:

1. A course in Power Plant Engineering /Arora and Domkundwar/Dhanpatrai& Co.
2. Power Plant Engineering /P.C.Sharma / S.K.Kataria Pub

REFERENCE BOOKS:

1. Power Plant Engineering: P.K.Nag/ TMH.
2. Power station Engineering – M.M.Ei-Wakil / McGrawHill.

Semester	VIII	L	T	P	C	Course Code
Regulation	V18	3	0	0	3	V18MEOE7
Name of the Course	**Mechatronics** Open Elective – III					
Branch	**Mechanical Engineering**					

Course Outcomes:

After successful completion of the course, the student will be able to

CO1	Understand the elements of Mechatronics & levels and explain various types of sensors , transducers and Mechatronics design process	K2
CO2	Sketch and explain various types of solid state devices like Diode, BJT, MOSFET, etc.,	K3
CO3	Illustrate and explain basic principles of Hydraulic, pneumatic, electro hydraulic, electro hydraulic servo actuating systems.	K3
CO4	Illustrate and explain microprocessors, microcontrollers and PLC	K3
CO5	Sketch and explain System interfacing and data acquisition systems.	K3
CO6	Sketch and explain Digital Controllers and Design of mechatronics systems.	K3

UNIT – I

MECHATRONICS SYSTEMS – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement,velocity, force, acceleration, liquid flow, liquid level, temperature and light sensors.

UNIT– II

SOLID STATE ELECTRONIC DEVICES - PN junction diode, BJT, FET, Analog signal conditioning, operational amplifiers, filters.

UNIT– III

HYDRAULIC AND PNEUMATIC ACTUATING SYSTEMS - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems.

UNIT– IV

DIGITAL ELECTRONICS AND SYSTEMS - Digital logic control, micro processors and micro controllers, programming, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT– V

SYSTEM AND INTERFACING AND DATA ACQUISITION – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing.

UNIT– VI

DYNAMIC MODELS AND ANALOGIES - System response. Process Controllers – Digital Controllers, Programmable Logic Controllers, Design of mechatronics systems & future trends.

TEXT BOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

REFERENCE BOOKS:

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/Thomson Publications,Chennai.
3. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdas shetty/Richard/Thomson.
5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W. Bolton/ Pearson, 2012
7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print

Annexure – III

Course structure & Syllabi for the courses offered in III & IV semesters B. Tech under V20 Regulations

Course Structure of Mechanical Engineering – V20 Regulation
(For 2020 – 2021 Admitted Batch)

III SEMESTER							
S.No	Category	Course Code	Course Title	Hours per week			
				L	T	P	C
1	Basic Science Course / Prof core course	V20MET03	Metallurgy and Material Science	3	0	0	3
2	Engineering Science Course	V20MET04	Mechanics of Solids	3	0	0	3
3	Professional Core Course	V20MET05	Fluid Mechanics with Machine Learning	3	0	0	3
4	Professional Core course	V20MET06	Thermodynamics	3	0	0	3
5	Humanities and Social Sciences		Managerial Economics and Financial Analysis (Under BOS of MBA)	3	0	0	3
6	Professional Core course (LAB)	V20MEL02	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
7	Professional Core course (LAB)	V20MEL03	Mechanics of Solids & Materials Engineering Lab	0	0	3	1.5
8	Professional Core course (LAB)	V20MEL04	Machine drawing	0	0	3	1.5
9	**Skill oriented course***	V20MESOC1	Certificate course offered by industries/Professional bodies/APSSDC or any other accredited bodies.	**1**	**0**	**2**	**2**
10	Mandatory course		PCS-I (Under BOS of English)	2	0	0	MNC
Total Credits				18	0	11	21.5

Total Contact Hours: 29 Total Credits: 21.5

IV SEMESTER							
S.No	Category	Course Code	Course Title	Hours per week			
				L	T	P	C
1	Basic Science course		Probability and Statistics (Under BOS of BSH)	3	0	0	3
2	Professional Core course	V20MET07	Kinematics of Machinery	3	0	0	3
3	Professional Core course	V20MET08	Manufacturing Science with Artificial Intelligence	3	0	0	3
4	Professional Core course	V20MET09	Mechanical measurements and Metrology	3	0	0	3
5	Professional Core course	V20MET10	Applied Thermodynamics	3	0	0	3
6	Engineering Science Course/Prof Core (Interdisciplinary) (LAB)	V20MEL05	Mechanical measurements and Metrology lab	0	0	3	1.5
7	Professional Core course (LAB)	V20MEL06	Manufacturing Process Lab	0	0	3	1.5
8	Professional Core course (LAB)	V20MEL07	Thermal Engineering Lab	0	0	3	1.5
9	**Skill oriented course***	V20MESOC2	Certificate course offered by industries/Professional bodies/APSSDC or any other accredited bodies.	**1**	**0**	**2**	**2**
10	Mandatory course		PCS-II (Under BOS of English)	**2**	**0**	**0**	**MNC**
Total Credits				18	0	11	21.5
Internship 2 months (Mandatory) during summer vacation							

Total Contact Hours: 29 Total Credits: 21.5

Syllabi for the courses offered in III & IV semester B. Tech under V20 Regulation for the Academic Year 2021-2022

III Semester

Semester	III	L	T	P	C	Course Code
Regulation	V20	3	0	0	3	V20MET03
Name of the Course	Metallurgy and Material Science					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to:	Knowledge Level
CO1	Explain the types of bonds in solids and crystallization of Metals.	K2
CO2	Construct phase diagrams for the study of alloys and phase Transformation reactions.	K2
CO3	Use different ferrous and nonferrous metals based on properties for various applications	K3
CO4	Apply suitable heat treatment process to achieve desired properties of metals and alloys.	K3
CO5	Illustrate the properties and applications of composites and Ceramic materials and understand the concepts of powder metallurgy.	K2

UNIT – I

INTRODUCTION TO METALLURGY AND MATERIAL SCIENCE: Structure of Metals, Properties of metals, Types of Bonds in Solids, Crystal geometry – Space Lattices, Unit cells, Crystal Structure, Miller indices. Imperfections in crystals- Line defects, Point defects, Surface defects. Crystallization of metals, grain, grain boundaries and their properties. Constitution of alloys: Necessity of alloying, types of solid solutions, Hume Rotherys rules.

UNIT – II

EQUILIBRIUM DIAGRAMS: Experimental methods of construction of equilibrium diagrams, phase rule, Isomorphous alloy systems, Lever rule, eutectic systems, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, Study of important binary phase diagrams of Cu-Ni, Al- Si, and Fe-Fe3C.

UNIT – III

FERROUS, NONFERROUS METALS AND THEIR ALLOYS: Production of Iron and steel: Blast furnace, Cupola, Electric furnace and Induction furnace, Types of Cast irons- White, Grey, Malleable and Nodular Cast Irons, Properties and application of cast irons, Effect of alloying elements on structure and properties of steels, Properties and uses of Silicon and Hadfield Manganese steels, High speed steels and Stainless steel. Properties and uses of important non-ferrous metals like Cu, Al, Pb, Sn, Zn. Study of important non-ferrous alloys: Brass & Bronzes, Bearing alloys, Al alloys & Ti alloys.

UNIT – IV

HEAT TREATMENT OF FERROUS AND NON-FERROUS ALLOYS: Types of heat treatment processes, Annealing, normalizing, hardening, tempering, hardenability, surface - hardening methods, TTT diagrams, Age hardening treatment

UNIT – V

ADVANCED MATERIALS: Composites and its classification, methods of manufacturing of composites – stir casting method, hand layup process, filament winding process. Properties and applications of crystalline ceramics, shape memory alloys, Bio materials and nano-materials

POWDER METALLURGY: Introduction, Steps in Powder metallurgy, Powder characterizations, powder compact methods.

TEXT BOOKS:

1. Introduction to Physical Metallurgy/ Sidney H.Avner/ 2nd edition, McGraw Hill Education (India) Private Limited/2016.
2. Materials Science and Engineering/William D Callister (Adapted by R. Bala subramaniam) /Wiley Inida (P) Ltd/ 2007
3. Material Science and Metallurgy/ Dr.V.D.Kodgire/40th edition, Everest Publishing House/2017

REFERENCE BOOKS

1. Materials Science and Engineering/ V. Raghavan /5th Edition) Prentice-Hallof India Pvt. Ltd/2004.
2. Essential of Materials science and engineering /Donald Askeland/2nd edition Thomson/2014
3. Engineering mechanics of Composite Materials/Isaac M.Daniel,OriIshai/ 5th edition/Oxford Publications/2015.

Semester	III	L	T	P	C	Course Code
Regulation	V20	3	0	0	3	V20MET04
Name of the Course	Mechanics of Solids					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Levels
CO1	Illustrate concept of stress and strain of composite bars.	K3
CO2	Solve shear force and bending moment in beams.	K3
CO3	Calculate flexural and shear stresses in a beam and understand the torsional rigidity of shaft.	K3
CO4	Analyze the principal stresses in structural members.	K4
CO5	Solve the buckling load capacity of columns, and longitudinal stress and strains in thin cylinders.	K3

UNIT – I

SIMPLE STRESSES & STRAINS: Definitions of stress and strain – types of stresses and strains – Elasticity –Hooke's law–Stress–Strain diagram for Mild steel – working stress- factor of safety-Lateral strain–Poisson's ratio and volumetric strain – Elastic Moduli and the relationship between elastic constants– Bars of varying section – composite bars – temperature stresses.

STRAIN ENERGY: Definition – Resilience – Strain Energy due to gradually applied; suddenly applied and impact loads–simple applications.

UNIT – II

SHEAR FORCE & BENDING MOMENT DIAGRAMS: Definition of beam –Types of beams – concept of SF and BM – SF & BM diagrams for cantilever, Simple support and over hanging beams subject end point loads, Uniform distributed load (UDL), uniformly varying loads– point of contra flexure –Relationship between S.F, BM and rate of loading.

UNIT – III

FLEXURAL STRESSES: Theory of simple Bending – Assumptions–Derivation of Bending equation – Neutral axis – Determination of bending stresses – section modulus of rectangular, Circular sections (Solid and Hollow), I and T channel sections.

DEFLECTION OF BEAMS: Relation between curvature, slope and deflection; Slope and deflection of cantilever, simply supported with point and U.D.L– Macaulay's method.

UNIT – IV

PRINCIPAL STRESSES AND STRAINS: Introduction – stresses on an inclined section of a bar under axial loading - compound stresses - Normal and tangential stresses on an inclined plane for biaxial stresses-Two perpendicular normal stresses–representation of stress on Mohr's circle diagram, Introduction to theories of Failure.

UNIT – V

COLUMNS: Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula.

THIN CYLINDERS: Thin seamless cylindrical shells– Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders.

TEXT BOOKS:

1. Strength of materials/R.K.Bansal/LaxmiPublications5th edition/2017
2. Mechanics of Materials/Gere and Timoshenko,/TMH4thedition/2010
3. Strength of materials/ S.Ramamrutham/Dhanpatrai publishers 1st edition /2016

REFERENCE BOOKS:

1. Solid Mechanics, by Popov/PHIpublications2nd edition/2017.
2. Introduction to Solid Mechanics / Irving H Shames/ 4th edition PEARSON /2014.
3. Strengthofmaterials/Young,D.H.Timoshenko,Stephen/CBSpublishers/2002

Semester	III	L	T	P	C	Course Code
Regulation	V20	3	0	0	3	V20MET05
Name of the Course	Fluid Mechanics with Machine Learning					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Levels
CO1	Explain the concepts of fluid properties and measurement of pressure.	K2
CO2	Describe the types of flows, lines & apply equations of fluid mechanics and its applications.	K3
CO3	Calculate losses and force on different types of vanes.	K3
CO4	Calculate the performance of turbines and pumps.	K3
CO5	understand the fundamentals of machine learning and machine learning for fluid mechanics.	K2

UNIT – I

FLUID STATICS: Dimensions and units-Physical properties of fluids-Density, Specific gravity, Viscosity, Surface tension, Vapour pressure, Capillarity, Bulk modulus. Pressure types-Atmospheric, absolute, gauge and vacuum pressure and measurement of pressure- Piezometer, different types of manometers.

UNIT – II

FLUID KINEMATICS: stream line, path line and steak line and stream line, classification of flows steady &un steady, uniform & non uniform, laminar & turbulent, rotational & irrotational flows-equation of continuity for one dimensional flow and three dimensional flow. Equation of continuity in differential form.

FLUID DYNAMICS: Surface and body forces, Bernouli's equation along a stream line, Momentum equation, application of momentum equation on pipe bend. Measurement of flow: Pitot tube, Venturimeter, Orifice meter.

UNIT – III

CLOSED CONDUIT FLOW: Reynolds experiments, Darcy-Weisbach equation, Major and minor losses, Hydraulic gradient line, Total energy line, Pipes in series and parallel.

BASICS OF TURBO-MACHINERY: Determination of hydrodynamic force of jet on stationary and moving flat, inclined, curved vanes (jet striking at tip and centre), velocity diagrams, work done and efficiency, flow over radial vanes, series of vanes.

UNIT – IV

TURBINES AND PUMPS: Classification of turbines, Pelton wheel, Francis turbine, Kaplan turbine-working proportions, work done, efficiencies. Draft tube-types, functions and efficiency.

CENTRIFUGAL PUMPS: Working, work done, heads, efficiencies, losses.

RECIPROCATING PUMPS: Working, work done, slip, indicator diagrams.

UNIT – V

FUNDAMENTALS OF MACHINE LEARNING: Supervised, semi-supervised and supervised learning.

MACHINE LEARNING FOR FLUID MECHANICS: Introduction, historical developments, challenges and opportunities; concepts of flow modelling and flow optimization & control.

TEXT BOOKS:

1. Hydraulics, Fluid mechanics and Hydraulic machinery – Modi & Seth.
2. Fluid mechanics and Hydraulic machines – R.K. Bansal.
3. Introduction to Fluid mechanics and fluid machines – S.K. Som & G. Biswas. (Tata – Mcgrawhill)
4. Ethem Alpaydin, Introduction to Machine Learning , MIT Press, Prentice Hall of India, Third Edition 2014.

REFERENCE BOOKS:

1. Fluid mechanics and machinery – G. Ramadurgaih (New age international publishers)
2. Fluid mechanics and fluid power engineering – D.S.Kumar (S.K. Kataria and sons)

Semester	III	L	T	P	C	Course Code
Regulation	V20	3	0	0	3	V20MET06
Name of the Course	Thermodynamics					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Levels
CO1	Discuss the basic terms related to work and heat.	K2
CO2	Explain first law of thermodynamics and internal energy.K2	K2
CO3	Apply the second law of thermodynamics to basic thermal systems.	K3
CO4	Analyze various thermodynamic cycles.	K4
CO5	Discuss about pure substance.	K2

UNIT – I

Thermodynamic System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi – static Process, Irreversible Process, Causes of Irreversibility – Energy in State Work and Heat, Point and Path function. Zeroth law of thermodynamics.

UNIT – II

Joule's Experiments – First law of Thermodynamics –First law applied to a Process – First law applied to a flow system –Energy balance for closed systems-Specific heats at constant volume and pressure - Internal energy and Enthalpy, Some steady flow energy equation applied to Nozzle, Turbine, Compressor and heat exchanger devices, PMM-I, Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance.

UNIT – III

Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Clasius theorem Clausius Inequality, Entropy, Principle of Entropy Increase, availability and irreversibility(Basic definitions), T-ds relations, Helmholtz and Gibbs functions, Gibbs relations, Maxwell relations, Elementary Treatment of the Third Law of Thermodynamics.

UNIT – IV

THERMODYNAMIC CYCLES: Carnot vapor cycle, ideal Rankine cycle, Rankine reheat cycle, air-standard Otto cycle, air-standard Diesel cycle, air-standard Brayton cycle, vapor-compression refrigeration cycle.

UNIT – V

PURE SUBSTANCES: P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations, Triple point and critical point, properties during change of phase, Dryness Fraction, Clausius – Clapeyron Equation.

TEXT BOOKS:

1. Engineering Thermodynamics, PK Nag 5th Edn, TMH,2014.
2. Thermodynamics, An engineering Approach, Y.A. Cengel& M.A. Boles, 7th Edn- McGraw Hill, 2014.
3. Internal Combustion Engine –V Ganeshan.4th edition, TMH, 2016

REFERENCE BOOKS:

1. Engineering Thermodynamics by Y.V.C. Rao, 1st edition, Universities, 2005.
2. A text book of Engineering thermodynamics, R.K Rajput, 4th edition, Lakshmi Publishers, 2010.

Semester	III	L	T	P	C	Course Code
Regulation	V20	0	0	3	1.5	V20MEL02
Name of the Course	Fluid Mechanics & Hydraulic Machines Lab					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Levels
C01	Determine the force exerted by jet, friction factor, loss of head due to sudden contraction.	K3
C02	Examine and Analyze the performance of pumps and turbines.	K3
C03	Calibrate different flow measuring devices.	K3

1. Determination of force exerted by jet on a flat vane.
2. Determination of loss of head due to sudden contraction.
3. Determination of friction factor.
4. Calibration of Venturimeter.
5. Calibration of Orifice meter.
6. Calibration of Turbine flow meter.
7. Analyze the performance of single stage centrifugal pump.
8. Analyze the performance of multi stage centrifugal pump.
9. Analyze the performance of reciprocating pump.
10. Analyze the performance of Pelton wheel.
11. Analyze the performance of Francis turbine.

Semester	III	L	T	P	C	Course Code
Regulation	V20	0	0	3	1.5	V20MEL03
Name of the Course	Mechanics of Solids & Materials Engineering Lab					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Levels
CO1	Assess the Mechanical properties of different metals.	K3
CO2	Examine the micro structures of different Ferrous and non Ferrous metals.	K3
CO3	Identify the effect of heat treatment and cooling rates on the Properties of steels.	K4

NOTE: Any 6 experiments from each section A and B.

A) MECHNICS OF SOLIDS LAB:

1. Direct tension test
2. Bending test

a) Simply supported beam
b) Can til ever beam

3. Torsion test
4. Hardness test

a) Brinell hardness test
b) Rockwell hardness test

5. Test on springs
6. Compression test on cube
7. Impact test
8. Punch shear test

B) METALLURGY LAB:

1. Preparation and study of the Micro Structure of pure metals like Iron, Cu and Al.
2. Preparation and study of the Micro structure of Mild steels, Medium carbon steels, and \ high–Csteels.
3. Study of the Micro Structures of Cast Irons.
4. Study of the Micro Structures of Non-Ferrous alloys–Brass and Bronze.
5. Study of the Micro structures of Heat treated steels.
6. Hard enability of steels by Jominy End Quench Test.
7. To find out the hardness of various treated and untreated steels.

REFERENCE BOOKS:

1. Strength of materials, S.S.Bhavikatti Vikas Publications, 4th edition, 2013.
Material Science and Metallurgy, Dr.V.D.Kodagire, Everest Publishing House, 40th Edition, 2017

Semester	III	L	T	P	C	Course Code
Regulation	V20	0	0	3	1.5	V20MEL04
Name of the Course	Machine Drawing					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Levels
CO1	Identify the national and international standards pertaining to machine drawing.	K2
CO2	Illustrate the importance of the linking functional and visualization aspects in the preparation of the part drawings	K3
CO3	Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.	K3
CO4	Interpret the Machining and surface finish symbols on the component drawings.	K3
CO5	Develop the part or assembly drawings as per the conventions.	K3

INTRODUCTION: (AUTO CAD or any other drafting Software)
Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap. Conversion of pictorial views into orthographic projections of simple machine parts (with and without section). Hidden line conventions. Precedence of lines

PART-A

SECTIONS OF SOLIDS: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections. Conversion of pictorial views into orthographic projections of simple machine parts. Hidden line conventions. Precedence of lines. Conversion of pictorial views into orthographic projections of simple machine parts (with section planes indicated on the part).

THREAD FORMS: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.

FASTENERS: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

KEYS: Parallel key, Taper key, Feather key, Gib-head key and Woodruff key.

JOINTS: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. Couplings: Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, and universal coupling (Hooks' Joint)

PART-B

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.

Assembly Drawings (Any modeling software)

1. Plummer block (Pedestal Bearing)
2. Stuffing box
3. Propeller Blade
4. Spur Gear
5. Tailstock of lathe
6. Machine vice
7. Tool head of shaper

TEXT BOOKS:

1. Machine drawing _ K.L. Narayana, P. Kannaiah& K.Venkata reddy, 1st edition, Radiant, 2016
2. Tool Engineering & Design _ G.R. Nagpal/Khanna publishers, 1st edition, Khanna Publishers,2009
3. Machine Drawing with Auto CAD- Pohit and Ghosh, 1st edition, Pearso, 2017

REFERENCE BOOKS:

1. Machine Drawing by Nagpal,1st edition, khanna publishers, 2009
2. Machine drawing, Ajeet Singh, 2nd edition, TMH, 2016
3. Machine drawing with autocad, Pohit; Goutam, 1st edition, Pearson, 2017.

IV Semester

Semester	IV	L	T	P	C	Course Code
Regulation	V20	3	0	0	3	V20MET07
Name of the Course	Kinematics of Machinery					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to:	Knowledge Level
CO1	Explain the inversion of the four bar, slider crank and double slider chains.	K2
CO2	Analyze and perform the velocities and accelerations in mechanisms by graphical method.	K4
CO3	Explain the working of copying mechanism, straight line motion mechanisms, steering gears and Hooke's joint.	K2
CO4	Develop the cam profiles for given follower motions.	K3
CO5	Describe tooth profiles for gears, gear trains and compute the velocity ratio and torque in gear trains and calculate various parameters related to belts.	K3

UNIT – I

MECHANISMS : Introduction, terminology, definitions and assumptions, planar, spherical and spatial mechanisms, mobility, classification of mechanisms, kinematic inversion, inversions of four bar chain, slider crank chain and double slider chain, Grashoff's law, mechanical advantage.

UNIT – II

VELOCITY ANALYSIS : Introduction, Absolute and relative motions, Vectors, Addition and subtraction of vectors, Motion of a link, Four-link mechanism, Velocity diagrams, Angular velocity of links, Velocity of rubbing, Slider-crank mechanism, crank and slotted lever mechanism, Instantaneous center, Kennedy's theorem, Locating I-centers, Angular velocity ratio theorem.

ACCELERATION ANALYSIS: Introduction -Acceleration, four-link mechanism, Acceleration of intermediate and offset points, Slider-crank mechanism, Coriolis component, Crank and slotted lever mechanism using graphical method, Klein's Construction.

UNIT – III

LOWER PAIRS: Pantograph, Exact straight line mechanism condition, Peaucellier, Hart Scott-Russel mechanisms. Approximate straight line mechanisms, Grasshopper, Watt, Chebyshev, Robert mechanisms. Steering gears-condition for correct steering, Davis, Ackerman steering gears, Hooke's joint-velocity ratio, angular acceleration of driven shaft, double Hooke's joint.

UNIT – IV

CAMS: Types of cams and followers, types of follower motion, velocity and acceleration diagrams, profile of cams.

UNIT – V

GEARS: Classification of gears, spur gears- terminology, fundamental law of toothed gearing, involute and cycloidal profile, Path of contact, arc of contact, contact ratio, minimum number of teeth, interference and methods of avoiding interference, rubbing velocity.

GEAR TRAINS: Introduction, Types - Simple , compound and reverted gear trains , Epicyclic gear train.

BELT DRIVES: Belt and rope drives, open and crossed belt drives, velocity ratio, slip, material for belts and ropes, crowning of pulleys, ratio of friction tensions, power transmitted, centrifugal effect on belts, maximum power transmitted by a belt, initial tension.

TEXT BOOKS:

1. Theory of Machines/ Rattan SS, Tata McGraw Hill Education Publishers, 4th Edition 2015.
2. Theory of Machines / Beven Thomos / CBS publication, 3rd edition /2005

REFERENCE BOOKS:

1. Theory of Machines / R.K.Bansal/ Laxmi Publications 5th edition /2016
2. Mechanisms of Machines, V Ramamurthy, Narosa publishing House, Reprint ,2019
3. Theory of Machines by R S Khurmi, S Chand Publications, 1st Edition, 2011.
4. Theory of Machines and Mechanisms, Ballaney P, Khanna publications,1st Edition,2011.

Semester	IV	L	T	P	C	Course Code
Regulation	V20	3	0	0	3	V20MET08
Name of the Course	Manufacturing Science with Artificial Intelligence					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to:	Knowledge Level
CO1	Understand fundamentals of casting-patterns and its materials, Gating System	K2
CO2	Distinguish various welding processes and select a suitable process based on the application and requirements, explain advanced welding techniques, testing methods	K2
CO3	Explain the knowledge on Hot working and Cold Working Process	K3
CO4	Describe various bulk forming processes, sheet metal forming and processing of plastics.	K2
CO5	Apply the concepts of Artificial intelligence in manufacturing processes.	K3

UNIT – I

CASTING - Steps involved in making a casting, types of sands – Advantage of casting and itsapplications.

PATTERNS AND PATTERN MAKING – Types of patterns – Materials used for patterns,pattern allowances and their construction, risers,Centrifugal, Die, Investment castings.

PRINCIPLES OF GATING – Gating ratio and design of Gating systems.

METHODS OF MELTING – Crucible melting and cupola operation.

SOLIDIFICATION OF CASTING – Concept – Solidification of pure metal and alloys.

UNIT – II

WELDING: Classification of welding process types of welds and welded joints and their characteristics, design of welded joints Gas welding, ARC welding, Forge welding, resistance welding, Thermit welding, Inert Gas welding - TIG & MIG, welding, Laser welding, Soldering & Brazing. welding defects, destructive non-destructive testing of welds.

UNIT – III

HOT & COLD WORKING: strain hardening, recovery, re-crystallization and grain growth, Comparison of properties of Cold and Hot worked parts.

ROLLING FUNDAMENTALS – Theory of rolling, types of Rolling mills and products

EXTRUSION OF METALS: Basic extrusion process and its characteristics.

Hot extrusion and cold extrusion - Forward extrusion and backward extrusion– Impact extrusion Hydrostatic extrusion

DRAWING – Wire drawing and Tube drawing

UNIT – IV

BULK FORMING PROCESSES: Principles of forging – Tools and dies – Types Forging – Smith forging, Drop Forging – Roll forging – Forging hammers: Rotary forging – forging defects.

SHEET METAL FORMING: Stretch Forming, Deep Drawing, Coining, Spinning, Blanking and Piercing – Bending and Forming, Stamping dies, Spring Back effect.

PROCESSING OF PLASTICS: Types of Plastics, Properties, applications and their Processing methods & Equipment (blow &injection moulding)

UNIT – V

ARTIFICIAL INTELLIGENCE IN MANUFACTURING INDUSTRY: Introduction, developments of Artificial intelligence in manufacturing Industry; Advantages, limitations and applications of Artificial Intelligence in Manufacturing industry- fault diagnosis, Quality inspection, inventory control, industrial safety and maintenance.

TEXT BOOKS:

1. Manufacturing Engineering and Technology/ Kalpakjian, Serope;Steven,Schmid R. / Pearson, 1st Edition 2013.
2. Manufacturing Technology / P.N. Rao/ Tata McGraw Hill, 4th Edition 2016.
3. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall.

REFERENCE BOOKS

1. Production Technology / R.K. Jain /Khanna publishers,17th edition 2004.
2. Principles of Metal Castings / Richard W Heine and Roenthal. McGraw HillEducation, 2nd Edition 2017.
3. Welding Process and technology /Dr. Paramar / Khanna Publishers,3rdEdition.
4. Production Technology /Sarma P C / S.Chand Publications,4th Edition 2014.

Semester	IV	L	T	P	C	Course Code
Regulation	V20	3	0	0	3	V20MET09
Name of the Course	Mechanical Measurements and Metrology					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to:	Knowledge Level
CO1	Discuss the basic concepts of measurement system and Linear measuring Instruments.	K2
CO2	Explain various types of Temperature, Pressure and Flow measuring Instruments.	K2
CO3	Understand the working of Acceleration, Vibration and Strain measuring devices.	K2
CO4	Apply tolerances and fits for selected product quality and explain various Linear, Angular and Optical measuring instruments and their applications	K3
CO5	Explain the measurement of surface finish with various comparators	K2

UNIT – I

BASIC CONCEPTS: Introduction, Fundamental Measuring Processes and methods, Generalized measurement system and its functional elements, Performance characteristics.

DISPLACEMENT MEASUREMENT: Principle and construction of various transducers – piezo electric, inductive, capacitance, resistance, ionization and photo electric transducers, calibration procedures.

UNIT – II

TEMPERATURE MEASUREMENT : Thermometry , scales of temperature, electrical resistance – thermister, RTD, thermocouple , pyrometers.

PRESSURE MEASUREMENT : Working of Various instruments - dead weight pressure gauge , bourdon pressure gauges, bellows , diaphragm gauges.

FLOW MEASUREMENT- Rota meter, Magnetic, Ultrasonic, hot – wire anemometer, Laser Doppler Anemometer (LDA).

UNIT – III

ACCELERATION AND VIBRATION MEASUREMENT: Principles of seismic instruments – Vibrometer and Accelerometer

STRAIN MEASUREMENTS: Various types of strain measuring instruments – electrical strain gauge – gauge factor – use of resistance strain gauge for measuring bending compressive and tensile strains, strain gauge rosettes.

UNIT – IV

LIMITS AND FITS: Introduction, Normal size, Tolerance limits, Deviations, Allowance, Fits and their types – unilateral and bilateral tolerance system, hole and shaft basis systems – interchangeability and selective assembly. Indian standard Institution system.

LINEAR MEASUREMENT: Standards of measurements- line and end standard. Basic principle and applications of slip gauges, dial indicator and micrometers.

ANGULAR MEASUREMENTS: Bevel protractor – angle slip gauges – sine bar, rollers and spheres used to determine the tapers, Applications of angular measurement.

OPTICAL MEASURING INSTRUMENTS: Tool maker's microscope and its uses – collimators, optical projector – optical flats and their uses, interferometer, and those applications.

UNIT – V

SURFACE TEXTURE: Factors effecting surface roughness, reasons for controlling surface texture, Differences between surface roughness and surface waviness, Elements of surface texture -Numerical assessment of surface finish – CLA, R, R.M.S Values – Ra values, and Rz values. Basic principle of profile meter and Talysurf. ISI symbols for indication of surface finish, Applications surface texture.

COMPARATORS: Types – Mechanical, Optical, Electrical and Electronic, Pneumatic Comparators and Their Uses.

TEXT BOOKS:

1. Measurement Systems: Applications & design / D.S Kumar/ Metropolitan/1st/2015
2. Mechanical Measurements / BeckWith, Marangoni,Linehard/ Pearson/6th/2018
3. Engineering Metrology by R.K.Jain / Khanna Publishers

REFERENCE BOOKS

1. Dimensional Metrology, Connie Dotson, Cengage Learning.
2. Engineering Metrology by I.C.Gupta / DhanpatRai Publishers.
3. Precision Engineering in Manufacturing by R.L.Murthy / New Age.
4. Engineering Metrology and Measurements by NV Raghavendra, L Krishna murthy, Oxford publishers.
5. Engineering Metrology by KL Narayana, Scitech publishers.
6. Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers/2008
7. Measurement systems: Application and design/Doeblin Earnest. O. Adaptation/ TMH/ 6th edition, 2018

Semester	IV	L	T	P	C	Course Code
Regulation	V20	3	0	0	3	V20MET10
Name of the Course	Applied Thermodynamics					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to:	Knowledge Level
CO1	Illustrate the working of various IC engines and associated systems such as lubricating system, cooling system, fuel feed system and ignition system.	K2
CO2	Explain the working of boilers and its performance parameters.	K2
CO3	Compute the performance of steam nozzles and steam turbines.	K3
CO4	Analyze the working of steam condensers and their performance parameters.	K4
CO5	Compute the performance of gas turbines.	K3

UNIT – I

I. C. ENGINES: Classification, Working principles of Four & Two stroke engine- SI & CI engines, Valve and Port Timing Diagrams, Engine systems- Carburetor, Fuel injection systems for CI engines, Ignition, Cooling and Lubrication system.

UNIT – II

STEAM BOILERS: Classification, working principles Cochran, Locomotive, Babcock and Wilcox, Benson and Loeffler boiler with sketches, mountings and accessories- working principles, boiler horse power, equivalent evaporation, efficiency and heat balance, Draught: classification, height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney.

UNIT – III

STEAM NOZZLES: Applications and Types, Flow through nozzles, Thermodynamic analysis – assumptions -velocity of fluid at nozzle exit, Ideal and actual expansion in a nozzle, velocity coefficient, Condition for maximum discharge, critical pressure ratio, Super saturated flow in nozzles- its effects, Wilson's line.

STEAM TURBINES: Classification, Impulse turbine- mechanical details- velocity diagram- effect of friction- power developed, axial thrust, blade or diagram efficiency- condition for maximum efficiency. Methods to reduce rotor speed-Velocity compounding, Pressure compounding and velocity & pressure Compounding, - Velocity and Pressure variation along the flow – Combined velocity diagram for a velocity compounded impulse turbine.

UNIT – IV

REACTION TURBINE: Mechanical details, principle of operation, thermodynamic analysis of a stage, degree of reaction, velocity diagram, Parson's reaction turbine, condition for maximum efficiency.

STEAM CONDENSERS: Classification of condensers- working principles of Jet, Evaporative and surface condensers, Vacuum and its Measurement, Vacuum efficiency and condenser efficiency, Sources of air leakage and its affects in condensers- Condenser Efficiency, Daltons law of partial pressures, Determination of mass of cooling water.

UNIT – V

GAS TURBINES: Simple gas turbine plant- Ideal cycle, essential components, parameters of performance, actual cycle, regeneration, inter cooling and reheating, closed and open cycles, merits and demerits.

TEXT BOOKS:

1. Engineering Thermodynamics, PK Nag 4th Edn, TMH.
2. Thermodynamics. An engineering Approach with student resources/ DVD. Y.A. Cengel & M.A. Boles/ 8th Edn-McGrawHill/2016.
3. Gas Turbines / V Ganesan/3rd edition, TMH/2016.

REFERENCE BOOKS

1. Thermal Engineering/ R.K.Rajput/4th edition/ Laxmi Publications/2010
2. Applied Thermodynamics-II / R. Yadav./6th edition, Central Publishing House/2016
3. Gas turbines and Propulsive Systems/1st edition, DhanpatRai/2014
4. Tables of the properties of steam and other vapours and temperature-Entropy table by Cecil H Peabody by Forgotten books
5. Steam tables by C.P Kodandaraman – New age International

Semester	IV	L	T	P	C	Course Code
Regulation	V20	0	0	3	1.5	V20MEL05
Name of the Course	Mechanical Measurements and Metrology Lab					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to:	Knowledge Level
CO1	Experiment and examine errors in calibration of various instruments	K3
CO2	Explain the working principle of metrology and measuring equipments.	K2
CO3	Compute distance, angle and surface finish by using standard measuring equipments	K3

List of experiments :

METROLOGY

1. Measurement of length, height and diameter by vernier calipers, micrometer and height gauge.
2. Surface roughness measurement using talysurf.
3. Taper angle measurement.
4. Tool maker's microscope.
5. Measurement of bores using dial bore indicator.
6. Measurement of thickness of gear tooth by vernier tooth caliper.

INSTRUMENTATION & CONTROL SYSTEMS LAB

List of experiments:

1. Study and calibration of LVDT transducer for displacement measurement.
2. Calibration of pressure gauge.
3. Angular Measurement using angular sensor.
4. Measurement of speed using opto-coupler pickup.
5. Calibration of strain gauge.
6. Study & calibration of resistance temperature detector (RTD) transducer for temperaturemeasurement.
7. Study and calibration of a rota meter for water flow measurement.
8. Vibration measurement trainer.

Semester	IV	L	T	P	C	Course Code
Regulation	V20	0	0	3	1.5	V20MEL06
Name of the Course	Manufacturing Process Lab					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Levels
CO1	Design and Make a pattern, test the properties of sand and prepare a casting.	K3
CO2	Perform Arc welding, Spot welding, TIG, MIG welding and Plasma Arc Cutting operations	K3
CO3	Perform blanking, piercing, Drawing and bending operations.	K3
CO4	Operate injection and blow moulding machines to manufacture plastic components	K3

METAL CASTING:
Pattern Design and pattern making using wood turning lathe Sand properties testing for Compression strength and permeability.Mould preparation, melting and casting.

WELDING:
ARC Welding Lap, Butt & T- JointSpot Welding –Lap &Butt Joint
TIG Welding -Butt Joint
MIG Welding- Butt JointPlasma Arc Cutting

METAL FORMING:
Blanking & Piercing operation by using Progressive die

PROCESSING OF PLASTICS:
Injection Molding, Blow molding

REFERENCE BOOKS:

1. Production technology lab – college manual.
2. Manufacturing Engineering and Technology/ Kalpakjian, Serope; Steven, Schmid R./Pearson, 1st Edition, 2013
3. Manufacturing Technology / P.N. Rao/TMH, 4th Edition, 2016.

Semester	IV	L	T	P	C	Course Code
Regulation	V20	0	0	3	1.5	V20MEL07
Name of the Course	Thermal Engineering Lab					
Branch	Mechanical Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Levels
CO1	Evaluate the performance of I.C.Engines.	K4
CO2	Evaluate the performance of compressors.	K4
CO3	Describe the working of Boilers.	K2

1. I.C. Engines valve and port timing diagrams.
2. I.C. Engines performance test and Exhaust emission measurements (4 -stroke diesel engine).
3. I.C. Engines Performance Test for 2 Stroke SI engines
4. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine.
5. Draw the heat balance sheet for 4- stroke multi cylinder petrol engine.
6. I.C. Engines Retardation Test
7. Economical speed test of an IC engine.
8. Performance test on variable compression ratio engines.
9. Performance test on reciprocating air compressor unit.
10. Dis-assembly / Assembly of Engines
11. Study of Boilers

Annexure – IV

Course structure & Syllabi of P.G Programme for approval under V21 regulations

M.Tech (Thermal Engineering) Programme Course Structure

(With effect from **2021-22** Admitted Batch onwards**)**

I-SEMESTER

S.No	Course Code	Course	L	T	P	C
1	**V21TET01**	Advanced Fluid Mechanics	3	0	0	3
2	**V21TET02**	Computational Fluid Dynamics	3	0	0	3
3		**Program Elective – I**	3	0	0	3
4		**Program Elective – II**	3	0	0	3
5	**V21TEL01**	Computational Fluid Dynamics Lab –I	0	0	3	2
6	**V21TEL02**	Thermal Engineering Lab-I	0	0	3	2
7		Research Methodology And IPR (Under BOS of MBA)	2	0	0	2
8		Audit course-I (Under BOS of English & MBA)	2	0	0	0
		Total:	**16**	**0**	**6**	**18**

Total Contact Hours = 22

II-SEMESTER

S.No.	Course Code	Course	L	T	P	C
1	**V21TET03**	Advanced Heat and Mass Transfer	3	0	0	3
2	**V21TET04**	Thermal Measurements and Process Controls	3	0	0	3
3		**Program Elective – III**	3	0	0	3
4		**Program Elective -IV**	3	0	0	3
5	**V21TEL03**	Computational Fluid Dynamics Lab–II	0	0	3	2
6	**V21TEL04**	Thermal Engineering Lab-II	0	0	3	2
7	**V21TET05**	Mini Project with Seminar	2	0	0	2
8		Audit course-II (Under BOS of English & MBA)	2	0	0	0
	Total		**16**	**0**	**6**	**18**

Total Contact Hours = 22

List of Audit course I & II

1. English for Research paper writing
2. Disaster Management
3. Value Education
4. Constitution of India
5. Pedagogy Studies
6. Stress management by yoga
7. Personality development through life enlightenment skills

III-SEMESTER

S.No	Course Code	Course	L	T	P	C
1		**Program Elective - V** (OR) **MOOCS-I Through NPTEL** /SWAYAM- 12 week Course related to the program which is not listed in the course structure.	3	0	0	3
2		**Open Elective** 1. Cost Management for Engineering Projects (Under BOS of MBA) 2. Operations Research (Under BOS of Maths) Students are advised to opt for an open elective course of their choice being offered by other Departments of the Institute (OR) **MOOCS-II Through NPTEL** /SWAYAM- Any 12weeek Course in Engineering/ Management certification courses duly approved by the Department.	3	0	0	3
3	**V21TEL05**	Dissertation phase –I	0	0	20	10
	Total		**6**	**0**	**20**	**16**

Total Contact Hours = 26

IV-SEMESTER

S.No.	Course Code	Course	L	T	P	C
1	**V21TEL06**	Dissertation phase –II	0	0	32	16
	Total		**-**	**-**	**32**	**16**

Total Contact Hours = 32
Total Credits (for all sem) = 68

Program Elective –I **V21TEE01 –** Advanced I.C engine, Electric & Hybrid Vehicles **V21TEE02 –** Gas Dynamics **V21TEE03 –** Cryogenic Engineering **V21TEE04 –** Advanced Thermodynamics	**Program Elective – II** **V21TEE05 –** Gas Turbines **V21TEE06 –** Alternative Fuel Technologies **V21TEE07 –** Energy Conservation and Management **V21TEE08 –** Theory and Technology of Fuel Cells
Program Elective – III **V21TEE09 –** Equipment Design for Thermal Systems **V21TEE10 –** Solar Energy Technologies **V21TEE11 –** Advanced Power Plant Engineering **V21TEE12 –** Combustion, Emissions and Environment	**Program Elective – IV** **V21TEE13 –** Jet Propulsion and Rocket Engineering **V21TEE14 –** Automotive Engineering **V21TEE15 –** Modelling of I.C engines **V21TEE16 –** Renewable Energy Technologies
Program Elective –V **V21TEE17 –** Optimization Techniques and Applications **V21TEE18 –** Design and Analysis of Experiments **V21TEE19 –** Convective Heat Transfer **V21TEE20 –** Extraction of Energy from Waste **V21TEE21 –** Advanced Finite Element Methods **(OR)** MOOCS/ NPTEL certification courses	

Syllabi for the courses offered in M. Tech under V21 Regulation for the Academic Year 2021-2022

I Semester

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TET01
Name of the Course	Advanced Fluid Mechanics					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Level
CO1	Apply equations of motion for fluid flow and in viscid flow problems	K3
CO2	Analyze fluid flow using Navier stokes equation	K4
CO3	Explain Boundary layer concepts to flow over flat plate	K2
CO4	Analyze turbulent layer equations and internal flow	K4
CO5	Illustrate Compressible flow	K3

UNIT – I

INVISCID FLOW OF INCOMPRESSIBLE FLUIDS: Lagrangian and Eulerain Descriptions of fluid motion, Path lines, Stream lines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three dimensional continuity equation, Stream and Velocity potential functions.

BASIC LAWS OF FLUID FLOW: Condition for irrotationality, circulation & vorticity Accelerations in Carte systems normal and tangential accelerations, Euler's, Bernouli equations in 3D– Continuity and Momentum Equations.

UNIT – II

VISCOUS FLOW: Derivation of Navier,Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases: Plain Poisoulle flow, Coutte flow with and without pressure gradient , Hagen Poisoulle flow, Blasius solution.

UNIT – III

BOUNDARY LAYER CONCEPTS : Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory , Boundary layer thickness for flow over a flat plate – Approximate solutions – Creeping motion (Stokes) – Oseen's approximation,Von,Karman momentum integral equation for laminar boundary layer — Expressions for local and mean drag coefficients for different velocity profiles.

UNIT – IV

INTRODUCTION TO TURBULENT FLOW: Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations , Prandtl Mixing Length Model , Universal Velocity Distribution Law: Van Driest Model –Approximate solutions for drag coefficients – MoreRefined Turbulence Models – k,epsilon model , boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders.

INTERNAL FLOW: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth and rough Pipes – Roughness of Commercial Pipes – Moody's diagram.

UNIT – V

COMPRESSIBLE FLUID FLOW – I: Thermodynamic basics – Equations of continuity, Momentum and Energy , Acoustic Velocity, Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State.

COMPRESSIBLE FLUID FLOW – II: Area Variation, Property Relationships in terms of Machnumber, Nozzles, Diffusers – Fanno and Releigh Lines, Property Relations – Isothermal Flow in Long Ducts – Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

TEXT BOOKS:

1. Fluid Mechanics / L.VictorSteeter / TMH
2. Fluid Mechanics / Frank M.White / MGH

REFERENCE BOOKS:

1. Fluid Mechanics and Machines/Modi and Seth/Standard Book House
2. Fluid Mechanics/Cohen and Kundu/Elsevier/5th edition
3. Fluid Mechanics/Potter/Cengage Learning
4. Fluid Mechanics/William S Janna/CRC Press
5. Fluid Mechanics / Y.A Cengel and J.M Cimbala/MGH
6. Boundary Layer Theory/ Schlichting H /Springer Publications
7. Dynamics & Theory and Dynamics of Compressible Fluid Flow/ Shapiro.
8. Fluid Dynamics/ William F. Hughes & John A. Brighton/TMH
9. Fluid Mechanics / K.L Kumar /S Chand & Co.

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TET02
Name of the Course	Computational Fluid Dynamics					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Level
CO1	Explain various finite element formulations/methods	K2
CO2	Apply Hyperbolic equations for non linear problems	K3
CO3	Differentiate formulations of Compressible and incompressible flows	K4
CO4	Differentiate various formulations for 2D & 3D problems	K4
CO5	Illustrate various formulations for steady state and transient problems	K3

UNIT – I

INTRODUCTION: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

SOLUTION METHODS: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

Parabolic equations, explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

UNIT – II

HYPERBOLIC EQUATIONS: Explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT – III

FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

TREATMENT OF COMPRESSIBLE FLOWS: Potential equation, Eluer equations, Navier- Stokes system of equations, flow-field, dependent variation methods, boundary conditions.

UNIT – IV

FINITE VOLUME METHOD: Finite volume method via finite difference method,formulations for two and three, dimensional problems.

UNIT – V

STANDARD VARIATIONAL METHODS: Linear fluid flow problems, steady state problems, Transient problems.

TEXT BOOKS:

1. Computational fluid dynamics, T. J.Chung, Cambridge University press,2002.
2. Computational Fluid Dynamics by John D. Anderson, McGraw Hill Book Company 2017.

REFERENCE BOOKS:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985.
2. Computational Techniques for Fluid Dynamics, Volume 1& 2 By C. A. J. Fletcher, SpringerPublication, 2012.

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE01
Name of the Course	**Advanced I.C Engine Electric and Hybrid Vehicles** Program Elective – I					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge Level
CO1	Explain static and dynamic effects of gas exchange process	K2
CO2	Illustrate motion of charge inside the cylinder	K3
CO3	Differentiate between the phenomena of combustion in IC engines	K4
CO4	Explain Electric vehicles and types of Batteries	K2
CO5	Analyze Hybrid and Fuel Cell Vehicles	K3

UNIT – I

GAS EXCHANIGING PROCESSES: Inlet and exhaust processes in the four stroke cycle volumetric efficiency quasi static effects combined quasi static and dynamic effects variation with speed and valve area lift and timing –flow through valves poppet valve geometry and timing flow rate and discharge coefficients, residual gas fraction , exhaust gas flow rate and temperature variation, scavenging in two stroke cyclic engines, scavenging parameters and models actual scavenging processes , flow through ports, super charging and turbo changing – methods of power boosting basic relationships compressors, turbines wave compression devices.

UNIT – II

CHARGE MOTION WITHIN THE CYLINDER: Intake Jet Flow, Mean velocity and turbulence characteristics definitions application to engine velocity data swirl – swirl measurement, swirl generation during induction swirl modification within the cylinder squish pre chamber engine flows crevice flows and blowby flows generated by piston –cylinder wall interaction.

UNIT – III

COMBUSTION IN S.I AND C.I ENGINES: Review of normal and abnormal combustion in SI and CI engine cyclic variation in combustionof SI engine , analysis of cylindrical pressure data in SI and CI engine ,MPFI in SI engines common rail fuel injection system in CI engines fuel spray behavior in CI engines.

UNIT – IV

ELECTRIC VEHICLES: Introduction: Limitations of IC Engines as prime mover, History of EVs, EV system, components of EV-DC and AC electric machines: Introduction and basic structure, Electric vehicle drive train, advantages and limitations, Permanent magnet and switched reluctance motors

BATTERIES: Battery: lead, acid battery, cell discharge and charge operation, construction, advantages of lead, acid battery, Battery parameters: battery capacity, discharge rate, state of charge, state of discharge, depth of discharge, Technical characteristics, Ragone plots.

UNIT – V

HYBRID VECHILES: Configurations of hybrids, Series and Parallel, advantages and limitations, Hybrid drive trains, sizing of components Initial acceleration, rated vehicle velocity, Maximum velocity and maximum gradeability, Hydrogen: Production, Hydrogen storage systems, reformers.

FUEL CELL VECHILES: Introduction, Fuel cell characteristics, Thermodynamics of fuel cells, Fuel cell types: emphasis on PEM fuel cell.

TEXT BOOKS:

1. J.B. Heywood Internal Combustion Engine Fundamentals, McGraw Hill Co.1988
2. Seth Leitman and Bob Brant Build your own electric vehicle McGraw Hill Co.2009.
3. F. Barbir PEM Fuel Cells-Theory and Practice Elsevier Academic Press,2005.

REFERENCE BOOKS:

1. W.W. Pulkrabek Engineering Fundamentals of IC Engine, PHI Pvt. Ltd 2002

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE02
Name of the Course	**Gas Dynamics** Program Elective – I					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain equations governing compressible flows	K2
CO2	Explain one dimensional compressible flow concepts	K2
CO3	Explain Two dimensional compressible flow concepts	K2
CO4	Illustrate equations governing quasi one dimensional flows	K3
CO5	Illustrate Unsteady wave motions	K3

UNIT – I

BASIC CONCEPTS : Introduction to compressible flow, A brief review of thermodynamics and fluid mechanics, Integral forms of conservation equations, Differential conservation equations, Continuum Postulates, Acoustic speed and Mach number, Governing equations for compressible flows.

UNIT – II

ONE-DIMENSIONAL COMPRESSIBLE FLOW: One dimensional flow concept, Isentropic flows, Stagnation/Total conditions, Characteristic speeds of gas dynamics, Dynamic pressure and pressure coefficients, Normal shock waves, Rankine , Hugonoit equations, Rayleigh flow, Fanno flow, Crocco's theorem.

UNIT – III

TWO-DIMENSIONAL FLOWS: Oblique shock wave and its governing equations, θ,B,M relations, The Hodograph and Shock Polar, Supersonic flow over wedges and cones, Mach line, Attached and Detached shock, Reflections and interaction of oblique shock waves, Expansion waves, Prandtl , Meyer flow and its governing equations, Supersonic flow over convex and concave corners, Approximation of continuous expansion waves by discrete waves.

UNIT – IV

QUASI-ONE DIMENSIONAL FLOWS: Governing equations, Area velocity relations, Isentropic flow through variable, area ducts, convergent, divergent (or De Laval) nozzles, Over, expanded and under, expanded nozzles, Diffusers.

UNIT – V

UNSTEADY WAVE MOTIONS: Moving normal shock waves, Reflected shock waves, Physical features of wave propagation, Elements of acoustic theory, Incident and reflectedwaves, Shock tube relations, Piston analogy, Incident and reflected expansion waves, Finite compression waves, Shock tube relations.

INTRODUCTION TO EXPERIMENTAL FACILITIES: Subsonic wind tunnels, Supersonic wind tunnels, Shock tunnels, Free, piston shock tunnel, detonation, driven shock tunnels, and Expansion tubes.

TEXT BOOKS:

1. Gas Dynamics by S.M Yahya, 2017
2. Gas Dynamics by E. Radha Krishnan, Prentice Hall India Learning Private Limited

REFERENCE BOOKS:

1. Fundamentals of Gas Dynamics by Robert D. Zucker, John Wiley & Sons, INC.
2. Dynamics and Thermodynamics of compressible fluid flow (Vol. I, II) by Ascher H.Shapiro.
3. Elements of Gas Dynamics by H.W. Liepmann and A. Roshko, Wiley.
4. Fundamentals of Gas Dynamics by V. Babu, John Wiley & Sons.
5. Modern Compressible Flow by John D. Anderson, Jr./McGraw Hill.

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE03
Name of the Course	**Cryogenic Engineering** Program Elective – I					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain Vapour compression Refrigeration System and its components	K2
CO2	Illustrate Multiple stage Refrigeration system	K3
CO3	Explain concepts of Cryogenics	K2
CO4	Illustrate the applications of Cryogenics	K3
CO5	Explain insulation to low temperatures	K2

UNIT – I

VAPOUR COMPRESSION REFRIGERATION SYSTEMS:

Analysis of vapor compression refrigeration cycle, Second law of Thermodynamics, Carnot refrigerator, Vapor Compression Refrigeration Cycle, components, Properties of Refrigerants.

UNIT – II

MULTIPLE STAGE REFRIGERATION SYSTEM : Introduction, Methods of improving COP of Multi Stage Compression with Intercooling , Multistage evaporator System, Cascade Refrigeration System, Dry ice Manufacturing, AutoCascade System, Joule-Thomson Coefficient.

UNIT – III

CRYOGENICS: Liquefaction of air, Linde system, Analysis, Liquefaction of Neon, Hydrogen and Helium.

UNIT – IV

APPLICATION OF LOWER TEMPERATURES: Effects on the properties of metal strength, Thermal properties, super conductivity, super fluidity. Applications, such as expansion fitting, cryobiology, cryosurgery, space research, computers , underground power lines.

UNIT – V

LOW TEMPERATURE INSULATION: Reflective insulation, Evacuated powders, Rigid foams, Super insulation. Cooling by adiabatic de-magnetization , Gas separation and cryogenic systems , separation of gases, Rectifying columns, Air separating, single and double columns Air separation plant.
Storage and handling of cryogenic liquids , Dewars and other types of containers.

TEXT BOOKS:

1. Refrigeration & Air, Conditioning by C.P. Arora, TMH, 2017
2. Cryogenic Systems by R.F Barron ,Oxford University Press, 1985 .

REFERENCE BOOKS:

1. Refrigeration& Air, Conditioning, StoeckerW.F. Jones, J.W., McGraw Hill, 2014.
2. Refrigeration & Air,Conditioning , Manohar Prasad New Age, 2018 .
3. Refrigeration & Air,Conditioning Domkunduwar, and Arora ,Dhanpatrai & Sons, 2015.

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE04
Name of the Course	**Advanced Thermodynamics** Program Elective – I					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain availability and irreversibility	K2
CO2	Explain relations of thermodynamic properties	K2
CO3	Differentiate between properties of mixtures of gases and liquids	K4
CO4	Illustrate equilibrium of vapour and liquid mixtures	K3
CO5	Explain combustion phenomena and reactions involved in combustion	K2

UNIT – I

AVAILABILITY AND IRREVERSIBILITY: Quality of Energy, available and unavailable energy, availability, surroundings work, reversible work and irreversibility, availability in a closed system, availability in a SSSF process in an open system, second law efficiencies of processes, second law efficiency of cycles and exergy balance equations.

UNIT – II

THERMODYNAMIC PROPERTY RELATIONS: Helmholtz and Gibbs Functions, two Mathematical Conditions for Exact Differentials, Maxwell Relations, Clapeyron Equation, Relations for Changes in Enthalpy, Internal Energy and Entropy, Specific Heat Relations, Generalized Relations/Charts for Residual Enthalpy and Entropy, Gibbs Function at zero Pressure: A Mathematical Anomaly, Fugacity, Fugacity Coefficient and Residual Gibbs Function, The Joule, Thomson Coefficient and Inversion Curve, Thermodynamic similarity.

UNIT – III

NON-REACTING MIXTURES OF GASES AND LIQUIDS: Measures of Composition in Multi Component Systems.

GAS MIXTURES: Mixtures of ideal Gases, Gas-Vapor Mixtures, Application of First Law to Psychometric Processes, Real Gas Mixtures.

LIQUID MIXTURES/SOLUTIONS: Ideal Solutions, Real Solutions.

THERMODYNAMIC RELATIONS FOR REAL MIXTURES: Partial Properties, Relation for Fugacity and Fugacity Coefficient in Real Gas Mixtures, Relations for Activity and Activity Coefficient in Real Liquid Mixtures/Solutions.

UNIT – IV

PHASE EQUILIBRIUM :VAPOUR LIQUID EQUILIBRIUM OF MIXTURES: Phase Diagrams for Binary Mixtures, Vapor, Liquid Equilibrium in Ideal Solutions, Criteria for Equilibrium, Criterion foe phase Equilibrium, Calculation of Standard State Fugacity of Pure Component, Vapor Liquid Equilibrium at Low to Moderate Pressures, Determination of Constants of Activity Coefficient Equations, Enthalpy Calculations.

UNIT – V

CHEMICAL REACTIONS AND COMBUSTION: Thermo chemistry, Measures of Composition in Chemical Reactions, Application of First Law of Thermodynamics to chemical Reactions, the Combustion Process-Standard Heat/Enthalpy of Combustion, Reactions at actual Temperatures, adiabatic Flame Temperature, Entropy Change of Reacting Systems, Application of second Law of Thermodynamics to chemical Reactions, chemical equilibrium-Advancement of Chemical Reactions, Equilibrium Criterion in Chemical Reactions, equilibrium Constant and Law of Mass Action, Equilibrium Constant for Gas Phase Reactions in the standard state.

TEXT BOOKS:

1. Basic and Applied Thermodynamics, P.K.Nag, TMH, 2019.
2. Thermodynamics, J.P Holman, Mc Graw Hill, 2017.
3. Thermodynamics ,CP Arora, Mc Graw Hill education (India pvt limited), 2016.

REFERENCE BOOKS:

1. Engg. Thermodynamics, PL.Dhar, Elsevier, 2008.
2. Thermodynamics, Sonnatag & Van Wylen, John Wiley & Sons, 2004.
3. Thermodynamics for Engineers, Doolittle-Messe, John Wiley & Sons, 2018.
4. Irreversible thermodynamics, HR De Groff, .
5. Thermal Engineering, Soman, PHI, 2011.
6. Thermal Engineering, Rathore, TMH, 2010.
7. Engineering Thermodynamics, Chatopadyaya, 2010.

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE05
Name of the Course	**Gas Turbines** Program Elective – II					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain turbo machines and cycles used in gas turbines	K2
CO2	Apply the concepts of rotating machines and centrifugal compressors	K3
CO3	Analyze Axial flow compressors and design concepts	K4
CO4	Illustrate Gas turbine combustion systems	K3
CO5	Illustrate Axial and Radial flow turbines	K3

UNIT – I

INTRODUCTION: Review of the fundamentals, Classification of turbo machines, Applications of gas turbines.

GAS TURBINE CYCLES FOR SHAFT POWER: Ideal shaft power cycles and their analysis, Practical shaft power cycles and their analysis.

UNIT – II

FUNDAMENTALS OF ROTATING MACHINES: Euler's energy equation, Components of energy transfer, Impulse and reaction machines, Degree of reaction, Flow over an airfoil, Lift and drag.

CENTRIFUGAL COMPRESSORS: Construction and principle of operation, Factors affecting stage pressure ratio, Compressibility effects, Surging and choking, Performance characteristics.

UNIT – III

AXIAL FLOW COMPRESSORS: Construction and principle of operation, Factors affecting stage pressure ratio, Degree of reaction, Three dimensional flow, Design process, Blade design, Stage performance, Compressibility effects, Off, design performance.

UNIT – IV

GAS TURBINE COMBUSTION SYSTEMS: Operational requirements, Factors affecting combustion chamber design, Combustion process, Flame stabilization, Combustion chamber performance, Practical problems, Gas turbine emissions.

UNIT – V

AXIAL AND RADIAL FLOW TURBINES: Construction and operation of axial flow turbines, Vortex theory, Estimation of stage performance, Overall turbine performance, Turbine blade cooling, Radial flow turbines.

TEXT BOOKS:

1. Sarvanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., Gas Turbine Theory, 7th Edition, Pearson Prentice Hall, 2017.
2. Ganesan, V., Gas Turbines, 3rd Edition, Tata McGraw Hill, 2017.

REFERENCE BOOKS:

1. Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbo machinery, 7th Edition,Elsevier, 2014.
2. Flack, R.D., Fundamentals of Jet Propulsion with Applications, Cambridge University Press, 2011.
3. Yahya, S. M., Turbines, Compressors and Fans, 4th Edition, Tata McGraw Hill, 2017. Lefebvre, A.H. and Ballal D. R., Gas Turbine Combustion – Alternative Fuels andEmissions, CRC Press, 2010

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE06
Name of the Course	Alternative Fuel Technologies Program Elective – II					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain alternative fuels	K2
CO2	Explain production methods of alternative fuels	K2
CO3	Illustrate performance characteristics of liquid alternative fuels	K3
CO4	Illustrate performance characteristics of gaseous alternative fuels	K3
CO5	Analyze performance characteristics of alternative fuels and methods to improve efficiency	K4

UNIT – I

Fossil fuels and their limitations Engine requirements; Potential alternative liquid and gaseous fuels.

UNIT – II

Methods of production; Properties, safety aspects, handling and distribution of various liquid alternative fuels like alcohols, vegetable oils, Di, methyl and Di, ethyl ether etc.

UNIT – III

Different ways of using alternative liquid fuels in engines, performance and emission characteristics; Conversion of vegetable oils to their esters and effect on engine performance.

UNIT – IV

Use of gaseous fuels like biogas, LPG, hydrogen, natural gas, producer gas etc. in SI/CI engines; Production, storage, distrbution and safety aspects of gaseous fuels.

UNIT – V

Different approaches like duel fuel combustion and surface ignition to use alternative fuels in engines; Use of additives to improve the performance with alternative fuels; Hybrid power plantsand fuel cell.

TEXT BOOK:

1. Alternative Fuels: The Future of Hydrogen, Second Edition**,** Michael Frank Hordeski, CRCPress

REFERENCE BOOKS:

1. Alternative Fuels for Transportation, A S Ramadhas, CRC Press
2. Alternative Fuels & Advanced Technology Vehicles: Incentives & Considerations, ThomasHuber, Jack Spera, Nova Science Publishers

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE07
Name of the Course	**Energy Conservation and Management** Program Elective – II					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain the importance of energy conservation and management	K2
CO2	Explain various methods of energy conservation	K2
CO3	Illustrate various methods of energy management	K3
CO4	Illustrate Economic analysis	K3
CO5	Explain standards and laws of energy conservation and management	K2

UNIT – I

The energy market, energy scenario, planning, utilization pattern and future strategy, Importanceof energy management.

UNIT – II

ENERGY CONSERVATION: Methods of energy conservation and energy efficiency for buildings, air conditioning, heat recovery and thermal energy storage systems Energy conservation in industries, Cogeneration, Combined heating and power systems.

UNIT – III

ENERGY MANAGEMENT: Principles of Energy Management, Energy demand estimation, Organising and Managing Energy Management Programs, Energy pricing

Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries

UNIT – IV

ECONOMIC ANALysis: Scope, Characterization of an Investment Project

UNIT – V

Relevant international standards and laws.

TEXT BOOK:

1. L.C. Witte, P.S. Schmidt, D.R.Brown, "Industrial Energy Management and Utilization", Hemispherical Publication, 1988.
2. Callaghan "Energy Conservation".

REFERENCE BOOKS:

1. D.A. Reeg, "Industrial Energy Conservation", Pergamon Press, 1980.
2. T.L. Boyen, "Thermal Energy Recovery" Wiley, 1980
3. L.J. Nagrath, "Systems Modeling and Analysis", Tata McGraw Hill, 1982.
4. W.C. Turner, "Energy Management Handbook ", Wiley, New York, 1982.
5. I.G.C. Dryden, "The Efficient Use of Energy ", Butterworth, London, 1982.
6. R. Loftnen, Van Nostrarid Reinhold C. "Energy Handbook", 1978.
7. TERI Publications.
8. WR Murphy, G McKay "Energy Management"

Semester	I	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE08
Name of the Course	**Theory and Technology of Fuel Cells** Program Elective – II					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain concepts of Fuel cells	K2
CO2	Explain various models of Fuels cells	K2
CO3	Illustrate Low and High temperature fuel cells	K3
CO4	Determine the production of fuels and design of various fuel cells	K4
CO5	Explain the components of fuel cell system	K2

UNIT – I

INTRODUCTION: Relevance, Principle, various configurations (Alkaline, Acid, Proton Exchange Membrane, direct methanol, molten carbonate and solid oxide fuel cells) fuel cell applications. Basic theory of electrochemistry, electrochemical energy conversion, electrochemical techniques, Thermodynamics of fuel cells, Heat and mass transfer in fuel cells, Single cell characteristics.

UNIT – II

MODELLING: Electrochemical model, Heat and mass transfer model, System thermodynamic model.

UNIT – III

LOW AND HIGH TEMPERATURE FUEL CELLS: Proton exchange membrane fuel cell(PEMFC) and direct methanol fuel cell (DMFC): their special features and characteristics.

Molten carbonate fuel cell (MCFC) and solid oxide fuel cell (SOFC) for power generation, theirspecial features and characteristics.

UNIT – IV

FUELS AND FUEL PROCESSING: Availability, production and characteristics of Hydrogen ,fossil fuel – diverted fuels and biomass, diverted fuels. Principles of design of PEMFC, DMFC and SOFC.

UNIT – V

FUEL CELL SYSTEM: Materials, component, stack, interconnects, internal and externalreforming, system layout, operation and performance.

TEXT BOOKS:

1. Basu, S. (Ed) Fuel Cell Science and Technology, Springer, N.Y. (2007).
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY(2006).

REFERENCE BOOKS:

1. J., Dick A., Fuel Cell Systems Explained, 2nd Ed. Wiley, 2003.
2. Liu, H., Principles of fuel cells, Taylor & Francis, N.Y. (2006).
3. Bard, A. J. , L. R., Faulkner, Electrochemical Methods, Wiley, N.Y. (2004) RefBook.
4. M.T.M. Koper (ed.), Fuel Cell Catalysis, Wiley, Larminie 2009.
5. J.O'M. Bockris, A.K.N. Reddy, Modern Electrochemistry, Springer 1998.

Semester	I	L	T	P	C	Course Code
Regulation	V21	0	0	3	2	V21TEL01
Name of the Course	Computational Fluid Dynamics Lab – I					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Analyze flow through pipes, Heat exchanger	K4
CO2	Analyze performance characteristics of combustion and air cooler	K4
CO3	Analyze thermal stresses, temperature gradient & Radiation heat transfer in cylinders	K4
CO4	Determination of Insulated Wall Temperature, thermal loading of support structure	K4
CO5	Illustrate Solid Liquid Phase Change	K3

1. Analysis of Transient state compressible flow through pipes
2. Performance Analysis of Heat Exchanger Device
3. Calibration Performance characteristics of Combustion
4. Estimation of C.O.P for Refrigeration Cycle
5. Analysis of Gas cooled Air-Cooler
6. Performance of Air-Conditioner
7. Thermal Stresses in long cylinder
8. Determination of Insulated Wall Temperature
9. Temperature Gradient across solid Cylinder
10. Radiation Heat Transfer between Concentric Cylinders
11. Solid Liquid Phase Change
12. Thermal Loading on Support structure

- MATLAB, ANSYS fluent modules: for conducting the simulation experiments.

Semester	I	L	T	P	C	Course Code
Regulation	V21	0	0	3	2	V21TEL02
Name of the Course	THERMAL ENGINEERING LAB – I					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Determination of fuel properties	K4
CO2	Investigate the exhaust emissions of IC Engines	K4
CO3	Test the Performance of compressors & IC Engines	K4

1. Abel's apparatus: Determination of flash and fire points of a given oil sample
2. Redwood Viscometer No.1: Determination of kinematic and absolute viscosities of anoil sample given
3. Measurement of Viscosity by Sayboltz's Viscometer.
4. Determination of Calorific Value of fuel.
5. Two-Stage Reciprocating Air-Compressor - Determination of volumetric efficiency of thecompressor as a function of receiver pressure.
6. I.C. Engines performance test and Exhaust emission measurements (4 -stroke diesel engine)
7. I.C. Engines performance test and Exhaust emission measurements (2-stroke petrol engine)
8. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine.
9. I.C. Engines heat balance at different loads and show the heat distribution curve.
10. Performance test on variable compression ratio engines.
11. Performance test on Rotary Air Compressor.

II Semester

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TET03
Name of the Course	Advanced Heat and Mass Transfer					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain Equations governing heat conduction heat transfer	K2
CO2	Illustrate finite difference methods for heat conduction and convection problems	K3
CO3	Analyze heat and mass transfer in internal and external flows	K4
CO4	Explain concepts related to free convection, boiling & condensation and Heat exchangers	K2
CO5	Explain concepts of Radiation heat transfer and mass transfer.	K2

UNIT – I

BRIEF INTRODUCTION TO DIFFERENT MODES OF HEAT TRANSFER: Conduction: General heat Conduction equation, initial and boundary conditions.

Transient heat conduction: Lumped system analysis, Heisler charts, semi infinite solid,use of shape factors in conduction,2D transient heat conduction, product solutions.

UNIT – II

FINITE DIFFERENCE METHODS FOR CONDUCTION: ID & 2D steady state and simple transient heat conduction problems, implicit and explicit methods.

FORCED CONVECTION: Equations of fluid flow, concepts of continuity, momentum equations, derivation of energy equation, methods to determine heat transfer coefficient: Analytical methods, dimensional analysis and concept of exact solution. Approximate method, ntegral analysis.

UNIT – III

EXTERNAL FLOWS: Flow over a flat plate: Integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows.

INTERNAL FLOWS: Fully developed flow: Integral analysis for laminar heat transfer coefficient,types of flow, constant wall temperature and constant heat flux boundary conditions, hydrodynamic &thermal entry lengths; use of empirical correlations.

UNIT – IV

FREE CONVECTION: Approximate analysis on laminar free convective heat transfer, boussinesque approximation ,different geometries, combined free and forced convection.

BOILING AND CONDENSATION: Boiling curve, correlations, Nusselts theory of film condensation on a vertical plate, assumptions & correlations of film condensation for different geometries.

HEAT EXCHANGERS Types of Heat Exchangers, LMTD and NTU methods

UNIT – V

RADIATION HEAT TRANSFER: Radiant heat exchange in grey, non, grey bodies, with transmitting, Reflecting and absorbing media, specular surfaces, gas radiation, from flames.

MASS TRANSFER: Concepts of mass transfer, diffusion & convective mass transfer analogies, significance of non-dimensional numbers.

TEXT BOOKS:

1. Principles of Heat Transfer / Frank Kreith / Cengage Learning
2. Heat Transfer / Necati Ozisik / TMH

REFERENCE BOOKS:

1. Fundamentals of Heat and Mass Transfer,5th Ed. / Frank P. Incropera/John Wiley
2. Elements of Heat Transfer/E. Radha Krishna/CRC Press/2012
3. Introduction to Heat Transfer/SK Som/PHI
4. Heat Transfer / Nellis& Klein / Cambridge University Press / 2012.
5. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press
6. Engg. Heat & Mass Transfer/ Sarat K. Das/DhanpatRai
7. Heat Transfer/ P.K.Nag /TMH
8. Heat Transfer / J.P Holman/MGH

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TET04
Name of the Course	Thermal Measurements and Process Controls					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain elements of measuring instruments	K2
CO2	Explain flow measuring devices	K2
CO3	Explain temperature measurement methods	K2
CO4	Illustrate various indicating, recording and data acquisition systems	K3
CO5	Analyze various process control systems	K4

UNIT – I

GENERAL CONCEPTS: Fundamental elements of a measuring instruments. Static and dynamic characteristics – errors in instruments – Different methods of measurement and their analysis – Sensing elements and transducers. Measurement of pressure – principles of pressure measurement, static and dynamic pressure, vacuum and high pressure measurement – Measurement of low pressure, Manometers, Calibration methods, Dynamic characteristics, design principles.

UNIT – II

MEASUREMENT OF FLOW: Obstruction meters, variable area meters, Pressure probes, compressible fluid flow measurement, Thermal anemometers, calibration of flow measuring instruments. Introduction to design of flow measuring instruments.

UNIT – III

TEMPERATURE MEASUREMENT: Different principles of Temperature Measurement, use of bimetallic thermometers – Mercury thermometers, Vapor Pressure thermometers, Thermo positive elements, thermocouples in series & parallel, pyrometry, measurement of heat flux, calibration of temperature measuring instruments. Design of temperature measuring instruments.

MEASURMENT OF : Velocity, moisture content , humidity and thermal conductivity .

UNIT – IV

VOLTAGE INDICATING, RECORDING AND DATA ACQUISITION SYSTEMS: Standards and calibration, analog volt meters and potentiometers. Electrical instruments. Digital voltmeters and multimeters. Signal generation. Electro mechanical servo type XT and XY recorders. Thermal array recorders and data acquisition systems. Analog and digital CROs. Displays and liquid crystals flat panel displays. Displays. Virtual instruments. Magnetic tape and disk recorders/reproducers. Fiber optic sensors.

UNIT – V

PROCESS CONTROL: Introduction and need for process control principles, transfer functions, block diagrams, signal flow graphs, open and closed loop control systems – Analysis of First & Second order systems with examples of mechanical and thermal systems.

Control System Evaluation – Stability, steady state regulations, transient regulations.

TEXT BOOK:

1. Measurement System, Application & Design – E.O. Doeblin, MGH

REFERENCE BOOKS:

1. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers.
2. Mechanical Measurements – Buck & Beckwith – Pearson.
3. Control Systems, Principles & Design, 2nd Edition – M. Gopal – TMH.
4. Mechanical Measurements – J.P Holman

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE09
Name of the Course	**Equipment Design for Thermal Systems** Program Elective – III					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain various Heat Exchangers and methods of designing them	K2
CO2	Illustrate design of double pipe heat exchanger	K3
CO3	Demonstrate condensation of vapours	K3
CO4	Explain concepts of vaporizers, evaporators and reboilers	K3
CO5	Outline concepts of designing of direct contact heat exchangers	K4

UNIT – I

CLASSIFICATION OF HEAT EXCHANGERS: Introduction, Recuperation & regeneration, Tabular heat exchangers, Double pipe, shell & tube heat exchanger, Plate heat Exchangers, Gasketedplate heat exchanger. Spiral plate heat exchanger, Lamella heat exchanger, Extended surface heat exchanger, Plate fin and Tabular fin.

BASIC DESIGN METHODS OF HEAT EXCHANGER: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow. Multipass, cross flow heat exchanger design calculations:

UNIT – II

DOUBLE PIPE HEAT EXCHANGER: Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature, The calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements.

Shell & Tube Heat Exchangers: Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1,2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1,2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2,4 exchangers.

UNIT – III

CONDENSATION OF SINGLE VAPOURS: Calculation of horizontal condenser, Vertical condenser, De,Super heater condenser, Vertical condenser,sub,Cooler, Horizontal Condenser,Sub cooler, Vertical reflux type condenser. Condensation of steam.

UNIT – IV

VAPORIZERS, EVAPORATORS AND REBOILERS: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler. Extended Surfaces: Longitudinal fins. Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve. Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube exchanger.

UNIT – V

DIRECT CONTACT HEAT EXCHANGER: Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.

TEXT BOOK:

1. Process Heat Transfer/D.Q.Kern/ TMH
2. Design of Thermal Systems / Wilbert F. Stoecker / McGrawHill 1. Heat Exchanger Design/ A.P.Fraas and M.N.Ozisicj/ John Wiely& sons, New York.
3. Cooling Towers / J.D.Gurney and I.A. Cotter/ Maclaren
4. Design & Optimization of Thermal Systems / Yogesh Jaluria / CRC Press

REFERENCE BOOKS:

1. Heat Exchanger Design/ A.P.Fraas and M.N.Ozisicj/ John Wiely& sons, New York.
2. Cooling Towers / J.D.Gurney and I.A. Cotter/ Maclaren
3. Design & Optimization of Thermal Systems / Yogesh Jaluria / CRC Press

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE10
Name of the Course	**Solar Energy Technologies** Program Elective – III					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain various elements of solar energy systems	K2
CO2	Illustrate the design of solar water heating system	K3
CO3	Illustrate solar energy storage systems	K3
CO4	Explain performance characteristics and energy conversion systems	K2
CO5	Explain economics of solar energy systems	K2

UNIT – I

INTRODUCTION: Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications.

Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors– cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

UNIT – II

DESIGN OF SOLAR WATER HEATING SYSTEM AND LAYOUT: Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio.

UNIT – III

THERMAL ENERGY STORAGE: Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations. Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration, active and passive heating systems.

UNIT – IV

DIRECT ENERGY CONVERSION: Solid, state principles – semiconductors – solar cells – performance – modular construction – applications. conversion efficiencies calculations.

UNIT – V

ECONOMICS: Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost based analysis of water heating and photo voltaic applications.

TEXT BOOK:

1. Principles of solar engineering/ Kreith and Kerider/Taylor and Franscis/2nd edition

REFERENCE BOOKS:

1. Solar energy thermal processes/Duffie and Beckman/John Wiley & Sons
2. Solar energy: Principles of Thermal Collection and Storage/Sukhatme/TMH/2nd edition
3. Solar energy/Garg/TMH
4. Solar energy/Magal/McGraw Hill
5. Solar Thermal Engineering Systems /Tiwari and Suneja/Narosa
6. Power plant Technology/ El Wakil/TMH

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE11
Name of the Course	**Adavanced Power Plant Engineering** Program Elective – III					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain various components of Steam power plant	K2
CO2	Explain various components of Gas turbine & Hydro power plant	K2
CO3	Explain Nuclear power station and types of reactors	K2
CO4	Illustrate operation of combined power plants	K3
CO5	Outline economics and environmental considerations of power plants	K4

UNIT – I

Introduction to the sources of energy – resources and development of power in India.

STEAM POWER PLANT: Plant layout, working of different circuits, fuel handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems. Combustion: properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, dust collectors, cooling towers and heat rejection. corrosion and feed water treatment.

UNIT – II

GAS TURBINE PLANT: Introduction – classification , construction – layout with auxiliaries, combined cycle power plants and comparison. Cogeneration of Power and Process heat. Waste heat recovery systems.

HYDRO PROJECTS AND PLANT: Classification – typical layouts – plant auxiliaries – plant operation pumped storage plants.

UNIT – III

NUCLEAR POWER STATION: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation.

TYPES OF REACTORS: Pressurized water reactor, boiling water reactor, sodium,graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.

UNIT – IV

COMBINED OPERATIONS OF DIFFERENT POWER PLANTS: Introduction, advantages of combined working, load division between power stations, storage type hydro, electric plant in combination with steam plant, run of river plant in combination with steam plant, pump storage plant in combination with steam or nuclear power plant, co ordination of hydro, electric and gas turbine stations, co ordination of hydro,electric and nuclear power stations, co ordination of different types of power plants.

POWER PLANT INSTRUMENTATION AND CONTROL: Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, O2 and CO2 measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit, nuclear measurements.

UNIT – V

POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor – related exercises. effluents from power plants and Impact on environment – pollutants and pollution standards – methods of pollution control.

TEXT BOOKS:

1. A course in Power Plant Engineering /Arora and Domkundwar/Dhanpatrai & Co.
2. Power Plant Engineering /P.C.Sharma / S.K.Kataria Pub

REFERENCES BOOKS:

1. Power Plant Engineering: P.K.Nag/ II Edition /TMH.
2. Power station Engineering – ElWakil / McGrawHill.
3. An Introduction to Power Plant Technology / G.D. Rai/Khanna Publishers

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE12
Name of the Course	**Combustion, Emissions and Environment** Program Elective – III					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain principles of combustion	K2
CO2	Illustrate the combustion phenomena	K3
CO3	Differentiate the laminar and turbulent flame propagation	K4
CO4	Illustrate the measurement and control of pollution	K3
CO5	Explain environmental considerations of pollution	K2

UNIT – I

PRINCIPLES OF COMBUSTION: Chemical composition , Flue gas analysis, dew point of products, Combustion stoichiometry, Chemical kinetics, Rate of reaction, Reaction order, Molecularity, Zeroth, first, second and third order reactions , complex reactions, chain reactions, Theories of reaction Kinetics, General oxidation behavior of HCs.

UNIT – II

THERMODYNAMICS OF COMBUSTION: Enthalpy of formation, heating value of fuel, Adiabatic flame Temperature, Equilibrium composition of gaseous mixtures.

UNIT – III

LAMINAR AND TURBULENT FLAMES PROPAGATION AND STRUCTURE: Flame stability, burning velocity of fuels, Measurement of burning velocity, factors affecting the Burning velocity. Combustion of fuel droplets and sprays, Combustion systems, Pulverized fuel furnaces- fixed, entrained and fluidized bed systems.

UNIT – IV

POLLUTION FORMATION MEASUREMENT AND CONTROL: Causes for Formation of NOx, SOx, COx, Smoke and UBHC. Different methods of measurement of pollutants. Methods of controlling the formation of pollutants, BHARAT and EURO standards of emissions.

UNIT – V

ENVIRONMENTAL CONSIDERATIONS: Air pollution, effects on environment, human health etc. Principal pollutants, Legislative measures, methods of emission control.

TEXT BOOK:

1. Fuels and combustion, Sharma and Chandra Mohan, Tata McGraw Hill, 1984..

REFERENCE BOOKS:

1. Combustion Fundamentals , Roger A strehlow , McGraw Hill.
2. Combustion Engineering and Fuel Technology , Shaha A.K., Oxford and IBH.
3. Principles of Combustion , KannethK.Kuo, Wiley and Sons.
4. Combustion , Samir Sarkar , Mc. Graw Hill, 2009.
5. An Introduction to Combustion , Stephen R. Turns, Mc. Graw Hill International Edition.
6. Combustion Engineering , Gary L. Berman & Kenneth W. Ragland, Mc. Graw Hill

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE13
Name of the Course	**Jet Propulsion and Rocket Engineering** Program Elective – III					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain Turbo Jet propulsion systems	K2
CO2	Outline the principles and characteristic parameters of jet propulsion and rockets	K4
CO3	Illustrate chemical formulations of combustion products	K2
CO4	Differentiate solid and liquid propellant rocket systems	K4
CO5	Explain Ramjet propellant rocket system	K2

UNIT – I

TURBO JET PROPULSION SYSTEMS: Gas turbine cycle analysis, layout of turbo jet engine. Turbo machinery, compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.

FLIGHT PERFORMANCE: Forces acting on vehicle, Basic relations of motion, multi stage vehicles.

UNIT – II

PRINCIPLES OF JET PROPULSION AND ROCKETRY: Fundamentals of jet propulsion, Rockets and air breathing jet engines,Classification,turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

NOZZLE THEORY AND CHARACTERISTICS PARAMETERS: Theory of one dimensional convergent, divergent nozzles, aerodynamic choking of nozzles and mass flow through a nozzle, nozzle exhaust velocity, thrust, thrust coefficient, Ac / At of a nozzle, Supersonic nozzle shape, non, adapted nozzles, Summerfield criteria, departure from simple analysis, characteristic parameters,1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

UNIT – III

AERO THERMO CHEMISTRY OF THE COMBUSTION PRODUCTS: Review of properties of mixture of gases, Gibbs, Dalton laws, Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation, calculation of adiabatic flame temperature and specific impulse, frozen and equilibrium flows.

SOLID PROPULSION SYSTEM: Solid propellants, classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates.

UNIT – IV

SOLID PROPELLANT ROCKET ENGINE: Internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat transfer considerations in solid rocket motor design. Ignition system, simple pyro devices.

LIQUID ROCKET PROPULSION SYSTEM: Liquid propellants, classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine,system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors,various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

UNIT – V

RAMJET AND INTEGRAL ROCKET RAMJET PROPULSION SYSTEM: Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification, critical, super critical and sub,critical operation of air intakes, engine intake matching, classification and comparison of Integral Rocket Ramjet (IRR) propulsion systems.

TEXT BOOKS:

1. Mechanics and Dynamics of Propulsion/ Hill and Peterson/John Wiley & Sons
2. Rocket propulsion elements/Sutton/John Wiley & Sons/8th Edition

REFERENCE BOOKS:

1. Gas Turbines/Ganesan /TMH
2. Gas Turbines & Propulsive Systems / Khajuria & Dubey / Dhanpat Rai& Sons
3. Rocket propulsion/Bevere/
4. Jet propulsion /Nicholas Cumpsty/University of Cambridge

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE14
Name of the Course	**Automotive Engineering** Program Elective – IV					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain classification of automobiles	K2
CO2	Illustrate Fuel, ignition and electrical systems of automobile	K3
CO3	Illustrate Cooling and lubrication systems of automobile	K3
CO4	Illustrate Steering system of automobile	K3
CO5	Explain automation in automobiles	K2

UNIT – I

INTRODUCTION: Overview of the course, Examination and Evaluation patterns, History of Automobiles, Classification of Automobiles.

POWER PLANT: Classification, Engine Terminology, Types of Cycles, working principle of and IC engine, advanced classification of Engines, Multi cylinder engines, Engine balance, firing order.

UNIT – II

FUEL SYSTEM, IGNITION SYSTEM AND ELECTRICAL SYSTEM: spark Ignition engines, Fuel tank, fuel filter, fuel pump, air cleaner/filter, carburetor, direct injection of petrol engines. Compression Ignition engines, Fuel Injection System, air & solid injection system, Pressure charging of engines, super charging and turbo charging, Components of Ignition systems, battery ignition system, magneto ignition system, electronic ignition and ignition timing. Main electrical circuits, generating & stating circuit, lighting system, indicating devices, warning lights, speedometer.

UNIT – III

LUBRICATING SYSTEMS AND COOLING SYSTEMS: Functions & properties of lubricants, methods of lubrication, splash type, pressure type, dry sump, and wet sump & mist lubrication. Oil filters, oil pumps, oil coolers. Characteristics of an effective cooling system, types of cooling system, radiator, thermostat, air cooling & water cooling.

TRANSMISSION, AXLES, CLUTCHES, PROPELLER SHAFTS AND DIFFERENTIAL: Types of gear boxes, functions and types of front and rear axles, types and functions, components of the clutches, fluid couplings, design considerations of Hotchkiss drive torque tube drive, function and parts of differential and traction control.

UNIT – IV

STEERING SYSTEM: Functions of steering mechanism, steering gear box types, wheel geometry. Braking and suspension system: Functions and types of brakes, operation and principle of brakes, constructional and operational classification and parking brake. Types of springs shock observers, objectives and types of suspension system, rear axles suspension, electronic control and proactive suspension system.

WHEELS AND TYRES : Wheel quality, assembly, types of wheels, wheel rims,construction of tyres and tyre specifications.

UNIT – V

AUTOMATION IN AUTOMOBILES: Sensors and actuators, electronic fuel injection system, electronic management system, automatic transmission, electronic transmission control, Antilock Braking System (ABS).

TEXT BOOKS:

1. Joseph Heitner, Automotive Mechanics, CBS publications,2017.
2. Srinivasan. S, Automotive Mechanics, 2nd Edition, Tata McGraw,Hill, 2003

REFERENCE BOOKS:

1. Crouse and Anglin, Automotive Mechanism, 9th Edition. Tata McGraw,Hill, 2003.
2. Jack Erjavec, A Systems Approach to Automotive Technology, Cengage Learning Pub.2009

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE15
Name of the Course	**Modelling of IC Engines** Program Elective – IV					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain fundamentals of IC Engine modeling	K2
CO2	Analyze thermodynamic combustion models of IC Engines	K4
CO3	Illustrate spray behavior of fuels	K3
CO4	Illustrate modeling of charging system	K3
CO5	Explain mathematical models of SI Engines	K2

UNIT – I

FUNDAMENTALS: Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, and approaches of modeling, model building and integration methods, gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves.

UNIT – II

THERMODYNAMIC COMBUSTION MODELS OF CI ENGINES: Single zone models, premixed and diffusive combustion models, combustion heat release using wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two zone model, application of heat release analysis.

UNIT – III

FUEL SPRAY BEHAVIOR: Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls.

UNIT – IV

MODELING OF CHARGING SYSTEM: Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler.

UNIT – V

MATHEMATICAL MODELS OF SI ENGINES: Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Autoignition modeling, single zone models, mass burning rate estimation, SI Engine with stratified charge. Friction in pumping, piston assembly, bearings and valve train etc. friction estimation for warm and warm up engines

REFERENCE BOOKS:

1. Haywood, "I.C. Engines", Mc Graw Hill.
2. Ramos **J** (1989**)** Internal Combustion Engine Modeling**.** Hemisphere Publishing Company
3. C. D. Rakopoulos and E. G. Giakoumis, "Diesel Engine Transient
4. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 1996.
5. P.A. Lakshminarayanan and Y. V. Aghav, " Modelling Diesel Combustion" Springer, 2010
6. Bernard Challen and Rodica Baranescu, "Diesel Engine Reference Book" Butterworth Heinemann, 1999.

Semester	II	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE16
Name of the Course	**Renewable Energy Technologies** Program Elective – IV					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain solar energy and its applications	K2
CO2	Explain Geothermal energy and techniques of harnessing it	K2
CO3	Illustrate energy conversion systems and application of hydrogen as fuel	K3
CO4	Illustrate Bio energy systems	K3
CO5	Illustrate Wind and Tidal energy systems	K3

UNIT – I

INTRODUCTION: Energy Scenario, Survey of energy resources. Classification and need for conventional energy resources.

SOLAR ENERGY: Sun , Earth relationship, Basic matter to waste heat energy circuit, Solar Radiation, Attention, Radiation measuring instruments.

SOLAR ENERGY APPLICATIONS: Solar water heating. Space heating, Active and passive heating. Energy storage. Selective surface. Solar stills and ponds, solar refrigeration, Photovoltaic generation.

UNIT – II

GEOTHERMAL ENERGY: Structure of earth, Geothermal Regions, Hot springs. Hot Rocks, Hot Aquifers. Analytical methods to estimate thermal potential. Harnessing techniques, Electricity generating systems.

UNIT – III

DIRECT ENERGY CONVERSION: Nuclear Fusion,Fusion, Fusion reaction, P,P cycle, Carbon cycle, Deuterium cycle, Condition for controlled fusion, Fuel cells and photovoltaic. Thermionic & thermoelectric generation, MHD generator.

HYDROGEN GAS AS FUEL: Production methods, Properties, I.C. Engine applications, Utilization strategy, Performance.

UNIT – IV

BIO,ENERGY: Biomass energy sources. Plant productivity, Biomass wastes, aerobic and Anaerobic bioconversion processes, Raw material and properties of bio,gas, Bio,gas plant technology and status, the energetic and economics of biomass systems, Biomass gasification

UNIT – V

WIND ENERGY: Wind, Beaufort number, Characteristics, Wind energy conversion systems, Types, Betz model. Interference factor. Power coefficient, Torque coefficient and Thrust coefficient, Lift machines and Drag machines. Matching, Electricity generation.

ENERGY FROM OCEANS: Tidal energy, Tides , Diurnal and semi,diurnal nature, Power from tides, Wave Energy, Waves, Theoretical energy available. Calculation of period and phase velocity of waves, Wave power systems, Submerged devices. Ocean thermal Energy, Principles, Heat exchangers, Pumping requirements, Practical considerations.

TEXT BOOK:

1. Renewable Energy Resources/ John Twidell& Tony Weir/Taylor & Francis/2nd edition

REFERENCE BOOKS:

1. Renewable Energy Resources, Basic Principles and Applications/ G.N.Tiwari and M.K.Ghosal/ Narosa Publications
2. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/ E&FN Spon
3. Renewable Energy Sources / G.D Rai /Khanna Publishers

Semester	II	L	T	P	C	Course Code
Regulation	V21	0	0	3	2	V21TEL03
Name of the Course	Computational Fluid Dynamics Lab – II					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Analyze the 3D laminar flow through pipe, internal & external flow and rectangular duct.	K4
CO2	Determine the variation of various parameters of rotor & rotary compressor and various losses in pipe flow due to variation of cross section	K4
CO3	Analyze Steady and transient state analysis of solids	K4
CO4	Analyze structural analysis of rectangular plate with hole and orifice in cylinder	K4
CO5	Analyze structural analysis of pressure and velocity in convergent divergent nozzle	K4

1. Static Structural Analysis of a Rectangular Plate with Circular hole
2. Steady State Analysis of a Composite Slab
3. Analysis of Laminar flow in a 3D Circular Pipe
4. Analysis of Pressure and Velocity in a Convergent Divergent Nozzle
5. Study of Variation of various losses in a sudden contraction in pipes
6. External flow analysis of a Cylinder
7. 3 D analysis of a Rectangular Duct
8. Internal Flow 3D analysis
9. Study of Variation of various parameters in a Rotor
10. Study of Variation of various parameters in a Rotary Compressor
11. Transient State Analysis of a Sphere
12. Analysis of Orifice in a Cylinder

Semester	II	L	T	P	C	Course Code
Regulation	V21	0	0	3	2	V21TEL04
Name of the Course	Thermal Engineering Lab – II					
Specialization	Thermal Engineering					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Determination of Heat transfer coefficient in convective heat transfer	K4
CO2	Examine the emissivity of test plate	K4
CO3	Test the performance of heat exchanger, Solar flat plate collector and water cooler	K4

1. Composite Slab Apparatus: Determination of theoretical end experimental values ofequivalent thermal resistance of a composite slab.
2. Natural Convection Apparatus: Determination of experimental and empirical values ofconvection heat transfer coefficient from a Vertical Heated Cylinder losing heat to quiescent air
3. Forced Convection Apparatus: Determination of theoretical, experimental and empiricalvalues of convection heat transfer coefficient for internal forced convection through a circular GI pipe
4. Pin-Fin Apparatus: Determination of temperature distribution, efficiency and effectiveness of the fin working in Natural & forced convection environment.
5. Emissivity Apparatus: Determination of surface emissivity of a given aluminium testplate at a given absolute temperature.
6. Heat Pipe Demonstrator: Demonstration of near isothermal characteristic exhibited by aheat pipe in comparison to stainless steel and copper pipes
7. Performance evaluation of Shell and Tube heat exchanger.
8. Determination of COP of water cooler test rig
9. Measurement of Dryness Fraction by using Throttling Calorimeter.
10. Performance evaluation of Solar Flat Plate Collector.
11. Determination of convective heat transfer coefficient in drop wise and film wise condensation.

Syllabi for the courses offered in M. Tech under V21 Regulation
III Semester

Semester	III	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE17
Name of the Course	**Optmization Techniques & Applications** Program Elective – V					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain various single variable optimization techniques	K2
CO2	Illustrate various multi variable optimization techniques	K3
CO3	Explain various linear programming methods	K2
CO4	Explain various non traditional optimization algorithms	K2
CO5	Analyze various applications of optimization techniques to thermal systems	K4

UNIT – I

SINGLE VARIABLE NON,LINEAR UNCONSTRAINED OPTIMIZATION: One dimensional Optimization methods:, Uni, modal function, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic & cubic interpolation methods.

UNIT – II

MULTI VARIABLE NON LINEAR UNCONSTRAINED OPTIMIZATION: Direct search method, Univariant method , pattern search methods, Powell's, Hook ,Jeeves, Rosenbrock search methods, gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

UNIT – III

LINEAR PROGRAMMING: Formulation, Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. Duality, importance of duality, solution of primal from dual.

UNIT – IV

NON TRADITIONAL OPTIMIZATION ALGORITHMS: Genetics Algorithm, Working Principles, Similarities and Differences between Genetic Algorithm & Traditional Methods. Simulated Annealing, Working Principle, Simple Problems.

UNIT – V

APPLICATIONS TO THERMAL SYSTEMS: Optimal design of heat exchangers, condensers, evaporator and IC Engines.

TEXT BOOKS:

1. Optimization theory & Applications / S.S.Rao / New Age International.
2. Optimization for Engineering Design, Kalyanmoy Deb, PHI

REFERENCE BOOKS:

1. S.D.Sharma / Operations Research
2. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia.
3. Design of Thermal Systems / W.F Stoecker/Mc Graw Hill Education

Semester	III	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE18
Name of the Course	**Design and Analysis of Experiments** Program Elective – V					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain various strategy of experimentation	K2
CO2	Illustrate various factorial design	K3
CO3	Illustrate various two level factorial design	K3
CO4	Analyze various regression models	K4
CO5	Illustrate the Response surface methods	K3

UNIT – I

STRATEGY OF EXPERIMENTATION: Guidelines for designing experiments, sampling and sampling distributions, hypothesis testing, choice of sample size. Experiments with single factor**:** Analysis of variance, analysis of the fixed effects model, model adequacy checking, sample computer output, regression approach to the analysis of variance.

UNIT – II

FACTORIAL DESIGNS: Principles, advantage of factorials, two-factor factorial design, general factorial design, fitting response curves and surfaces.2k factorial design: 22 design, 23 design, General 2kdesign, single replicate of 2k design.

UNIT – III

TWO-LEVEL FRACTIONAL FACTORIAL DESIGNS: one-half fraction of 2K design, one-quarter fraction of 2K design, blocking replicated 2K factorial design, confounding in 2K factorial design. Three-level and mixed-level factorial design: 3K factorial design, confounding in 3K factorial design, fractional replication of 3K factorial design, factorials with mixed levels.

UNIT – IV

REGRESSION MODELS: Linear regression models, estimation of the parameters, hypothesis testing in multiple regression, confidence intervals in multiple regression, prediction of new response observations, regression model diagnostics.

UNIT – V

RESPONSE SURFACE METHODS: Introduction, method of steepest ascent, analysis of second-order response surface, experimental designs for fitting response surfaces.

TEXT BOOK:

1. D.C. Montgomery, “Design and Analysis of Experiments”, 5th edition, John Wiley and sons, 2009.

REFERENCE BOOKS:

1. D.C. Montgomery,” Introduction to Statistical Quality Control”, 4th edition, John Wiley and sons, 2001.
2. Angela Dean and Daniel Voss, “Design and Analysis of Experiments”, Springer, 1999

Semester	III	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE19
Name of the Course	**Convective Heat Transfer** Program Elective – V					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain free, forced convection and equations governing the phenomena	K2
CO2	Illustrate convection heat transfer in laminar, turbulent flows both internal & external	K3
CO3	Illustrate equations of natural convection laminar flow heat transfer	K3
CO4	Analyze equations of combined convection heat transfer in laminar and turbulent flows	K4
CO5	Explain convection heat transfer in porous media	K3

UNIT – I

Introduction to free, forced combined convection,convective heat transfer coefficient,Application of dimensional analysis to convection,Physical interpretation of dimensionless numbers.

EQUATIONS OF CONVECTIVE HEAT TRANSFER: Continuity, Navier,Strokes equation & energy equation for steady state flows,similarity,Equations for turbulent convective heat transfer,Boundary layer equations for laminar, turbulent flows,Boundary layer integral equations.

UNIT – II

EXTERNAL LAMINAR FORCED CONVECTION: Similarity solution for flow over an isothermal plate,integral equation solutions,Numerical solutions,Viscous dissipation effects on flow over a flat plate.

EXTERNAL TURBULENT FLOWS: Analogy solutions for boundary layer flows,Integral equation solutions,Effects of dissipation on flow over a flat plate.

INTERNAL LAMINAR FLOWS: Fully developed laminar flow in pipe, plane duct & ducts with other cross,sectional shapes,Pipe flow & plane duct flow with developing temperature field,Pipe flows & plane duct flow with developing velocity & temperature fields.

INTERNAL TURBULENT FLOWS: Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.

UNIT – III

NATURALCONVECTION: Boussineq approximation,Governingequations,Similarity,Boundary layer equations for free convective laminar flows, Numerical solution of boundary layer equations. Free Convective flows through a vertical channel across a rectangular enclosure,Horizontal enclosure,Turbulent natural convection.

UNIT – IV

COMBINED CONVECTION: Governing parameters & equations,laminar boundary layer flow over an isothermal vertical plate,combined convection over a horizontal plate,correlations for mixed convection,effect of boundary forces on turbulent flows,internal flows , internal mixed convective flows,Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct.

UNIT – V

CONVECTIVE HEAT TRANSFER THROUGH POROUS MEDIA: Area weighted velocity,Darcy flow model, energy equation, boundary layer solutions for 2D forced convection, Fully developed duct flow, Natural convection in porous media, filled enclosures, stability of horizontal porous layers.

TEXT BOOK:

1. Convective Heat & Mass Transfer /Kays& Crawford/TMH

REFERENCE BOOKS:

1. Introduction to Convective Heat Transfer Analysis/ Patrick H. Oosthuigen & David Naylor, MGH.
2. Convection Heat Transfer / Adrian Bejan / Wiley
3. Principles of Convective Heat Transfer / Kaviany, Massoud /Springer

Semester	III	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE20
Name of the Course	**Extraction of Energy from Waste** Program Elective – V					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain energy from waste, types of waste and energy conversion devices.	K2
CO2	Explain the methods of yield of biomass	K2
CO3	Illustrate various gasifiers of biomass	K3
CO4	Illustration various combustors of biomass	K3
CO5	Explain concepts of biogas technology	K2

UNIT – I

INTRODUCTION TO ENERGY FROM WASTE: Classification of waste as fuel, Agro based, Forest residue, Industrial waste , MSW, Conversion devices, Incinerators, gasifiers, digesters

UNIT – II

BIOMASS PYROLYSIS: Pyrolysis, Types, slow fast, Manufacture of charcoal, Methods Yields and application, Manufacture of pyrolytic oils and gases, yields and applications.

UNIT – III

BIOMASS GASIFICATION: Gasifiers, Fixed bed system, Downdraft and updraft gasifier–Fluidized bed gasifiers, Design, construction and operation, Gasifier burner arrangement for thermal heating, gasifier engine arrangement and electrical power Equilibrium and kinetic consideration in gasifier operation.

UNIT – IV

BIOMASS COMBUSTION: Biomass stoves, Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation , Operation of all the above biomass combustors.

UNIT – V

BIOGAS: Properties of biogas (Calorific value and composition) , Biogas plant technology and status , Bio energy system , Design and constructional features , Biomass resources and their classification , Biomass conversion processes , Thermo chemical conversion , Direct combustion ,biomass gasification , pyrolysis and liquefaction , biochemical conversion , anaerobic digestion ,Types of biogas Plants, Applications , Alcohol production from biomass, Bio diesel production ,Urban waste to energy conversion , Biomass energy programmed in India.

TEXT BOOKS:

1. Biogas Technology , A Practical Hand Book , Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley &Sons, 1996.

REFERENCE BOOKS:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

Semester	III	L	T	P	C	Course Code
Regulation	V21	3	0	0	3	V21TEE21
Name of the Course	**Advanced Finite Elements Methods** Program Elective – V					
Specialization	**Thermal Engineering**					

Course Outcomes:

	After successful completion of the course, the student will be able to	Knowledge level
CO1	Explain various approaches to finite element formulations	K2
CO2	Illustrate the displacement, stresses of ID elements used in Finite element analysis	K3
CO3	Differentiate various 2D elements used in Finite element analysis	K4
CO4	Illustrate the iso parametric formulation and convergence criteria	K3
CO5	Analyze the various elements in structural analysis	K4

UNIT – I

FORMULATION TECHNIQUES: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – II

ONE-DIMENSIONAL ELEMENTS: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – III

TWO DIMENSIONAL PROBLEMS: CST, LST, four nodded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions.

Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary Conditions. Heat Transfer problems: Conduction and convection, examples: - two- Dimensional fin.

UNIT – IV

ISOPARAMETRIC FORMULATION: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle, Patch test.

UNIT – V

FINITE ELEMENTS IN STRUCTURAL ANALYSIS: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

ANALYSIS OF NON LINEAR ELASTIC SYSTEMS: Introduction to nonlinear FEM, Nonlinear elastic analysis, Numerical integration for elastoplasticity.

TEXT BOOK:

1. Finite element methods by Chandrubatla & Belagondu.
2. The Finite Element Method in Engineering By Singiresu S. Rao, 5th Edition, Publisher: Butterworth-Heinemann.

REFERENCE BOOKS:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994
2. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996
4. Finite Element Analysis, P. Seshu, Publisher: PHI Learning Pvt. Ltd., New Delhi, 2012.