M.Tech. in Mechanical Engineering with Thermal EngineeringCourses

Course Contents
Academic Year 2019-20

Table of Contents

PC-MTTH101: Transport Phenomena
Course Pre-requisite:BTM 403

Course Objective:

- How to use fundamental principles of fluid mechanics to solve thermal problem.
- How to use basic principles of thermodynamics to solve thermal problem.
- How to use basic principles of heat transfer to solve thermal problem.
- How to use basic principles of mass transfer to solve thermal problem.

Course Outcome:

Upon successful completion of the course, students should be able to

1. have knowledge of advanced features of fluid mechanics, thermodynamics, heat and momentum transfer pertaining to thermo-fluid problem,
2. Understand the significance of course contentforthermo-fluid problems,
3. Apply knowledge in analysis and interpretation of thermo-fluid problem
4. Analyze and evaluate an existing thermal system and recommend their ideas.

Course Content

Module No.	Description	Hrs.
1.	Introduction to transport phenomena: Basic transport quantities in thermal system; Conservation principle of mass, momentum, energy and species; **Thermodynamics:** Thermodynamic terms; laws; energy, entropy and exergy analysis;	6
2.	**Fluid Mechanics:** Types of flow, Integral and differential form of governing equation. Navier-Stokes equation, Dimensionless form of conservation equation and their use. Common flow boundary conditions. Boundary layer	6
3.	**Turbulence:** Laminar and turbulent transport of fluid. Characteristics, RANS Equation, Turbulence models.	5
4	**Momentum Transport: Internal** Internal incompressible viscous flow –Developing and developed flow. Estimating laminar velocity profile of flow between infinite parallel plates Fully developed laminar pipe flow. Turbulent velocity profile. Head loss estimation, Flow through Non-circular ducts.	6
5	**Momentum Transport: External** External incompressible viscous flow –Blasius solution of flow over plates, Von-Karmon's momentum integral equation. Flow separation, lift and drag. Flow over cylinders and spheres.	6

6	**Energy Transport:** Thermal boundary conditions. Diffusion transport: Energy equation, conduction through plane and cylindrical surfaces, Fins, Transient conduction – lumped and distributed model. Convective transport: Energy equation, heat transfer coefficient, non-dimensional numbers, Nu correlations –external flow over flat plate, cylinders and spheres, Internal flow -developing and developed for isothermal and constant heat flux boundary conditions.	6
7	**Mass Transport:** Diffusivity and the mechanism of mass transport –Fick's law of diffusion, mass diffusivity, Mass transfer in non-stationary media, Stationary medium approximation, conservation of species for a stationary medium, boundary condition and discontinuous concentration at interfaces, Mass diffusion with homogeneous chemical reaction	5

Recommended books:

1. White, F. M. *Fluid Mechanics*, McGraw-Hill, New York, 1986.
2. Ozisik, M. Necati. *Heat transfer: a basic approach*. (1985).
3. Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey. *Fundamentals of engineering thermodynamics*.John Wiley & Sons, 2010.
4. Incropera, F.P. and Dewitt, D.P. *Fundamentals of Heat and Mass Transfer*, Wiley
5. Fox, Robert W., Alan T. McDonald, and Philip J. Pritchard. *Introduction to fluid mechanics*.Vol. 7. New York: John Wiley & Sons, 1985.
6. Cengel, Yunus A., and Michael A. Boles. "*Thermodynamics: an engineering approach*." *Sea* 1000 (1994): 8862.
7. Eckert, Ernst Rudolf Georg, and Robert M. Drake Jr. "*Analysis of heat and mass transfer*." (1987).
8. SadıkKakaç, YamanYener, Carolina P Naveira-Cotta. "*Heat Conduction",*5th Edition, (2018), CRC Press.

Course Evaluation Scheme:

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PC-MTTH102: Energy Resources, Storage and Management

Course Pre-requisite:BTM305, BTM504

Course Objective:

- To know the different energy resources
- Understand thermodynamic power cycles and the associated processes and fuels
- Understand the basic principles of nuclear energy, solar energy, fuel cells, and wind energy
- Understand the economics of energy conversion

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Develop knowledge to identify, explain and compare competing energy resources, conversion technologies on an economic and efficiency basis
2. Understand the significance of energy conversion anddevelop capability to applydifferenttools to assess the validity of energy conversion claims
3. Analyze different energy systems and related economics.
4. Evaluate different energy resources, their conversion, storage and management.

Course Content

Module No.	Description	Hrs.
1.	**Current Energy Scenario:** Globaland India **Conventional Energy Resources** – Efficient use of Solid Fuels, Manufactured Fuels, Agro Fuels, Indian coals, Petroleum, Refining and Other Conversion Processes, Nature of Indian Crudes & Petroleum Refining in India, Refinery Gas, LPG, pet coke.	8
2.	**Non – conventional Renewable Energy Sources** - Solar Energy, Nuclear Power, Energy from Biomass, Wind Power, Tidal Power, Geothermal Energy.	6
3.	**Analyzing Tools for energy conversion:** Pinch analysis, energy entropy and exergy analysis.	6
4.	**Thermal Energy Storage**: Types and Material Selection, Sizing of Storage system for various applications, Hydrogen Storage, Storage in vehicles, Chilled Energy storage for HVAC and Refrigeration Application.	6
5.	**Electrochemical energyStorage** –Major Types of Electrochemical Cells. Lead-Acid Batteries, Negative Electrodes in Lithium Systems, Positive Electrodes in Lithium Systems, Primary, Non-rechargeable Batteries, Energy Storage for Medium-to-Large Scale Applications	4
6.	**Energy Economics**Economic analysis of power generation-Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples –procedure for optimized system selection and design – load curves - sensitivity analysis –regulatory and financial frame work of power generation.	6
7.	**Energy Auditing**–Definition, need, types of energy audit methodologies,	6

	barriers. Role, Duties and responsibilities of energy managers and auditors. Energy audit questionnaire, Energy Conservation Act 2003.	

Recommended Books:

1. Weston, Kenneth C. "*Energy conversion–the ebook*." University of Tulsa(2000).
2. A Culp, Jr ,Principles of Energy Conversion, 2nd ed., McGraw-Hill, Inc., 1991.
3. Smith, Craig B., and Kelly E. Parmenter. *Energy, Management, Principles: Applications, Benefits, Savings*. Elsevier, 2013.
4. Hamies, *Energy Auditing and Conservation; Methods, Measurements, Management and Case study*, Hemisphere, Washington, 1980.
5. Witte, Larry C, *Industrial Energy Management and Utilization*, Hemisphere Publishers, Washington, 1988.
6. S. P. Sukhatme, Solar Energy.
7. Huggins ESS

Course Evaluation Scheme:

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PC-MTTH103: Thermal Laboratory-I
Course Pre-requisite: BTM 305, BTM403

Course Objective:

The course intends to provide opportunity to student for performing actual experiments on heat transfer mechanism and related phenomenon.

Course Outcomes:

1. Student will be able to apply the skill learnt in theory subjects to do hands on experiments.
2. Students will be able to analyze and do basic calculations on thermos-fluid related problems.
3. Students will be able to collect, analyze and interpret the data.
4. Student will be able to analyze and evaluate different thermal equipment's.

Course Content:

Laboratory experiments on topics such as:

1. Transient heat transfer
2. Convective heat conduction
3. Plate heat exchanger
4. Shell and Tube type heat exchanger
5. Fluidized bed combustion system
6. Performance on cooling tower

Practical Examination shall be based on above mentioned experiments and oral.

PC-MTTH104: Thermal Laboratory-II

Course Pre-requisite: PC-MTTH102

Course Objective:

The course intends to provide opportunity to student for performing actual experiments or virtual labs on transport phenomena and energy storage.

Course Outcomes:

1. Students will acquire hands on experience on the various test rigs, experimental set up.
2. Students should be able to measure the various technical parameters by instrument and by mathematical relationship.
3. Students will be able to identify the effect of various parameters on the system and able to co-relate them.

Course Content:

Laboratory experiments on topics such as:
Multiphase Flow phenomena
Laminar boundary layer
Turbulent boundary layer
Energy analysis tutorials
Energy storage systems
Visit to non-conventional power plant

Practical Examination shall be based on above mentioned experiments and oral.

MC-MT001: Research Methodology& IPR

Course Pre-requisites: BTM898

Course Objectives

1. To develop an ability to identify, formulate research problem.
2. To develop an ability to apply knowledge of research methodology to engineering Problems.
3. To develop an ability to investigate the phenomenon in a critical manner.
4. Develop critical thinking to find business opportunities and to solve questions related to industries.
5. To get knowledge on various kinds of research questions and research designs

Course Outcomes

Learner shall be able.

1. To carry out literature survey methodically
2. To formulate the problem statement using research considerations.
3. To carry out data collection systematically and to carry out data analysis using various data analysis tools
4. To be able to investigate what can be patented .

Course Content:

Module No.	Description	Hrs.
1	Introduction to Research Definition of Research, How to define the research problem Various considerations for defining research problem	**8**
2	Literature Survey Search Engines, Source of Literature, Identifying the appropriate period for Literature, Key words Primary key words, secondary key words, research Gaps	**4**
3	Data collection Techniques • Interviews techniques, Structured semi-structured, unstructured interviews • Sampling Techniques, simple random sampling, Sample Size Calculation, Sample Design Case study method	**6**
4	Data Analysis Hypothesis , Null and alternate hypothesis statements, Z test, F test, T Test, Chi square Test, Annova	**6**
5	Simulation techniques • Monte Carlo Simulation, Simulation exercises for Product Design , Service Design , System Design	**6**
6	Intellectual property right Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	**6**
7	New Developments in IPR: Administration of Patent System. New	**6**

	developments in IPR; IPR of Biological Systems	

Recommended Books:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers, Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi,¬ Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners,¬ (2nd ed), Singapore, Pearson Education.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Sr No.	Examinations	Module
1	T1	1, 2 and part of 3
2	T2	3 , 4 and 5
3	End Exam	All modules 1 to 7

PC-MTTH201: Design of Heat Exchanger
Course Pre-requisite: BTM501

Course objectives:

- It provides exposure to different kind of heat exchanger, their working and selection for a given application.
- Students will come to know about different techniques of heat exchanger analysis.
- Student will be able to learn construction and thermal design methodology of shell and tube, Plate and compact heat exchanger

Course outcomes:

Upon successful completion of the course, students should be able to

1. have knowledge of different techniques of heat exchanger analysis and be aware of common heat exchangers with their constructions, working principles andperformance parameters,
2. Understand the significance of contents of the course for the design and development of heat exchangers.
3. Apply their knowledge for thermal design of a heat exchanger such as shell and tubes, compact and plate heat exchanger,
4. Analyze an existing heat exchanger with reference to rating and sizing.

.

Course Content

Module No.	Description	Hrs.
1	**Introduction to Heat Exchangers:** Mechanism of heat exchange, Classification, Geometrical construction of Tubular, plat and compact heat exchanger, Applications and Selection.	04
2	**Basic Design Methods of Heat Exchanger:** Heat exchanger design calculation- heat transfer and pressure drop calculation including pumping power, Heat exchangers design methodology- rating and sizing.	06
3	**Fouling of Heat Exchangers:** Effect of fouling, Process of Fouling, Prediction of fouling, Operation of heat exchanger under fouling, Controlof fouling and cleaning of heat exchanger..	04
4	**Shell And Tube Heat Exchanger:** Basic components, TEMA and other standards, Basic design methodology – heat transfer and pressure drop calculation, Shell side calculation- KERN'S and Bell-Delaware Method.	06
5	**Compact Heat Exchanger:** Plate fin and tube fin heat exchanger- application, construction and heat transfer and pressure drop calculation.	06
6	**Plate Heat Exchangers, Helical Coil Heat Exchangers and Air Cooled Heat Exchanger:** Application, mechanical features, operational characteristics, flow	08

	arrangement, heat transfer and pressure drop calculation.	
7	**Heat Exchangers for Phase Change Applications:** Condensers and Evaporators, Features, types, construction, working, design and operational considerations, and thermal analysis.	06

Recommended books:

1. Kakac, Sadik, Hongtan Liu, and AnchasaPramuanjaroenkij. *Heat exchangers: selection, rating, and thermal design*. CRC press, 2012.R K Shah, Fundamental of Heat Exchanger Design
2. Kays and London, *Compact heat exchanger*, Krieger Pub Co,., 1998
3. Hesselgreaves, John E. *Compact heat exchangers: selection, design and operation*. Gulf Professional Publishing, 2001.T. Taborek, G.F. Hewitt and N. Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980
4. Taborek, Jerry. "Industrial Heat Exchangers: A Basic Guide By G. Walker, Hemisphere Pub L. Corp. Washington Dc, 1982, $41.50, 408 Pg." *AIChE Journal* 29, no. 2 (1983): 349-350.
5. Fraas, Arthur P. *Heat exchanger design*. John Wiley & Sons, 1989.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PC-MTTH202: Computational Fluid Dynamics

Course Prerequisite: PC-MTTH101, BTM403, BTM501

Course Objective:

- To learn the methodology of numerical analysis of heat and fluid flow problems.
- To learn methods of direct and iterative methods of solving linear equations.
- To learn methods of domain discretization – FDM and FVM.
- To learn about the numerical treatment of diffusive, convective and transient heat transfer.
- To learn about the numerical treatment of fluid flow problem.

Course Outcome:

Upon successful completion of the course, students should be able to

1. have good knowledge and understanding of computational aspects of fluid dynamics,
2. Describe need of modeling and simulation and its overall methodology of execution,
3. Apply their knowledge to solve a system of linear algebraic equation using standard direct and iterative technique,
4. Examine, analyze and formulate a thermal and fluid flow problem using techniques of computational fluid dynamics

Course Content

Module No.	Description	Hrs.
1.	**Introduction to Modeling and Simulation:** Experimental and Analytical approach, Physical, Mathematical and Numerical modeling, Model validation, Simulation. Introduction and Methodology of Numerical simulation. Computational fluid dynamics and its application, merits and limitations	**06**
2.	**Solution of Linear Algebraic Equation:** Direct methods: Gauss Elimination, LU decomposition, TDMA etc. Iterative methods: Jordon method and Gauss Seidel Method, SOR and SUR, ill-conditioned system, condition number.	**06**
3.	**Mathematical Modeling:** Integral and differential form of governing equation of steady and unsteady incompressible flow and heat transfer system. Mathematical nature of PDE, Initial condition and boundary conditions (thermal and flow).	**06**
4	**Discretization Schemes:** Introduction to Finite difference method, Finite Element Method and Finite Volume Method. Developing discretized form of partial derivative terms of different order by FDM and FVM techniques. Central, Forward, Backward difference,Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.	06
5	**Numerical Modeling of Diffusive Heat Transfer:** Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one- dimensional problem, Two-dimensional Transient Problems. Stability condition under different condition.	**06**

6	**Numerical Modeling of Convective Heat Transfer:** Steady One-Dimensional and Two-Dimensional Convection - Diffusion, Unsteady one-dimensional convection - Diffusion, Unsteady two-dimensional convection - Diffusion Upwind Schemes- Central Difference, First order, second order, QUICK and Power law scheme.	**06**
7	**Numerical Modeling of Fluid Flow:** Complexities in numerical modeling of fluid flow. Common flow modeling technique- MAC, SIMPLE, SIMPLEC and PISO. Turbulence models: Algebraic Models - One equation model, K-ε Models, K-ω Models, SST Model, Standard and High and Low Reynolds number models.	**06**

Recommended books:

1. Muralidhar, K., Sundararajan,T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House ,New Delhi1995.
2. Ghoshdastidar, ParthaSarathi. *Computer Simulation of flow and heat transfer*. Tata McGraw-Hill Publishing Company Limited, 1998.
3. Patankar, Suhas. *Numerical heat transfer and fluid flow*. CRC press, 1980.
4. Taylor, Cedric, and T. G. Hughes. *Finite element programming of the Navier-Stokes equations*.PineridgePressLtd, 1981.
5. Anderson, Dale Arden, John C. Tannehill, and Richard H. Pletcher. "Computational fluid mechanics and heat transfer." (1984).
6. Fletcher, Clive. *Computational techniques for fluid dynamics 2: Specific techniques for different flow categories*. Springer Science & Business Media, 2012.
7. Bose,T.K.,*Numerical Fluid Dynamics*,Narosa Publishing House, 1997

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PC-MTTH203: Thermal Laboratory III

Course Pre-requisite: PC-MTTH202

Course Objective:

- To learn 2-D and 3-D modelling
- To learn hand on simulation of fluid flow and heat transfer problems.
- To do hand on simulation of internal and external flow.
- Derive results from numerical simulation

Course Outcomes:

1. Students will be able to do 2-D and 3-D modelling.
2. Student will be able to apply the skills learnt in theory subjects to do hands on simulations of fluid flow and heat transfer problems.
3. Students will be able to do simulations of internal and external flow.
4. Students will be able to analyze results of numerical simulation of thermal and fluid flow problems.

Course Content:

Laboratory experiments on topics such as:

1. 2-D Modelling and meshing
2. 3-D Modelling and meshing
3. Simulation of conductive steady state heat transfer
   a) 2-Dimensional
   b) 3-Dimensional
4. Simulation of convective heat transfer
   a) 2-Dimensional
   b) 3-Dimensional
5. Internal flow simulation
6. External flow simulation

PC-MTTH204: Thermal Laboratory IV
Course Pre-requisite: EC-MTTH201, EC-MTTH202

Course Objective:

- To learn hand on simulation of fluid flow problems.
- To learn 2-D and 3-D modelling and meshing.
- Derive results from numerical simulation

Course Outcomes:

1. Students will acquire hands on experience on the various test rigs, experimental set up.
2. Students should be able to measure the various technical parameters by instrument and by mathematical relationship.
3. Students will be able to identify the effect of various parameters on the system and able to co-relate them.

Course Content:

Laboratory experiments on topics such as:

1) Simulation of double pipeHeat Exchanger
2) Simulation of shell and tube heat exchanger
3) Simulation of helical coil Heat Exchanger
4) Simulation of plate fin heat exchanger
5) Simulation of tube fin heat exchanger
6) Simulation of heat transfer with phase change
7) Simulation of flow with turbulence model
8) Simulation of flow with k-ω model
9) Simulation of flow with k-ε model
10) Simulation of flow with low standard high and low Reynold's number model

Practical examination is to be conducted based on above experiments and oral.

PC-MTTH299: Seminar/ Mini Project
Course Pre-requisite: Nil

Course Objective:
The course intends to provide opportunity to the student for self-learning to beyond syllabus contents related to thrust area of engineering and technology. This will inculcate the habit of lifelong learning.

Course Outcomes:
1. Student will be able to apply the skill of presentation and communication techniques.
2. Student will be able to use the knowledge of the fundamentals of subjects to search the related literature.
3. Student will be able to analyze and evaluate the available resources and to select/design/create most appropriate one.

Course content (Seminar):

Sr.no.	Description	Hrs.
1	The student gathers and presents information/data about seminar topic allotted to him/her. The report and presentation shall include review of literature, case studies if applicable and findings about recent trends in the area of seminar topic. On completion of the work the student shall prepare a report and will give a Seminar on the report.	**48**

Course Content (Mini Project):

Sr.no.	Description	Hrs.
1	The mini project work extends for a single semester and exposes the student to develop and present his/her work related to specific topic. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report.	**48**

Guidelines for Seminar-II/Mini Project
1. Seminar/mini project should be based on thrust areas in Mechanical Engineering (Machine Design aspect is appreciated)
2. Students should do literature survey and identify the topic of seminar/mini project and finalize inConsultation with mentor/Guide/Supervisor.
3. Students should use multiple literature and understand the topic and compile the report in standard format as in front of Examiners.

Assessment Guidelines:
1. Quality of Literature survey and Novelty in the topic
2. Relevance to the specialization
3. Understanding of the topic
4. Quality of Written and Oral Presentation

EC-THPE01: Refrigeration System Design

Course Pre-requisite: BTM601

Course Objective:

- To know about the different refrigeration cycles
- Understand the hardware related to the refrigeration systems
- Understand how the different components harmonize together
- Understand the importance of the auxiliary systems.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. have a review of refrigeration cycles and alternate refrigeration system to enhance their knowledge of refrigeration, and will be able to explain them,
2. Understand and solve the problem of component selection, refrigerant related issues and system balancing and control
3. Apply their knowledge to appraise different refrigeration system components and environmental issues caused by refrigerant.
4. Analyze a refrigeration problem to carryout necessary calculation.

Course Content

Module No	Description	Hrs.
1	**Refrigeration Cycles – Analysis** Evolving vapour compression cycle from basic Carnot cycle -analysis of multi- pressure systems – cascade systems	05
2	**Refrigeration System Components** Compressors, condensers-evaporators- expansion devices- types, performance, and their selection, **condensers:** estimation of heat transfer coefficient – fouling factor – friction factor – design procedures – Wilson plots – designing different types of condensers – bis standards – optimization studies – design of evaporative condensers. **evaporators:** design procedure – thermal stress calculations – matching of components	07
3	**Refrigerants-** Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact- ODP, GWP, TEWI Montreal/Kyoto protocols, Paris Agreement, Phase out plans, -eco-friendly Refrigerants, Natural Refrigerants	05
5	**Refrigeration System Design** Estimation of cooling load – systemcold storage, cold chain, low temperature chillers, equilibrium, balancing and matching of components – cycling controls – different defrosting and capacity control methods – electronic controls in refrigerators	08
4	**Refrigeration System Components** System Capacity control – piping – Oil return – Oil separators – Different types- Refrigerant driers- strainers – Receivers – Accumulators – Low pressure receivers – Refrigerant Pumps. Cooling Tower components-Air Washers – Spray ponds.	05
6	**Alternate Refrigeration Systems**– Aqua Ammonia & Li-Br Systems	06

	Thermo-Electric Refrigeration- Solar vapour absorption refrigeration system – Pulsetuberefrigeration	
7	**Tools**-Different Types of Refrigeration Tools – Evacuation and Charging Unit – Recovery and Recycling Unit.	06

Recommended books:

1Dossat, Roy J. *Principles of refrigeration*.No. 621.56 D68 1978. 1978.
2. Stoecker, Wilbert F. *Refrigeration and air conditioning*. Vol. 3. London: McGraw-Hill, 1958.
3. Ananthanarayanan, P. N. *Basic refrigeration and air conditioning*. Tata McGraw-Hill Education, 2013.
4. Goshnay W.B., Principles and Refrigeration, Cambridge, University Press, 1982.
5. Langley, Billy C., Solid state electronic controls for HVACR, Prentice-Hall 1989.
6. AHSRAD

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE02: Advanced Combustion Techniques

Course Pre-requisite: BTM604

Course Objectives:

The objective of this course to make student aware of-

- the fundamental of combustion phenomena in general,
- the different combustion process, its thermodynamics and kinetics,
- the combustion mechanism in different types of combustion,
- the burner design for efficient combustion,
- different combustion models.

CourseOutcomes:

Upon successful completion of the course, students should be able to

1. have knowledge of fundamentals of combustion, thermodynamics of combustion, different combustion processes,
2. understand the significance of contents of the course for combustion technology,
3. be able to apply knowledge to solve simple/advance numerical problem of a combustion system,
4. be able to analyze and design a combustion system such as furnace and burner

Course Content

Module No.	Details	Hrs.
01	**Stoichiometry** Combustion Reactions, Gravimetric & Volumetric Analysis,Stoichiometric Relations, Theoretical air required for complete combustion of solid, liquid and gaseous fuels	06
02	**Combustion Process (Stoichiometry)** Combustion Stoichiometry: Application of General Methods, Rapid Methods (Use of Fundamental Formulae) and Empirical Co-Relations for solution of combustion problems, Combustion problems involving Loss of Combustibles with flue gases and ash, Air Ratio, Combustion calculations involving humid air in place of dry air for combustion.	06
03	**Combustion Process (Thermodynamics)** Heat of Combustion, Hess's Law, Combustion Efficiency, Enthalpy of Combustion System & calculations using these concepts, Equilibrium Constants of Combustion Reactions, Phenomenon of Dissociation, Degree of Dissociation, Enthalpy-Temperature (h-t) Diagrams, Concepts of Theoretical, Adiabatic, Actual& Maximum Adiabatic Flame Temperature, Combustion problems based on these concepts.	06
04	**Combustion Process (Kinetics)** Nature of Combustion Process, Types of Combustion Processes: Combustion with Stationary Flames, Surface Combustion, Submerged Combustion, Combustion with Explosion flame, Pulsating Combustion, Slow Combustion, Combustion of Solid Fuels on grate, Mechanism of Combustion Reactions:- Chain Reaction, Thermal Mechanism, Hydrogen-Oxygen Reaction, Combustion of Elementary Carbon.	06

05	**Ignition** Concept of Ignition, Spontaneous Ignition Temperature (SIT):- Influencing factors, Methods of determination, Flame Propagation, Velocity of Flame Propagation:-Influencing Factors, Methods of measuring, Limits of Inflammability:-Influencing Factors, Methods of determination, Combustion Problems to determine Limits of Inflammability, Structure & Nomenclature of Flames, Types of Flames, Flame Stability:- Influencing Factors, Methods.	06
06	**Burners for Combustion Process** Detailed Classification of Gas Burner & Oil Burners with constructional features, design considerations, Advantages, Limitations & Applications, Coal Burning Equipment, Pulverized Coal Firing, Cyclone Firing, Fluidized bed Combustor, Recuperative & Regenerative Burners.	06
07	**Combustion Models and Modeling** Classification, zero-dimensional modeling, quasi-dimensional modeling, multidimensional, comparison of different combustion systems, combustion efficiency, applications Different standard Combustion Models	06

Recommended Books:-

1. Sarkar, Samir. *Fuels and combustion*. Universities Press, 1974.
2. Mishra, D. P. *Fundamentals of combustion*. PHI Learning Pvt. Ltd., 2007.
3. Bhatt, B. I., and S. M. Vora. *Stoichiometry:(si units)*. Tata McGraw-Hill Pub.Co., 1996.
4. Oppenheim, A. K. *Advanced combustion methods*: Felix J. Weinberg, Editor, Academic Press, New York, 1986, (1988)
5. Kuo, Kenneth K. "Principles of combustion." (1986).

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE03: Fuel Cells

Course Pre-requisite: BTM305, BTM501

Course Objectives:

- To understand the basics of Fuel Cell operation
- To know how the fuels are prepared to be used in fuel cells
- Know about different applications

Course Outcomes:

Upon successful completion of the course, students should be able to

1. have good knowledge and understanding of Fuel cells,
2. Describe working principle and process of a fuel cell storage system,
3. Express different methods to preparing and processing fuel for fuel cell,
4. Use and identify application of fuel cell with knowledge to new generation fuel cells.

Course Content

Module No.	Description	Hrs.
1	**Introduction**- Fuel Cell Basic- Physics, Power Generation , Loss Mechanism, Equivalent Circuit , Power Conditioning,Fuel Cell Systems Storage System	05
2.	**Voltage Regulation**- DC/DC and DC/AC Converters., Power Transistors DC/DC,DC/AC. Small Scale Systems, Increased Available Power, Size and Weight Reduction	06
3	**Solid Oxide Fuel Cells**- Materials, SOFC stack, Micro-tubular SOFC,PEM Fuel Cells, Components and Their Properties,Stack Design Principles, System Design .	06
4	**Fuel Cell Applications**- Residential Application, Power Plant and Grid Support , Auxiliary Power Unit Automotive Applications, Stationary Power Applications, Portable Power Applications	05
5	**Fuels and Fuel Processing** - Feedstocks for H_2 Production - Natural Gas- Liquid Petroleum Gas, Liquid Hydrocarbon Fuels: Gasoline and Diesel Alcohols: Methanol and Ethanol Ammonia BiomassFuel Processing for Fuel Cell Application Desulfurization Fuel Reforming.	06
6	New Generation of Catalyst Layers for PEMFCs Basedon Carbon Aerogel Supported Pt Catalyst (CASPC)	06
7.	**Microbial Fuel Cells** Introduction- Historical Perspective -MFC Performance -MFC Applications Microbiology Overview-Bacterial Structure Nutrient Transport	06

Recommended books:

1. Sammes, Nigel, ed. *Fuel cell technology: reaching towards commercialization*. Springer Science & Business Media, 2006.
2. Handbook of Fuel Cells, Wiley on line library
3. Viswanathan, Balasubramanian, and M. AuliceScibioh. *Fuel cells: principles and applications*. CRC PressILlc, 2007.

4. Fuel Cell Systems Explained (Second Edition) by James Larminie, Wiley,2003
5. Kordesch, Karl, and Günter R. Simader. *Fuel cells and their applications*. (1996).

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE04: Design and Analysis of Thermal Systems

Course Pre-requisite: BTM403, BTM501, BTM505

Course Objective:

- To learn overall design requirement and methodology of a thermal system.
- To learn tools and techniques of analysis of a thermal system.
- How to do modeling of a thermal system.
- To techniques of economic analysis of thermal system.
- How to do optimization of a thermal system

Course Outcome:

Upon successful completion of the course, students should be able to

1. have knowledge of different aspects of designing of a thermal system,
2. Identify and examine a design problem associated to a thermal system,
3. Understand basics of modeling and their associated techniques,
4. Explain economic aspect of designing and able to apply different techniques of optimization applicable to thermal system.

Course Content

Module No.	Description	Hrs.
1.	Requirement of engineering design, Other similar terms: Analysis, Synthesis, Selection and Optimization. Characteristics of a thermal system, types and analysis.	6
2.	Formulation of the Design Problem, Conceptual Design, Steps in the Design Process, Computer-Aided Design, Material Selection	6
3.	**Modelling Basics:** Importance of Modelling in Design, basic features of modelling, Types of Models- Analogue, Mathematical, Physical and Numerical. Mathematical modelling – general procedure, final model and validation.	6
4.	**Modelling Techniques:** Physical modelling and dimensional analysis, Curve fitting – exact and best fit. Synthesis of Different Design Steps – Initial design, Design strategies- commonly used design approach and Iterative design procedure.	6
5.	**Economic Considerations:** Calculation of interest- simple, compound, continuous compounding and effective. Worth of money as function of time. Types of payments. Bonds and stocks, Taxes and depreciations. Cost comparison and rate of return. Application to thermal system.	5
6.	**Optimization- Introduction:** Need of optimization, Basic concepts- Objective function, constraints, mathematical formulation for optimization.	5
7.	**Methods of Optimization:** Calculus method, Search method and Geometrical programming Practical aspect of Optimal design – choice of variables, sensitivity analysis, dependence on objective function, multi-objective optimization.	6

Recommended books:

1. Jaluria, Yogesh. *Design and optimization of thermal systems*. CRC press, 2007.
2. Stoecker, W.F. Design of Thermal Systems, McGraw-Hill, New York.
3. Dieter, G.E.,*Engineering Design: A Materials and Processing Approach*, McGraw-Hill, 2008.
4. Janna, William S. *Design of Fluid Thermal Systems-SI Version*. Cengage learning, 2010.
5. Rieder, W.G. and Busby, H.R. Introductory Engineering Modelling Emphasizing differential Models and Computer Simulation, Wiley, 1986.
6. Collier, Courtland A., and William Burl Ledbetter. *Engineering economic and cost analysis*. Harpercollins College Division, 1988.
7. Fox, R.L. *Optimization Methods for Engineering Design*, Addison-Wesley, 1971.
8. Rao, Singiresu S., and S. S. Rao. *Engineering optimization: theory and practice*. John Wiley & Sons, 2009.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE05: Fundamentals of Gas Dynamics

Course Pre-requisite:–BTM305, BTM403, BTM504

Course Objectives:

- To understand fundamental of gas dynamics
- To know types of compressors and turbines used in aircrafts
- Know different jet propulsion cycles.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Understand fundamental of gas dynamics
2. Understand working of compressors, turbines etc.
3. Understand working of jet propulsion cycles.
4. Able to do analysis of jet propulsion systems.

Course Content

Module No.	Description	Hrs.
1.	Introduction, Cycles, Performance characteristics and improvement, Gas dynamics	05
2.	Centrifugal, axial and mixed flow compressor, principles and characteristics	05
3.	Turbine construction, Blade materials, manufacturing techniques, blade fixing, problems of high temperature operation, blade cooling	06
4	Practical air cooled blades Combustion Systems, various fuels and fuel systems	05
5.	Jet propulsion cycles andtheir analysis, parameters affectingperformance,	05
6	Thrust augmentation, environmental considerations	05
7	Applications of gas dynamics in aeroplanes.	05

Recommended books:

1.H Cohen, GFC Rogers and HIH Saravanamuttoo, “Gas Turbine Theory”, Pearson Education,2000.
2.V. Ganesan, “Gas Turbines”, Tata McGraw Hill, 2003.
3.S.M.Yahya “Turbines, Compressors and Fans”, Tata McGraw Hill, 1992.
4.Vincent “The theory and design of Gas Turbine and Jet Engines”, McGrawHill, 1950.
5. W WBathic, “Fundamentals of Gas Turbines”, John Wiley and Sons.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE06: Hydraulic and Pneumatic control systems

Course Pre-requisite: BTM403, BTM503, BTM505

Course Objectives:

- To understand fundamental principles of hydraulic and pneumatic machines
- Know about design and operation of hydraulic and pneumatic machines
- Know different components used in hydraulic and pneumatic machines

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Have good knowledge and understanding of hydraulic and pneumatic machines
2. Identify hydraulic and pneumatic components
3. Ability to design hydraulic circuits
4. Ability to design pneumatic circuits.

Course Content

Module No.	Description	Hrs.
1.	Introduction: - Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids Basics of Hydraulics – Pascal's Law- Principles of flow – Work, Power and Torque. Properties of air– Perfect Gas Laws.	05
2.	Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps, Hydraulic Actuators: Cylinders – Types and construction.	06
3.	Hydraulic motors Control Components: Direction control, Flow control and Pressure control valves- Types, Construction and Operation- Applications – Types of actuation. Accessories: Reservoirs, Accumulators, Intensifiers, Pressure Switches- Applications- Fluid Power ANSI Symbol.	06
4	Industrial hydraulic circuits- Regenerative, Pump Unloading, Double-pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Hydrostatic transmission, Accumulators, Electro hydraulic circuits, Mechanical Hydraulic servo systems.	06
5.	Pneumatic Systems: Compressors, Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Servo systems. Introduction to Fluidics, Pneumatic logic circuits.	06
6.	Design of Hydraulic Circuits: Design of circuits using the components of hydraulic system for Drilling, Planning, Shaping, Punching, Press. – Selection, fault finding and maintenance of hydraulic components- Sequential circuit design for simple application using cascade method	06

7.	Design of pneumatic circuits: Electro pneumatic circuits. Selection criteria of pneumatic components – Installation fault finding and maintenance of pneumatic components. Microprocessor and PLC- Applications in Hydraulic and Pneumatics- Low cost Automation – Hydraulic and Pneumatic power packs.	06

Recommended books:

1. Anthony Esposito," Fluid Power with Applications", PHI / Pearson Education, 2005..
2. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.
3. Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2001
4. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.
5. Micheal J, Pinches and Ashby, J.G., "Power Hydraulics", Prentice Hall, 1989.
6. Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
7. Srinivasan. R, "Hydraulic and Pneumatic Control", IInd Edition, Tata McGraw - Hill Education,

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE07: Air-Conditioning System Design

Course Pre-requisite: BTM601

Course Objectives:

- Understand basics of air conditioning
- Estimate the capacity of an air conditioning system
- Select the equipment for the system

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Develop knowledge and understanding of air conditioning system design,
2. Describe the fundamental of psychometrics and different air condition system
3. Analyze an air conditioning system, carryout related calculation and select appropriate components
4. Apply knowledge their knowledge to solve many real life problems of air conditioning system

Course Content

Module No.	Description	Hrs.
1.	**Psychometrics:** Introduction, properties of air and water vapour mixture, psychrometric chart and its use in air-conditioning, air and human comfort.	**04**
2.	**Air-conditioning system:** Window type, package type, split type, central units-direct and indirect, VRF systems, construction details, specification and testing, evaporative cooling system.	**06**
3.	**Heat Load Calculations:** Load calculation for residential, commercial and industrial applications.	**08**
4.	**System selection:** Selection of Chillers, VRF, Packaged etc. based on heat load calculation of module 3 including details of each of the above systems.	**06**
5.	**Air distribution**: air distribution devices-air circuits-design of supply system, noise consideration	**06**
6	**Air-conditioning controls:** Instruments and sensors for air conditioning equipment's and their incorporation with Building Management System	**06**
7	**Trends in HVAC:** Green Building, Net Zero Buildings, Radiant Cooling, Chilled Beams, Direct outdoor air systems Recent.	**06**

Recommended books:

1. Edward Pita, *Air-conditioning-An Energy Approach*, Pearson Press, 2002
2. Wang, Shan Kuo, and Shan K. Wang. "Handbook of air conditioning and refrigeration." (2000).
3 Carrier Air Conditioning Co., Handbook of Air Conditioning Systems design, McGraw Hill.

4. Langley, Billy C. Refrigeration and Air Conditioning Ed. 3, Engle wood Cliffs (N.J) Prentice Hall, 1995.
5. ASHRAE, Handbooks. All volumes
6. Jones, William Peter. Air conditioning engineering.Routledge, 2007.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE08: Advanced Turbo machinery

Course Pre-requisite: PC-MTTH101

Course Objective:

- To make students familiar with different type of common turbo machinery involving gas.
- To impart knowledge about construction, working and performance of centrifugal, axial and radial turbo machines.
- To understand the blade theory and apply it to develop understanding of turbo machines.

Course Outcome:

Upon successful completion of the course, students should be able to

1. Develop an advance knowledge and understanding of turbomachinery,
2. Explain the working principle and different terminology used in turbo machinery
3. Compare different system and select an appropriate turbo machines for a given application
4. Organize his understanding and apply for the analysis a given turbo system

Course Content

Module No.	Description	Hrs.
1	**Introduction:** Introduction to turbo machinery, Classification and Selection, Dimensional analysis, Model testing, Prototype and model efficiency	**06**
2	**Energy transfer in turbo-machines:** Basic thermodynamics and fluid mechanics for turbo machines. Different efficiency terms, Energy transfer in turbo machines, Euler Turbine Equation, Component of energy transfer. Specific speed	**06**
3	**Blade theory:** Aero-foil Section, Drag and lift, Energy transfer in terms of lift and drag, Blade terminology, Cascade Nomenclature, Turbine Cascade Nomenclature, Cascade testing and curves, Cascade lift and drag coefficient, Losses in cascade.	**06**
4	**Centrifugal compressor and fans:** Construction, working, velocity diagram, slip factor, energy transfer, Stage pressure rise and loading coefficient, pressure coefficient, Diffuser, Degree of reaction, Effect of blade shape on performance, Pre-whirl, Centrifugal compressor characteristics-Surging, Stall and choking, characteristic curves, losses	**06**
5	**Axial compressor and fans:** Advantages of axial flow turbo system, Construction and working principle, Stage work, pressure rise, Range of operation, efficiency, Pressure coefficient and Reaction ratio, characteristic curves, Multistage compression	**06**
6	**Axial flow and radial flow gas turbines:** Construction and working, Velocity triangle and work output, Blade loading	**06**

	coefficient, degree of reaction, stator and rotor losses. Efficiency	
7.	**Power transmitting turbo-machines:** Introduction, Hydraulic coupling, working principle, efficiency, slip, Torque converter, Characteristics of fluid coupling and converter.	**06**

Recommended books:

1. Stepanoff A.J. Turboblowers, John Wiley & sons, 1970.
2. Gorla, Rama SR, and Aijaz A. Khan. *Turbomachinery: design and theory*. CRC Press, 2003.
3. Austin, H. Chruch. "Centrifugal pumps and blowers." (1980).
4. Dixon, S. Larry, and Cesare Hall. *Fluid mechanics and thermodynamics of turbomachinery*.Butterworth-Heinemann, 2013.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE09: Advanced Fluid Dynamics

Course Pre-requisite: BTM403

Course objectives:

- To learn different governing equations in fluid dynamics
- To understand exact solution of Navier-Strokes equations and potential flow theory.
- To learn laminar boundary layer theory and characteristics of turbulent flows
- To know about experimental techniques in fluid dynamics

Course outcomes:

Upon successful completion of the course, students should be able to

1. The student shall be able to understand and define the fluid flow problems along with range of governing parameters
2. The students shall be eligible to take a fluid flow problems of industrial base
3. The students shall be able to device experiments in the field of fluid mechanics
4. The students shall be able to understand different flow patterns and differentiate between different flow regimes and its effects.

Details Syllabus:

Module No.	Details	Hrs.
01	**Governing equations:** Governing equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities	08
02	**Exact Solutions of Navier-Stokes Equations**: Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows.	08
03	**Potential Flow:** Kelvin's theorem, Irrotational flow, Stream function-vorticity approach,	06
04	**Laminar Boundary layers:** Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations	06
05	**Turbulent Flow**: Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution	06
06	**Experimental Techniques:** Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers,	04
07	**Instruments:** Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry	04

Recommended books:

1. Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha Science International, 2005
2. Irwin Shames, Mechanics of Fluids, , McGraw Hill, 2003
3. Fox R.W., McDonald A.T , Introduction to Fluid Mechanics, John Wiley and Sons Inc, 1985
4. Pijush K. Kundu, Ira M Kohen and David R. Dawaling, Fluid Mechanics, Fifth Edition, 2005

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE10: Experimental Analysis and Instrumentation

Course Pre-requisite: BTM404

Course objectives:

- To learn different techniques of instrumentation involved in thermal quantity measurement.
- To understand the static and dynamic behavior of a measuring system.
- To learn different kind of errors involved in experimentation and their analysis.
- To know about the transducers for different types of thermo-physical quantities.

Course outcomes:

Upon successful completion of the course, students should be able to

5. have good knowledge and understanding of experimental analysis and Instrumentation related to thermal system,
6. Apply general concept of measurement, statistical analysis of experimental data and performance analysis of a measuring system
7. Examine a given experimental requirement and recommend a correct measurement procedure and device pertaining to kinetic and thermo-physical measurement
8. Understand the integration of digital to analog way of measurement

Details Syllabus:

Module No.	Details	Hrs.
01	**General Concepts and Statistical Analysis** General Concepts:- Types of Instruments, Functional Elements & Input-Output configuration of Measurement System / Instrument, Desired, Modifying & Interfering Inputs, Methods of correction for Interfering & Modifying Inputs. Statistical Analysis:- Gross, Systematic & Random, Causes and methods of elimination, Limiting Errors, Mean value, Deviation, Mean Deviation, Standard Deviation , Variance, Probable Errors, Probable Errors of Combination of Components, Uncertainty Analysis & Propagation of Uncertainties.	06
02	**Performance Characteristics** Static Characteristics: Important parameters. Dynamic Characteristics:-Standard inputs, Mathematical Model of Linear & Non Linear systems, Electrical Networks, Mechanical Systems, Thermal Systems, Liquid Level Systems & Pneumatic Systems, Transfer Function, Zero, First & Second order systems, First Order Electrical, Thermal & Liquid Level Systems, Differential Equation of a General First Order System, Time Domain Analysis:-Response of First and Second order system to Step, Ramp &Impulse Input, Frequency Domain Analysis:-Frequency Response of First and Second order system.	06

03	**Displacement, Velocity and Acceleration Measurement:** Classification & Characteristics of Transducers, Choice of Transducers,Displacement Measurement:-Resistive (Potentiometric), Resistance Strain Gauge, Inductive, LVDT, Capacitive, Piezo-Electric type devices, Shaft Encoder, Optical Encoder. Velocity Measurement: Doppler Effect, Mechanical, Electrical & Digital Tachometers, Non Contacting Methods, Stroboscope. Acceleration: Seismic Transducers, Resistive (Potentiometric), Resistance Strain Gauge, LVDT, Variable Reluctance, Piezo-Electric type	06
04	**Pressure, Temperature and Flow Measurement** Pressure Measurement: Pressure Transducers- Potentiometric, Resistance Strain Gauge, Inductive, LVDT, Capacitive, Piezo-Electric, Photoelectric type, High Pressure Measurement: Bridgman Gauge, Vacuum Measurement:- McLeod Gauge, Knudsen Gauge, Viscosity Gauge, Thermal Conductivity Gauge, Ionization Gauge. Temperature Measurement: Electrical Methods - RTD, Thermistor, Thermocouples, Pyrometry: Total Radiation and Optical Pyrometers, Quartz Crystal Thermometer, Liquid Crystal Thermography. Flow Measurement: Orifice, Flow Nozzles, Pitot Tube, Rotameter, Vortex Meter, Hot Wire Anemometer, Turbine Flow Meter, Ultrasonic Flow Meter, Laser Doppler Anemometer,	06
05	**Measurement of Thermo-Physical Properties** Thermal Conductivity Measurement:-Steady State Methods- Guarded Hot Plate Apparatus for Solid and Liquid Samples, Radial Heat Conduction Apparatus for Liquids and Gases, Thermal Conductivity Comparators, Transient Methods: Laser Flash Method. Measurement of Heat Capacity: Solid & Liquid Samples. Measurement of Heat Transfer Coefficient: Film Coefficient Transducer, Cylindrical Heat Transfer Coefficient probe.	06
06	**Strain , Viscosity and Humidity Measurement** Strain Measurement:Theoryand Types of Strain Gauges, Gauge Factor, Gauge Sensitivity, Temperature compensation: Need & Methods. Measurement of Viscosity: Rotating cylinder, Capillary Tube, Saybolt& Redwood Viscometers. Measurement of Humidity:Terms used, Galvanometric and Electrical Hygrometers, Sling Psychrometer, Use of Dew Point Temperature.	06
07	**Instrumentation** Bridge Circuits: Wheatstone Bridge Types, Filters: Types, Operational Amplifiers: Various modes, Analog to Digital & Digital to Analog Convertors, Types of Recorders, Devices indicating & recording Voltage, Data acquisition & processing.	06

Recommended Books:-

1. DobelinE.O ,*Measurement Systems, Application & Design*,., McGraw Hill, New York, 2001.
2. Holman, J. P. J. P. *Experimental methods for engineers*. 2001.
3. Beckwith T.N. Buck L., Roy M.,*Mechanical Engineering Measurement*, Narosa Publishing House, .
4. Venkateshan, S. P. *Mechanical measurements*. John Wiley & Sons, 2015.
5. Rangan, C. S., Garimella R. Sarma, and V. S. V. Mani. *Instrumentation: devices and systems*. Tata McGraw-Hill, 1983.
6. Sawhney, A. K., and PuneetSawhney. "A Course on Mechanical Measurements, Instrumentation and Control." *Dhanpath Rai and Co* (2004).
7. Nakra, B. C., and K. K. Chaudhry. *Instrumentation, measurement and analysis*.Tata McGraw-Hill Education, 2003.
8. Thaval A.K., *Instrumentation and Mechanical Measurements*.
9. Anderson, Norman A. *Instrumentation for Process Measurement and Control, Third Editon*. Crc Press, 1997.
10Morris, Alan S. *Principles of measurement and instrumentation*. Prentice-Hall, Inc., 1994.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE11: Piping Engineering

Course Pre-requisite: BTM305, BTM505

Course Objectives

The piping engineering forms the backbone of industrial development & growth. Transportation of raw materials, basic energy inputs, finished products, utilities, wastes, etc. are utmost important to almost every industry. Even a small failure or malfunctioning of piping systems may bring industries to halt. Therefore, ensuring reliable, safe & cost effective pipeline & piping system is crucially important.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Discuss needs and requirements of a piping system
2. Explain the fundamental of piping such as reading pipe layout, materials for construction-fabrication, fittings and supports, and different codes associated to piping
3. Select and analyze a pipe network for specified application
4. Calculate pressure drop in piping system using fluid mechanics fundamentals

Course Content:

Module No.	Description	Hrs.
1	**Introduction** Overview of Industry and role of piping engineering in various fields. Inputs received & outputs given by piping engineering department. Role of piping designer, engineer, analyst, etc. Preparation of fundamental drawings/diagrams such as PFD, P& ID, Plot plans, Layouts, Isometrics, etc.	**4**
2	**Materials of Construction and Fabrication** Material classification &selection of material for various processes, Preparation of Material Specification Sheets. Metallurgy of piping materials. Review of fabrication methods; their precautions, preparations & requirements relevant to pipes & piping system.	**6**
3	**Codes and Standards** Brief study of various codes/standards & rules/regulations relevant to piping engineering such as ASME B 31.1 & 31.3, IBR, Indian Explosives Act, Factories Act, NFPA rules, etc.	**6**
4	**Design of Pipes and Pipe Fittings** Pipe specification, Line designation list, Calculations for piping and pipeline sizing, Pressure drop in pipelines, piping and pipeline pressure integrity regarding thickness, including straight pipe, curved pipe, and intersections. Design of branch pipe & miter bends. Stress Intensification Factors& Flexibility Factors for pipe fittings.	**6**
5	**Valves and allied Fittings** Study & selection of various types of valves for various services such as On-Off, Throttling, Non-return, Safety, etc. Preparation of Valve data Sheets. Use of vendor data in design.	**6**

	Study & selection of various types of steam traps, expansion devices, etc.	
6	**Pipe Supports** Study & selection of various types of pipe supports. Design considerations, supporting span of overhead pipelines. Calculations for occasional loadings such as wind and earthquake. Piping flexibility, reactions, for sustained, thermal and occasional loading. Calculations for high frequency vibration as opposed to low frequencyslug flow and fluid transients.	**8**
7	**Standard Piping Arrangements and Software** Various standard piping arrangements such as Pump piping, Compressor piping, Heat exchanger piping, Tank farm piping, Storage vessel piping, Reactor piping, Distillation Column piping, etc. Relevant software hands on training.	**6**

Recommended books:

1. MW Kellogg Co. *Design of Piping Systems*. Wiley, 1961.
2. Silowash, Brian. *Piping systems manual*.McGraw Hill Professional, 2009.
3. Peng, Liang-Chuan, and Tsen-Loong Peng. *Pipe stress engineering*. ASME press, 2009.
4. Menon, Shashi. *Piping calculations manual*.McGraw Hill Professional, 2004.
5. Wilson, B. *Detail engineering and layout of piping systems*, 2011.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE12: Nuclear Engineering

Course Pre-requisite: BTM305, BTM403, BTM501, PC- MTTH102

Course Objectives

- General awareness of fundamentals of Nuclear energy
- Learn about effects of nuclear radiation on materials of construction
- Know about the positive and negative aspects of NuclearEnergy

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Develop knowledge and understanding of nuclear engineering
2. Describe the mechanism of nuclear reaction, different type of nuclear reactors, nuclear materials and their processing and reprocessing etc.
3. Assess the significance of nuclear waste disposal and will be able to understand the need of safety and pollution control in nuclear power station
4. Discuss international safety standard practiced by the world

Course Content

Module No.	Description	Hrs.
1.	**Nuclear reactions** :Mechanism of nuclear fission - nuclides - radioactivity – decay chains - neutron reactions - the fission process	06
2.	**Nuclear reactors** - types - design and construction of nuclear reactors - fast breeder reactors- heat transfer techniques in nuclear reactors - reactor shielding	06
3.	**Reactor materials nuclear fuel cycles** - characteristics of nuclear fuels - Uranium - production and purification of Uranium - conversion to UF4 and UF6 - other fuels like Zirconium, Thorium - Beryllium.	06
4.	**Reprocessing: Nuclear fuel cycles - spent fuel characteristics** - role of solvent extraction in reprocessing - solvent extraction equipment.	06
5.	**Separation of reactor products :** Processes to be considered - 'Fuel Element' dissolution - precipitation process – ion exchange - redox - purex - TTA - chelation -U235 - Hexone - TBP and thorax Processes - oxidative slaging and electro - refining - Isotopes - principles of Isotope separation.	06
6.	**Waste disposal and radiation protection** Types of nuclear wastes - safety control and pollution control and abatement	06
7.	**International conventions**- on safety aspects - radiation hazards and prevention	06

Tutorial work consists on class room tutorial session based on above syllabus

Description of Tutorial Topics	Hrs.
1. Nuclear reactions	4
2. Nuclear reactors	4
3. Reactor materials nuclear fuel cycles	4
4. Reprocessing: Nuclear fuel cycles - spent fuel	4

	characteristics	
5.	Separation of reactor products	4
6.	Waste disposal and radiation protection	4
7.	International conventions	4

Recommended books:

1. Glasstone, Samuel, and Alexander Sesonske. *Nuclear reactor engineering: reactor systems engineering*. Springer Science & Business Media, 2012.
2. Duderstadt, James J., and Louis J. Hamilton. "Nuclear reactor analysis." (1976).
3. Lamarsh, J.R., Introduction to Nuclear Reactor Theory, Wesley, 1996.
4. Waltar, Alan Edward, and Albert Barnett Reynolds. *Fast breeder reactors*. Alan E. Waltar, 1981.
5. Winterton, Richard HS. *Thermal design of nuclear reactors*.Elsevier, 2014.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE13 Cryogenics Engineering
Pre-requisites: BTM601

Course Objectives:

The objective of this course is to:

1. To outline the history, developments, pre-requisite principles, scope and applications of Cryogenic Engineering.
2. To explain concepts and principles of fundamental knowledge areas such as behavior of engineering materials and fluids at cryogenic temperatures, cryogenic insulation, vacuum technology as well safety aspects in the domain of Cryogenic Engineering.
3. To explain fundamental principles, detailed features of arrangements and operation of various cryogen liquefaction systems with critical components involved.
4. To develop understanding and insight for the field of Cryogenic Engineering

Course Outcomes:

Upon successful completion of the course, the students should be able

1. To explain and exemplify the history and developments as well as scope and applications of Cryogenic Engineering.
2. To explain and interpret principles of behavior of engineering materials and fluids at cryogenic temperatures, explain and compare various cryogenic insulations, vacuum technology, explain and apply various safety aspects in Cryogenic Engineering.
3. To explain fundamental principles, discuss detailed features of arrangements, interpret and compare the operation of various cryogen liquefaction systems with critical components involved.
4. To apply the acquired knowledge to analyze and evaluate the problems in the field of Cryogenic Engineering.

Course Contents:

Module No.	Details	Hrs.
1.	**Introduction to Cryogenic Engineering:** Introduction, Historical background, Developments, Scope of application, Present areas involving Cryogenic Engineering, Principles of Thermodynamics, Heat Transfer, Momentum Transfer, Cool down.	02
2.	**Low Temperature Properties of Engineering Materials:** **Properties of Solids:**-Mechanical Properties, Thermal Properties, Electrical and Magnetic Properties of solids including metals and non-metals (insulators), Design considerations, Material selection criterion for Cryogenic Applications. **Cryogenic Fluids: -** P-V-T Behaviour of a Pure substance, T-s and T-h diagrams of a Pure substance, Properties of cryogenic fluids:- Fluids other than Hydrogen and Helium, Hydrogen , Helium.	04
3.	**Gas Liquefaction Systems-I:** Introduction, System performance parameters, The thermodynamically ideal system, Production of low temperatures: - Joule-Thompson effect, Adiabatic expansion. Simple Linde-Hampson system, Pre-cooled Linde- Hampson system, Linde dual pressure system, Cascade system, Claude system, Kapitza system, Heylandt system. Liquefaction systems for LNG, Comparison of liquefaction	06

	systems.	
4.	**Gas Liquefaction Systems-II:** Liquefaction systems for Neon and Hydrogen:- Pre-cooled Linde-Hampson system for Neon and Hydrogen, Claude system for Neon and Hydrogen, Helium refrigerated Hydrogen liquefaction system, Ortho-Para Hydrogen conversion. Liquefaction systems for Helium:-Collins Helium liquefaction system, Simon Helium liquefaction system. Critical components of liquefaction systems:-Heat Exchangers, Compressors and expanders, Losses for real machines and effect on system performance, Effect of heat transfer to system.	06
5.	**Cryogenic Insulations:** Introduction, Heat transfer, Concept of apparent thermal conductivity, Different types of cryogenic insulations:-Expanded foam insulations, Gas-filled powders and fibrous insulations, Vacuum insulation, Evacuated powder and fibrous insulations, Opacified-powder insulations, Multilayer insulations, Comparison of insulations. Composite insulation, Adhesives and other materials, Placement of cryogenic insulation.	04
6.	**Vacuum Technology:** Importance of vacuum technology in cryogenic, Flow regimes in vacuum systems, Conductance in vacuum system, Components of vacuum system, Differrent types of vacuum pumps:- Mechanical vacuum pumps, Difussion pumps, Ion pumps, Cryopumping, Getters and sorption pumping, Vacuum gauges, Vacuum valves.	04
7.	**Safety with Cryogenic Systems:** Introduction, Physiological hazards, Suitability of materials and construction techniques, Explosions and flammability, Excessive pressure gas, Special considerations for Hydrogen and Oxygen gas, General safety principles, Safety checklist.	02

* Numerical Assignments based on Course Contents for continuous assessment of students.

Recommended Books :

1. Barrron, Randall F, *Cryogenic Systems*, 2nd edn, Oxford University Press, New York, 1987.
2. Flynn, Thomas M 2005, *Cryogenic Engineering*, 2nd edn, CRC Press, New York, 2005.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

EC-THPE14: Advanced I. C. Engines

Course Pre-requisite: BTM604

Course Objectives:

The studentsafter studying these topics should be able to

1. To understand the function and fundamental designs of I. C. engine components.
2. To understand the requirements of materials of engine components
3. To understand the mechanical limitations of obtaining ideal performance.
4. To learn and analysis of the performance and emission problems of I. C. engines

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Design the components of I.C. engines.
2. Apply the knowledge for analyzing and calculating emission and performances of I.C. engines.
3. Understand and apply the knowledge of supercharger and turbocharger during design.
4. Understand advanced and modified I.C. engines.

Course Content:

Module No.	Details	Hrs.
01	**Need of Basic Engine Design:** Design of I C engine components. Design of combustion chamber. Basic Engine Design Fundamentals.	**02**
02	**Fuels and Bio-Diesel Fuels:** Effect of fuel characteristic on engine performance. Introduction of biodiesel in the engines. Performance and emission analysis of I. C. Engines.	**02**
03	**Engine Basic Theory** Overall engine system parameters and configuration, Factors affecting combustion phenomenon. Engine Modification for alternative fuels**.**	**02**
04	**Engine Block and Cylinder Head** General design considerations, Design of Engine Bolck and Cylinder head. Material Selcetion, 2 Valve & 4 valve cylinder heads. Bolts loads and gasket design.	**02**
05	**Crank Train and Valve train** Design of Crank Train and Valve Train Mechanism, Function, Requirements, Materials – Piston and crankshaft. Recent trends in design of piston assembly – Piston, Piston rings, Piston pin, Connecting rod assembly and Crankshaft.	**02**
06	**Fuel Injection, Cooling & Lubrication** Functional requirement, Fuel Filter, Types of Injectors, Pump-line-injector, injector system, Unit Injection, CRDI, Injection Pressure, Multiple Injections. Cooling system, Cooling Circuits, Water Pump and Thermostat and its types. Lubrication – Types & Layout, Requirement of Lubricants, Oil Filters, Oil Pan, Oil pump types.	**02**
07	**Recent Trends in Design of I C Engine Parts:** Hybrid electric technology, Functional Requirement of intake and Exhaust system, Air Induction, Swirl &Turbulance, Swirl Generation, Air Filter, Intake Manifold, Exhaust	**02**

	Manifold, Turbochargers, EGR, EGR Cooler, Silencer etc, Part design philosophy.	

Text Books:

1. Sharma, R. P., and M. L. Mathur. "Internal Combustion Engine." (1980).
2. Obert, Edward F. "Internal combustion engines and air pollution." (1973).
3. Domkundwar, V. M. "A course in internal combustion engines."*Dhanpat Rai and CO.(P) Ltd* (2000).
4. Ganesan, V. *Internal combustion engines*. McGraw Hill Education (India) Pvt Ltd, 2012.

References:

1. Stone, Richard. *Introduction to internal combustion engines*. (1999).
2. Beohar S.L., *Internal Combustion Engine*,
3. Gill, Paul W., James H. Smith, and Eugene Ziurys.*Fundamentals of Internal Combustion Engines*. United States Naval Institute, 1952.
4. Heldt, Peter Martin. *High-speed combustion engines: design, production, tests*. Chilton Co., 1956.
5. Morse, Frederick T. *Power plant engineering*. Van Nostrand, 1963.
6. Maleev, Vladimir Leonidas. *Internal-combustion engines: theory and design*. 1945.
7. Taylor, Charles Fayette, and Edward Story Taylor. *The internal-combustion engine*.Vol. 1. International Textbook Co., 1961.
8. Heywood, J. B. "Internal combustion engine fundamentals/John B. Heywood." (1988).
9. Thipse, S. S. *Internal Combustion Engines*. Jaico, 2010.
10. Willard, W. Pulkrabek. *Engineering fundamentals of the internal combustion engine.* Prentice Hall.New Jersey (2004).

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

THAU1 AUDIT I: ENGLISH FOR RESEARCH PAPER WRITING

Course Pre-requisites: BTM406

Course outcomes:

Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
Ensure the good quality of paper at very first-time submission

Course Content:

Units	Content	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	3
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	3
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	3
4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	3
5	Skills are needed when writing the Methods, skills needed when writing the Results	3
6	Skills are needed when writing the Discussion,skills are needed when writing the Conclusions	3
7	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	3

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

THAU2 AUDIT I: CONSTITUTION OF INDIA

Course Pre-requisites: BT025

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Course Content:

Units	Content	Hours
1	➢ History of Making of the Indian Constitution: HistoryDrafting Committee, (Composition & Working)	3
2	➢ Philosophy of the Indian Constitution: PreambleSalient Features	3
3	➢ Contours of Constitutional Rights & Duties: ➢ Fundamental Rights ➢ Right to Equality ➢ Right to Freedom ➢ Right against Exploitation ➢ Right to Freedom of Religion ➢ Cultural and Educational Rights ➢ Right to Constitutional Remedies ➢ Directive Principles of State Policy ➢ Fundamental Duties.	3
4	➢ Organs of Governance: Model Curriculum of Engineering & Technology PG Courses [Volume - II][194] ➢ Parliament ➢ Composition ➢ Qualifications and Disqualifications	3

	➢ Powers and Functions ➢ Executive ➢ President ➢ Governor ➢ Council of Ministers ➢ Judiciary, Appointment and Transfer of Judges, Qualifications ➢ Powers and Functions	
5	➢ Local Administration: ➢ District's Administration head: Role and Importance, ➢ Municipalities: Introduction, Mayor and role of Elected Representative, CEOof Municipal Corporation. ➢ Pachayati raj: Introduction, PRI: ZilaPachayat.	3
6	➢ Elected officials and their roles, CEO ZilaPachayat: Position and role. ➢ Block level: Organizational Hierarchy (Different departments), ➢ Village level: Role of Elected and Appointed officials, ➢ Importance of grass root democracy	3
7	➢ Election Commission: ➢ Election Commission: Role and Functioning. ➢ Chief Election Commissioner and Election Commissioners. ➢ State Election Commission: Role and Functioning. ➢ Institute and Bodies for the welfare of SC/ST/OBC and women	3

Reference Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

THAU3 -AUDIT II: DISASTER MANAGEMENT

Course Pre-requisites: BTM399, BTM499

Course Outcomes: -Students will be able to:
1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and Humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Units	Content	Hours
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	3
2	**Repercussions Of Disasters And Hazards:** Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods,Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	3
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases AndEpidemics	3
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	3
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment,	3
6	**Global Co-Operation** In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	3
7	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	3

Reference Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

THAU4: AUDIT II: STRESS MANAGEMENT BY YOGA

Course Pre-requisites: BT107

Course Objectives:

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Unit	Content	Hours
1	➢ Definitions of Eight parts of yog. (Ashtanga)	3
2	➢ Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	3
3	Yoga & The Brain ➢ Brain Based Learning ➢ The Brain ➢ Teaching to the Developing Brain ➢ Supporting the Learning Brain with Yoga	3
4	Social Emotional Learning	3
5	POSITIVE CLASSROOM MANAGEMENT ➢ Transitions and Engagement ➢ Dynamic Teaching ➢ Understanding Behavior ➢ Classroom Boundaries	3
6	THE YOGA ENVIRONMENT ➢ Clothing ➢ Assistants • ➢ Adjustments	3
7	➢ Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects- ➢ Types of pranayam	3

Suggested reading

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

VATH101Value Addded Course: Internet of Things

Course Pre-requisites: General knowledge of networking, sensing, databases, programming, and related technology

Course Objectives:

Upon successful completion of the course, students will be

• Explored to the interconnection and integration of the physical world and the cyber space.
• They are also able to design & develop IOT Devices.

Course Outcomes:

After successful completion of the course student should be able to

1. Describe the theory related to Internet of things
2. Apply theoretical knowledge of IOT in practice
3. Select the hardware & software for different applications.
4. Develop an application using IOT hardware & software

Course Content:

Sr. No.	Syllabus	Hrs
1.	Introduction Fundamentals of Internet of Things (IOT), Components in IOT, Architecture of IOT, Security, Privacy, Advantages, Applications: Smart Vehicles, Medical, Smart city, Smart Supply Chain etc.	2
2.	Enabling Technologies of IOT Technology Roadmap, RFID, Augmented Reality, Blue Tooth, Zigbee, WiFi, RFLinks, MEMS etc	2
3.	Programming the Microcontroller for IOT Cloud computing and IOT – Arduino/Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors - Communication-Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using WiFi / Ethernet	2
4.	Resource Management Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results	2
5.	IOT PROTOCOLS Network Overview, Various Types of Networks, Network Protocols, Selecting the Right Network for the Right Use case, Network Challenges for IOT: Connecting sensors, Integrating with Application Platform	2
6.	IOT Platforms Introduction, Necessity of IOT Platform, Industrial Grade Platform, Key IOT Platform Features, IOT Platform Architecture, Getting access to IOT platforms, Introduction to Model based development on IOT platforms	2
7.	Challenges & Opportunities of IOT New business markets in IOT, IOT Design Challenges, IOT Design Opportunities, Technological challenges faced by IOT devices	2

Tutorial Work:

It consists of at least one tutorial and/or assignments and/or hands-on excercises from each module of the curriculum mentioned for the course.

Text Books:

1. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011.

Reference Books:

1. CharalamposDoukas, "Building Internet of Things with the Arduino", Create space, April 2002

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

VATH102:ValueAdded Course: Introduction to Big Data Analytics

Course Pre-requisites: BTM 301, BTM 401

Course Objectives:

1. Understand the role of business analytics within an organization.
2. Analyse data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyse and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course Outcomes:

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on dataand deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptivemodeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

Course Content:

Sr. No.	Syllabus	Hrs
1.	Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	2
2.	Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression.Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	2
3.	Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.	2
4.	Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	2
5.	Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor	2

	Model, Overbooking Model, Cash Budget Model.	
6.	Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	2
7.	Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	2

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

VATH203: Value Addded Course: Introduction to AI and Machine Learning

Course Pre-requisites: Mathematics, Knowledge of programming language (Python preferred),

Course Objective:
The students after studying these topics should be able to

1. understand applications of Artificial Intelligence and Machine Learning for engineering applications
2. apply suitable algorithms for simple engineering problems

Course Outcomes:
Upon successful completion of the course, students should be able to

1. discuss applications of Artificial Intelligence for engineering problem solving
2. apply fundamental concepts in machine learning and select popular machine learning algorithms for engineering problem solving
3. compose computer code for solving problems using machine learning algorithms
4. explain advanced machine learning concepts such as Neural Network, Reinforcement Learning.

Course Content:

Module No.	Details	Hrs.
01	Artificial Intelligence, Intelligent agents, types of learning, steps involved in problem solving using Machine Learning	2
02	Linear regression, Decision trees, overfitting	2
03	Instance based learning, Feature reduction, Collaborative filtering-based recommendation	2
04	Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM	2
05	Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network	2
06	Clustering: k-means, adaptive hierarchical clustering	2
07	Introduction to Reinforcement Learning	2

TermWork/Laboratory:

Journal work shall consist of e-folder with computer code for solution to problems based on each module.

TextBooks:

1. Tom Mitchell, Machine Learning, First Edition, McGraw- Hill (1997).
2. Stuart Russel and Peter Norvig, Artificial Intelligence – A modern approach, Pearson (2015)
3. EthemAlpaydin, Introduction to Machine Learning, PHI (2015).
4. Gopal M., Applied Machine Learning, McGraw Hill (2018)

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

VATH204:Value Addded Course: Introduction to Augmented Reality
Course Pre-requisites: MTMD102

Prerequisite:- General knowledge of CAD Modelling

Course Objectives:

- Explore the basic concepts of Augmented Reality.
- They are also able to design & develop AR application.

Course Outcomes:

After successful completion of the course student should be able to

1. Describe the theory related to Augmented Reality
2. Apply theoretical knowledge of AR in practice
3. Select the hardware & software for different applications.
4. Develop interactive augmented reality applications for both PC based mobile devices using a variety of novel input devices

Course Content:

Sr. No.	Syllabus	Hrs
1.	**Introduction** History of AR, Basics of Augmented Reality, Architecture/Framework, Various applications of AR in Automotive & Auto Component industries, Construction Managemen, Educationt etc. AR Browsers, Marker & Marker less AR	2
2.	**Enabling Technologies of Augmented Reality** Mobile, Camera, Cloud Computing, Unity, AR with Google Sketch up	2
3.	**Remote Maintainence/Training using AR** Architecture, Benefits, Challenges	2
4.	**Lighting and Illumination Issues in AR** Conversion of CAD Model to AR Model	2
5.	**HOLOLENS INTERFACE**	2
6.	**Integration of AR** Integration with IOT. Integarting with CRM, New market Opportunities of AR, Business models, Revenue models & AR in Other Fields	2
7.	**Challenges & Opportunities of AR** New business markets in AR, Technological challenges faced by AR	2

Term Work:

- It consists of at least one tutorial and/or assignments and/or hands-on excercises from each module of the curriculum mentioned for the course.
- One Presentation / Seminar related to AR
- Mini Project

Text Books:

1.Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.

2. Steve Aukstakalnis Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR

3. Jonathan Linowes, Krystian, Augmented Reality for Developers, 2017.
4. Stephen Cawood and Mark Fiala, Augmented Reality: A practical guide

Augmented Reality (AR) Course Evaluation Scheme:

Students shall select an Mechanical or any interdisciplinary application & apply concepts of AR, learned during theory & tutorial/Practical. Following evaluation scheme will be adopted for the evaluation of the course.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

OPMD304 Open Elective: Industrial Safety

Course Pre-requisites: BTM803/BTM898

Course Outcomes:

At the end of the course students will be able to

1. Understand basic safety norms, rules and regulations and hazards
2. Understand maintenance of utility systems and its service life expectancy
3. Understand fault and diagnostics and preventive measures
4. Understand repair cycles of machines and trouble shootings

Course Content:

Units	Content	Hours
1	Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	**4**
2	Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	**4**
3	Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity Lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods	**4**
4	Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	**4**
5	Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor	**4**
6	Troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive Maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets	
7	Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance	

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OPMD305 Open Elective: Operations Research

Course Pre-requisites: BTM803

Course Outcomes:

At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

Course Content:

Unit	Content	Hours
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis,	**5**
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming	**6**
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem – CPM/PERT	**5**
4	Scheduling and sequencing – single server and multiple server models – deterministic inventory models –	**5**
5	Inventory Control Models, Probabilistic inventory control models – Geometric Programming.	**5**
6	Competitive Models,Single and Multi-channel Problems, Sequencing Models	**5**
7	Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	**5**

Reference Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

OPMD306 Open Elective: Cost Management of Engineering Projects

Course Pre-requisites: BTM803

Course Outcomes:

At the end of the course students will be able to

1. Estimate project cost and project commisioning
2. Analyse cost behaviour in project
3. Know different project strategies
4. Apply quantitative techniques for cost management of engineering projects

Course Content:

Unit	Content	Hours
1	Introduction and Overview of the Strategic Cost Management Process	**4**
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunitycost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational Control; Provision of data for Decision-Making.	**4**
3	Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnicalactivities. Detailed Engineering activities. Pre project execution main clearances and Documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar chartsand Network diagram. Project commissioning: mechanical and process	**8**
4	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.	**8**
5	Pricing strategies: Pareto Analysis. Target Costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.	**6**
6	Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	**6**
7	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	**6**

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OPMD307 Open Elective: Waste to Energy

Course Pre-requisites: BTM504

Course Outcomes:

At the end of the course students will be able to

1. Classify waste from ebergy recovery point of view
2. Know biomass pyrolysis and gasification
3. Understand biomass combustion
4. Understand working of biogas plant and importance of biomass energy programme in India

Course Content:

1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	**6**
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	**6**
3	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – 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.	**6**
4	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.	**6**
5	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	**6**
6	Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion	**6**
7	Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	**6**

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley &Sons, 1996.

OPTH305 Essentials for NX Designers

Course Pre-requisites: None

Course Objectives:

1. Document design intent.
2. Create and edit parametric solid models.
3. Create Assembly Structures and Drawings.

Course Outcomes:

Upon successful completion of the course, Participants should be able to

1. Get an idea about Design Intent and parametric CAD system.
2. Create 3D CAD models using NX.
3. Prepare assemblies using essential tools in NX assembly environment.
4. Create drawing for manufacturing or presentation.

Course Content:

Sr.No.	Description	Hrs.
1	Getting to know the NX interface and Coordinate Systems	6
2	Documenting design intent and Creating parts with sketches	10
3	Creating and editing Parametric models	6
4	Examining the structure and working with secondary features	10
5	Modifying geometry of imported parts using synchronous technology	4
6	Loading and working with assemblies	10
7	Creating simple drawings	10

Course Evaluation Scheme:

Sr. No.	Examination	Module
4.	**T-I (Online MCQs)**	1and 2
5.	**T-II (Online MCQs)**	3 and 4
6.	**End Sem (Tool Test)**	1 to 7

OPTH306 Advanced Simulation

Course Pre-requisites: None

Course Objectives:

1. Fundamentals of stress and strain.
2. Understand Displacement Field and Hooke's Constitutive law.
3. Analyze stress problems with the application of basic laws and equations.

Course Outcomes:

Upon successful completion of the course, Participants should be able to

1. Applying Numerical Methods to solve problems with variety of loading situations.
2. Working with Stress-Strain relation of ductile and brittle materials.
3. Analyze and calculate stress/strain distributions for 1D, 2D and 3D problems.
4. Analyze various types of Engineering Problems and interpolate the results.

Course Content:

Sr.No.	Description	Hrs.
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	**8**
2	Geometry Simplification and Meshing	**8**
3	Working with the results and interpolation	**8**
4	Solving Structural Static Analysis, Buckling Analysis and Natural Frequency Analysis	**8**
5	Solving Thermal, Response and Nonlinear Analysis	**8**
6	Solving Symmetry, Assembly FEM and Contact & Gluing problems	**8**
7	Flexible Body Analysis and Optimization	**8**

Course Evaluation Scheme:

Sr. No.	Examination	Module
7.	**T-I**	1 and 2
8.	**T-II**	3 and 4
9.	**End Sem**	1 to 7

OPTH307 Composite and Structure Assembly

Course Pre-requisites: None

Course Objectives:

1. Understanding the Structure of Composites.
2. Creating Laminates.
3. Analyzing composite structure problems.

Course Outcomes:

Upon successful completion of the course, participants should be able to

1. Create Laminate Composite Structures.
2. Understand Laminate Failure Theory.
3. Analyze Composite Structures and interpolate the results.
4. Optimize Laminate Composite Structures.

Course Content:

Sr.No.	Description	Hrs.
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	**8**
2	Creating Finite Element Models	**8**
3	Solving various type of Analysis	**8**
4	Introduction to Composite Structure, Creating Laminates using zone based Process and Ply based Process.	**8**
5	Modeling 3D laminates, Solving and Post Processing	**8**
6	Laminate Theory and Failure Analysis	**8**
7	Laminate Dynamic Analysis and Optimization	**8**

Course Evaluation Scheme:

Sr. No.	Examination	Module
10.	**T-I**	1and 2
11.	**T-II**	3 and 4
12.	**End Sem**	1 to 7

OPTH308 Collaborative Engineering using Team center

Course Pre-requisites: None

Course Objectives:

1. To Organize, Manage and Secure product data using Teamcenter
2. To Integrate NX with Teamcenter
3. To 3D Model using NX in Teamcenter Integrated Envirnomemt

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Organize, Manage and secure the product data.
2. To Assign, Perform and Track the workflow process.
3. Defining the Assembly Structure in integrated mode.
4. Understand Part Modeling Techniques using NX.

Course Content:

Sr.No.	Description	Hrs.
1	Introduction to Teamcenter	2
2	Creating and Managing Datasets and Items	4
3	Creating and Managing Product Structure	10
4	Initiating and Managing Workflow Tasks	10
5	Viewing and Working with Vizualization	6
6	Creating Part Models and Assemblies	8
7	How to Integrate NX with Teamcenter	16

Course Evaluation Scheme:

Sr. No.	Examination	Module
13.	**T-I (Online MCQs)**	1,2 and 3
14.	**T-II (Online MCQs)**	4 and 5
15.	**End Sem (Tool Test)**	1 to 7

OPTH309 Technomatix process

Course Pre-requisites: None

Course Objectives:

1. Process Designer Basics
2. Simulating a work cell using Robcad
3. Defining Kinematics using Robcad.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Understanding how to work with Process Designer software.
2. Manage Engineering and Manufacturing data in Process Designer.
3. Creating Robot workcell Layout and sequence of operation
4. Creating automatic kinematics and parameters in Robcad

Course Content:

Sr.No.	Description	Hrs.
1	Process Designer Interface and Environment	6
2	Productivity Tools and Placement commands	6
3	Creating and Saving Engineering Data	4
4	Robot Workcell Layout, Modeling and Kinematics	10
5	Workcell and Robot Simulation Techniques	6
6	Automatic Kinematics Creation	14
7	Kinematic Functions	10

Course Evaluation Scheme:

Sr. No.	Examination	Module
16.	**T-I (Online MCQs)**	1,2 and 3
17.	**T-II (Online MCQs)**	4 and 5
18.	**End Sem (Tool Test)**	1 to 7

OPTH310 Advanced Finite Element Analysis

Course Pre-requisites: None

Course Objectives:

1. To develop participants understanding using NX solvers.
2. Analyze stress problems with application of basic laws and equations.
3. Solve various types of Engineering Problems.

Course Outcomes:

Upon successful completion of the course, Participants should be able to

1. Work effectively with NX Solvers.
2. Working with Nastran input deck file (create, modify and edit).
3. Analyze and calculate stress/strain distributions for 1D, 2D and 3D problems.
4. Analyze various types of Engineering Problems and interpolate the results.

Course Content:

Sr.No	Description	Hrs
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	**8**
2	Introduction to Finite Element Analysis and Solution Control	**8**
3	Working with Nodes and Elements	**8**
4	Applying Constraints and loads	**8**
5	Understanding Special caeses, Model quality and File Management	**8**
6	Working with Pre Processing	**8**
7	Working with Post Processing	**8**

Course Evaluation Scheme:

Sr. No.	Examination	Module
1.	**T-I**	1,2 and 3
2.	**T-II**	4 and 5
3.	**End Sem**	1 to 7

OPTH311 Thermal and Flow Analysis

Course Pre-requisites: None

Course Objectives:

1. Fundamentals of Heat Transfer.
2. Understanding Energy Equations.
3. Analyze Thermal and Flow problems.

Course Outcomes:

Upon successful completion of the course, Participants should be able to

1. Apply Finite Element Method to solve Thermal Problems.
2. Apply Finite Volume Method to solve Flow Problems.
3. Analyze and calculate stress/strain distributions for 1D, 2D and 3D problems.
4. Analyze the Coupled Thermal Fluid problems.

Course Content:

Sr. No	Description	Hrs
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	**8**
2	Meshing and Applying loading and boundary conditions	**8**
3	Simulation and Validation	**8**
4	Introduction to Thermal Analysis (Conduction, Convection and Radiation)	**8**
5	Thermal Simulation	**8**
6	Introduction to Flow analysis and Creating Fluid Volumn	**8**
7	Flow Simulation and Mapping Results	**8**

Sr. No.	Examination	Module
1.	**T-I**	1,2 and 3
2.	**T-II**	4 and 5
3.	**End Sem**	1 to 7

DS-MTTH396: Seminar on Literature Review
Prerequisite: PC-MTTH299

Course Objective:
To inculcate self learning and research aptitude among students to handle and investigate a real life problem.

Course Outcomes:

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques.
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution.
3. Student will be able to use knowledge for formulation / fabrication of the desired project.
4. Student will be able to analyze the available resources and to select most appropriate one.

Course Content:

Sr. No.	Description	Hrs
1	The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a thesis for evaluation.The work at this stage may involve review of literature, laboratory experimental work, development of software, development of model, case study, field data collection and analysis etc. On completion of the work the student shall prepare a report and will give a Seminar on the report.	48

DS-MTTH397: Dissertation Stage-I Seminar
Prerequisite: MTTH299

Course Objective:
To inculcate self learning and research aptitude among students to handle and investigate a real life problem.

Course Outcomes:
1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques.
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution.
3. Student will be able to use knowledge for formulation / fabrication of the desired project.
4. Student will be able to analyze the available resources and to select most appropriate one.

Course Content:

Sr. No.	Description	Hrs
1	Student shall finalize a theme, related to his/her area of specialization for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report.	48

Guidelines for Dissertation
Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I
Dissertation I should be assessed based on following points
1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope

DS-MTTH498: Dissertation Stage-II Seminar (Pre-Synopsis)
Prerequisite: DS-MTTH396, DS-MTTH397

Course Objective:
To inculcate self learning and research aptitude among students to handle and investigate a real life problem.

Course Outcomes:
1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques.
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution.
3. Student will be able to use knowledge for formulation / fabrication of the desired project.
4. Student will be able to analyze the available resources and to select most appropriate one.

Course Content:

Sr. No.	Description	Hrs
1	Student shall study the problem of dissertation in the light of outcome of Stage I and Stage II seminars. On completion of data collection, analysis, and inference the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis.	48

Guidelines for Assessment of Dissertation II
Dissertation II should be assessed based on following points
1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization or current Research / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

DS-MTTH499: Dissertation and Viva Voce
Prerequisite: DS-MTTH396, DS-MTTH397, DS-MTTH498

Course Outcomes:

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques.
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution.
3. Student will be able to use knowledge for formulation / fabrication of the desired project.
4. Student will be able to analyze the available resources and to select most appropriate one.

Course Content:

Sr. No.	Description
1	On finalization of the dissertation student shall submit the dissertation report. The student shall have to appear for a Viva-voce examination for the dissertation.

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points

1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization or current Research / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation