Bharatiya Vidya Bhavan's
SARDAR PATEL COLLEGE OF ENGINEERING
(Government Aided Autonomous Institute under Mumbai University)
Andheri (W) Mumbai - 400058

COURSE CONTENTS

(T.Y. B.Tech. in Mechanical Engineering)

Year: 2019-20

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2019-20

List of Courses

PC-BTM501 Heat and Mass Transfer

Course Pre-requisites: PC-BTM305

Course Objectives:

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

1. Identify different mode of heat and mass transfer occurring in thermal system.
2. Analyze steady and transient conduction problem.
3. Learn the fundamentals of convective heat transfer
4. Understand the methods of analyzing a heat exchanger.
5. Learn about basic concept of mass transfer

Course Outcomes:

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

1. Understand different modes of heat transfer and estimate the heat transfer by using classical laws.
2. Apply the knowledge of mathematics, science and heat transfer to develop mathematical models.
3. Analyze heat exchange through radiation.
4. Analyze and evaluate heat transfer in context with conduction, convection and heat exchangers

Course Contents:

Module No.	Details	Hrs.
1	**Basic Concepts:** Understanding generalized energy equation in the mathematical form, Modes of heat transfer, its mechanism and mathematical models.	05
2	**Conduction:** General conduction equation in cartesian, cylindrical and spherical Coordinates (Only use of equations and no derivations) Steady state solution of one-dimensional conduction equation for isotropic materials of various configurations such as plane wall, plane composite wall, cylindrical and spherical composite walls.	08
3	**Transient Conduction:** Lumped capacity method, Distributed parameter treatment.	04
4	**Fundamental of Convection:** Natural and Forced convection, hydrodynamic and thermal boundary layers. Heat transfer coefficient. Effect of various parameters such as physical properties of the fluid, system geometry, fluid flow etc. on heat transfer coefficient. Physical significance of dimensionless numbers such as Nusselt's Number, Grashoffs Number, Prandtl's Number, Reynolds Number and Stanton's Number. Empirical relations for free convection for standard cases.	08
5	**Fundamental of Radiation:** Origin of thermal radiation, Concept of black body and grey body. Emissive power and Emissivity. Basic laws of Radiation: Planck's law, Radiation heat exchange between two black bodies. Electrical network	06

	analogy for radiation heat exchange between two and three grey bodies.	
6	**Heat Exchangers:** Classification of heat exchangers. Logarithmic Mean Temperature Difference, Correction factor and effectiveness of heat exchangers. Effectiveness as a function of Number of Transfer Units and heat capacity ratio. Overall heat transfer coefficient, Fouling factor.	**06**
7	**Mass Transfer:** Mechanism of mass transfer. Importance of mass transfer in engineering. Fick's law of diffusion. Empirical relations for mass transfer, in terms of Sherwood Number, Reynolds Number and Schmidt's number.	**05**

Text Books:

1. Holman, J. P. "Heat transfer, Eighth SI Metric Edition." (2001)
2. Incropera and Dwitt, *Fundamentals of Heat and Mass Transfer*, Wiley India (2010)
3. Kreith, Frank, Raj M. Manglik, and Mark S. Bohn. *Principles of heat transfer* Cengage learning, (2012)
4. Arora C. P. ,*Heat and Mass Transfer*., Dhanpatrai and Co. (2014)
5. Nag P.K.,*Heat and Mass Transfer* , Tata McGraw Hill (2014)
6. Ozisik M.N., *Heat Transfer*, McGraw Hill (2010)
7. Rajput, R. K. "„Heat and Mass Transfer", pub." *Tata McGrawhill*(2009).

References:

1) Heat Transfer - Schaums Series - Mc Graw Hill International.
2) Welty, James R. "Engineering heat transfer." *New York, John Wiley and Sons, Inc.*(1974).
3) Hsü, Shao-ti. *Engineering heat transfer*. Van Nostrand, 1963.
4) Eckert and Drake, *Heat and Mass Transfer*, (2010)

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

PC-BTM503 Mechatronics
Course Pre-requisites: Engineering sciences, PC-BTM402

Course Objectives:

- In the recent trend of automation in industry environment has changed rapidly from mechanical to electromechanical. Hence aim is to implement such a mechatronics system in industry to enhance the performance as well as cost, size & power. Such as microcontroller base systems & programmable logic controller base systems.
- Knowledge of systems such as microprocessor, microcontroller, Programable logic controller, Electropneumatic& electro hydraulics & other systems such as MATLAB & software's will be useful.

Course Outcomes:

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

1. To explain principles of operation/interfacing of microprocessor, microcontrollers, PLCs, in mechatronics systems
2. To use hydraulic and pneumatic actuation systems for developing circuits for industrial automation and to describe fundamentals of modelling control systems
3. To calculate response of first and second order systems and to explain concepts of frequency response analysis and state space representation of control systems
4. To explain state space representation of control systems

Course Content:

Module No	Details	Hrs.
Module 01	Introduction to Mechatronics, Mechatronics Systems in Factory, Home and Business Applications. Basic Components of Mechatronic Systems, Mechatronics Design process, Objectives.	02
Module 02	Overview of microprocessors and micro-controllers 8051microcontrollers: Functional block diagram and architecture, Instruction set and assembly language programming. Interfacing of: HEX-keyboards, LCD display, ADC, DAC and Stepper motor	07
Module 03	Pneumatic and Hydraulic actuation systems: Pneumatic and hydraulic systems. Electro-Pneumatic systems Electro-Hydraulic systems. Development of circuits for Industrial Automation PLC in Automation: Basic structure, I/O processing. Ladder logic diagram. Selection of PLC.	07
Module 04	Introduction to control systems, open loop and closed loop systems, Mathematical modeling of control systems, concept of transfer function, Block diagram algebra, State space modeling, Process control systems, ON-OFF control, P-I-D Control. Control system components: servomotor, stepper motors.	06
Module 05	Transient Response Analysis of First and Second orders system, Time domain specifications. Step response of second order system. Classification of control systems according to 'TYPE' of systems, steady-state errors, static error constants, steady state analysis of different type of systems	08

	using step, ramp and parabolic inputs. Stability analysis: Introduction to concepts of stability, The Routh and Hurwitz Stability criteria, Relative stability analysis.	
Module 06	Root locus concepts. Frequency Response Analysis: Frequency domain specifications, Correlation between time and frequency response, Polar Plots, Bode Plots.	07
Module 07	State-Space methods, Single degree of freedom, Multi-degree of freedom, Forced response, State Space representation of Control systems	05

Term Work:
At least 06 assignments (one on each module).

Theory Examination:

1. Question paper will comprise of total seven question, each of 20 Marks
2. Question one will be compulsory and based on maximum part of syllabus.
3. Remaining questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only five questions need to be solved.

Text books:

1. Uchino, Kenji, and Jayne Giniewicz, eds. *Micromechatronics*. CRC Press, 2003.
2. Shetty, Devdas, and Richard A. Kolk. *Mechatronics System Design, SI Version*. Cengage Learning, 2010.
3. Gaonkar, Ramesh S. *Microprocessor architecture, programming, and applications with the 8085*. Prentice-Hall, Inc., 1995.
4. Nagrath, I. J., and Madan Gopal. *Textbook Of Control Systems Engineering (Vtu)*. New Age International, 2008.
5. Ogata, Katsuhiko, and Yanjuan Yang. "Modern control engineering." (1970): 1.
6. Kenneth, J. Aiyala. "The 8051 Microcontroller, Architecture, programming and applications." (1991).
7. Fawcett, John R. *Pneumatic circuits and low cost automation*. Brookfield Publishing Company, 1968.
8. Manik D.N., *Control Systems*, CENGAGE Learning (2012)

References:

1. Horowitz, Paul, and W. Hill. "Art of electronics 2nd edn." (1997).
2. *Fundamentals of Pneumatics*: Festo Series (2002)
3. *Fundamentals of Electro-Pneumatics*: Festo Series (2002)
4. *Fundamentals of Hydraulics*: Festo Series (2002)
5. *Fundamentals of Electro-Hydraulics*: Festo Series (2002)
6. Mechatronics, H. M. T. "Tata McGraw Hill." *New Delhi* (1968).
7. Pippenger, John J. *Hydraulic valves and controls: selection and application*. Marcel Dekker Inc, 1984.
8. . Dukkipati, Rao V. *Analysis and design of control systems using MATLAB*. New Age International, 2006.

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

PC-BTM512 Dynamics of Machinery
Course Pre-requisites: BTM412

Course Outcomes:

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

1. To examine construction and analyze motion of mechanical subsystems such as dynamometers, governors, gyroscope, gear trains.
2. To analyze static and dynamic balancing of rotor and reciprocating mass systems.
3. To define damped and undamped SDOF vibration system
4. To derive governing equations of motion for damped and undamped vibration systems.

Module no.	Descriptions	hrs
01	Dynamometers–Absorption and transmission dynamometers, Study and analysis of absorption type dynamometer –Proney brake, Rope brake, dynamometers, Study and analysis of transmission type dynamometers.	**04**
02	Gyroscope: Introduction- Gyroscopic couple and its effect on spinning bodies, Gyroscopic effect on naval ships during steering, pitching and rolling, Ship stabilization with gyroscopic effect. Two wheeler and four wheeler on curved path- effect of gyroscopic and centrifugal couples, maximum permissible speeds on curve paths, Gyroscopic effect due to lateral misalignment of rigid disc mounted on shaft.	**04**
03	Governors: Comparison between governors and flywheel, Types- centrifugal governors, inertia governors, Force analysis of gravity loaded governors– Watt, Porter, Proell, Force analysis of spring loaded governors- Hartnell, hartung, Wilson Hartnell, Force analysis of spring and gravity loaded governor, Performance characteristics of governor stability, sensibility, isochronisms, Hunting, governor effort and governor power, coefficient of insensitiveness	**04**
04	Gear Trains: Kinematics and dynamic analysis of- simple gear trains, compound gear trains, reverted gear trains, and epi-cyclic gear trains with spur, or bevel gear combination	**04**
05	Basic Concepts of Vibration: Vibration and oscillation, causes and effects of vibrations, Vibration parameters -spring, mass, damper, Damper models, Motion periodic, non periodic, harmonic, non–harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis, Free Undamped Single Degree of Freedom Vibration System: Longitudinal, transverse, torsional system, Methods for formulation of differential equations by Newton, Energy, Lagrangian (Rayleigh's method), Effect of spring's mass and shaft inertia on natural frequency,	**04**
06	Free Damped Single Degree of Freedom Vibration System: Viscous damped system- underdamped, critically damped, overdamped. Logarithmic decrement. Coulomb's damping. Combined viscous and coulomb's damping.	**04**

07	Balancing: Static and dynamic balancing of multirotor system, Balancing of reciprocating masses In-line engines, V-engines	**04**

Text Books:

1. Bevan, Thomas. The theory of machines. Pearson Education India, 1944.

2. Rattan, Sarjit S. Theory of machines. Tata McGraw-Hill, 2005.

3. Ballaney, P. L. Theory of machines. Khanna, 1980.

4. Grover, Gopal Krishan. Mechanical Vibrations: MKS System. Nem Chand, 1972.

5. Kelly, S. Graham. "Fundamentals of mechanical vibrations." (1992).

6. Rao, Singiresu S., and Fook Fah Yap. Mechanical vibrations. Vol. 4. New York: Addison-Wesley, 1995.

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

PC-BTM514 Thermal Systems
Pre-requisite Courses: Thermodynamics

Course Objective:
The students after studying this course should be able to
- Understand fundamentals involved in compressor technology and power generation.
- Understand working of Compressors, turbine, steam generators and condensers.
- Carry out basic calculation involving compressor, turbine, condensers and steam generators.
- Understand performance parameters of compressors and turbines.

Course Outcome:
Upon successful completion of the course, students should be able to
1. apply knowledge of thermodynamics and fluid mechanics to study the performance of different types of compressors.
2. do simple calculations on the performance of compressors.
3. get knowledge about working of different types of steam generators, turbines and condensers.
4. do simple calculations on the performance of steam turbines and gas turbines.

Course Content:

Module No.	Details	Hrs.
01	**Introduction to thermal systems and reciprocating compressors:** Basic principles of steam power cycle – Carnot cycle, rankine cycle; Equipments and accessories of thermal power plant. Single stage reciprocating compressor-neglecting clearance. Multistaging of compressors. Two stage air compressors, Perfect inter-cooling. Ideal inter cooler pressure. Minimum work, Free air delivered, volumetric efficiency, isothermal and adiabatic efficiency. Effect of clearance volume on F.A.D and volumetric efficiency, Work, power and efficiency calculations.	9
02	**Rotodynamic Compressor:** Energy conversion in rotodynamic machines, Rotary, centrifugal and axial compressor; Surging, chocking and stalling, Multi-staging, performance parameters and characteristics.	6
03	**Steam Generator**: High pressure steam generator. Constructional and working features, accessories- superheaters, economizers, reheaters, air preheaters. Once through steam generator, control of steam generation. Examples of HP boilers, Boiler performance. Boiler efficiency. Fluidized bed system in steam generation. Use of nuclear energy in steam generation and power production.	5
04	**Steam Condensers:** Need of condenser, Elements of condensing plant, Types of condensers, surface and evaporative condenser. Partial pressure, effect of air leakage, vacuum efficiency, Air pump capacity, Cooling tower and associated calculations.	6
05	**Steam Turbines:** Flow through steam nozzle, Basic of steam turbine, Classification, compounding of turbine, Impulse turbine-velocity diagram, condition for maximum efficiency. Reaction turbine- velocity diagram, degree of reaction, Parson's turbine. Condition for maximum efficiency.	4

06	**Gas Turbine**: Application of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration. Effect of operating variable on thermal efficiency and work ratio.	6
07	Introduction to hydraulic machinery, classification of hydraulic machines, impulse and reaction turbines, Pelton turbine, Kaplan turbine, Francis turbine, hydraulic pumps.	6

Text Books:

1. Nag, P. K. *Power plant engineering*. Tata McGraw-Hill Education, 2002.
2. Kothandaraman, C. P., S. Domkundwar, and Anand Domkundwar. *Cource in Thermal Engineering*. Dhanpat Rai & Company (P) Limited, 2010.
3. Yadav, R. "steam and gas turbine and Power Plant Engineering." (2009)
4. Yadav, R. "Thermodynamics and Heat Engines." *Allahabad: Central Publishing House* (2001).
5. Yahya, S. M. *Turbines compressors and fans*. Tata McGraw-Hill Education, 2010.
6. Lal, Jagdish. *Hydraulic machines*. Metropolitan Book Company, 1961.
7. Vasandani, VP Dr. *Hydraulic Machines: Theory and Design*. Khanna Publishers, 1996.
8. Douglas J., Gasiorek J., Swaffield J., Jack L., *Fluid Mechanics*, Prentice Hall, 2006.

References:

1. Sorensen, Harry A. *Principles of Thermodynamics*. Holt, Rinehart and Winston, 1961.
2. Eastop, T. D., and A. McConkey. "Applied thermodynamics for engineering technologists, 1996.
3. Yunus A Cengel and Michael A. Boles, *Thermodynamics an Engineering Approach*. Tata McGraw-Hill Education, 2014.

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

PC-BTM515 Computer Aided Machine Drawing
Course pre-requisites: Engineering Graphics

Course Objective:
In this course students will:

1. Learn to understand drawing, which includes clear spatial visualization of objects and the proficiency in reading and interpreting a wide variety of production drawings.
2. Learn drafting skills depending upon job function, to perform day to day activities i.e. communicating and discussing ideas with supervisors and passing instructions to subordinates also knowledge of computer aided drafting is essential part.

Course Outcome:

Upon successful completion of this course, students should be able:

1. To create and compose engineering drawings for standard machine components on CAD Software.
2. To sketch free hand proportionate illustrative representation of common machine components.
3. To assemble various standard machine components on CAD Software.
4. To plot assembly and detail production drawings with bill of Material.

Course Contents:

Module No.	Details	Hrs.
01	**Solid Geometry:** Intersection of surfaces and Interpenetration of solids- Intersection of prism or cylinder with Prism, cylinder or cone (both solids in simple and offset position only). Primary auxiliary views and aux. projections of simple machine parts.	03
02	**Free Hand Sketching of :** **Machine elements** such as bolts, nuts, washers, studs, components tapped holes; **Types of Conventional Threads**; V-form and Square form, Conventional representation of assembly of threaded parts in normal and sectional views; **Limits fits and tolerances:** dimensioning with tolerances indicating various types of fit in details and assembly drawings.	02
03	**Details and Assembly Drawing:** Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details and vice versa. **Preparation of details & assembly drawings of** Cotter joints, knuckle joint. **Free Hand sketches of Keys**: sunk, parallel, woodruff, saddle, feather etc.	03
04	**Preparation of Details & Assembly Drawings of:** **Coupling** - simple, muff, flanged, protected flange coupling, Oldham's coupling and universal Coupling. **Bearings**- simple, open, bushed, pedestal, footstep, I.S. conventional representation of ball and roller bearings.	02
05	**Preparation of Details & Assembly Drawings of:**	02

	Belt Pulleys- V-belt, rope belt, fast and loose pulleys, **Pipe Joints:** flanged joint, spigot and socket joint, stuffing box, expansion joint, union joint.	
06	**Preparation of details & assembly drawings of:** **Valves** - Air cock, Blow off cock, Steam stop valve, gates valve, globe valve, non-return valve. **I.C. Engine Parts:** piston, connecting rod, cross head and crankshaft.	01
07	**Preparation of details & assembly drawings of:** Jigs & Fixtures, Clapper block, Single tool post, Crane Hook, Lathe & Milling tail stock. Exporting CAD files for 3d printing.	01

Text Books:

1. Bhatt, N. D., and V. M. Panchal. Machine Drawing. Charotar, 1991.
2. Dhawan, R. K. Machine Drawing. S. Chand Limited, 1998.

Reference Books:

1. Narayana, K. L., P. Kannaiah, and K. Venkata Reddy. Machine drawing. New Age International, 2009.
2. John, K. C. Textbook of Machine Drawing. PHI Learning Pvt. Ltd., ed.1.

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

PC-BTM551 Heat and Mass Transfer Laboratory
Course Pre-requisites: PC-BTM501

Course Objectives:
Upon successful completion of the course, students should be able to
1. Identify different mode of heat and mass transfer occurring in thermal system,
2. Analyze steady and transient conduction problem,
3. Learn the fundamentals of convective heat transfer,
4. Understand and analyze radiative mode of heat transfer,
5. Understand the methods of analyzing a heat exchanger,
6. Learn about basic concept of mass transfer

Course Outcomes:
Upon successful completion of the course, students should be able to
1. Understand different modes of heat transfer and estimate the total heat transfer
2. Understand design concepts of different heat exchanger equipment
3. Analyze heat exchange through different modes of heat transfer
4. Develop equations for different modes of heat transfer

List of Experiments to be conducted is as follows.
Term work shall consist of minimum **06** experiments and at least one assignment on each module.
1. To find Thermal conductivity and Thermal resistance of composite material.
2. To find the emissivity of given radiating surface.
3. To study Working and construction of Heat pipe.
4. To study heat transfer by Natural convection.
5. To study heat transfer by Forced convection.
6. To study heat transfer from Pin-Fin

Term Work:
The term work will comprise of following
1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Examination (MCQ) based on topics mentioned in latest GATE syllabus
4. Oral Examination
5. Mini Presentation on small topic of the syllabus

PCC–BTM553 Mechatronics Laboratory
Course Pre-requisites: PC-BTM503

Course Objectives:

- In the recent trend of automation in industry environment has changed very fast from mechanical to electromechanical. Hence aim is to implement such a mechatronics system in industry to enhance the performance as well as cost, size & power. Such as microcontroller base systems & programmable logic controller base systems.
- Knowledge of systems such as microprocessor, microcontroller, Programable logic controller, Electropneumatic & electro hydraulics & other systems such as MATLAB & software's will be useful.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To do interfacing of microprocessor, microcontrollers, PLCs, in mechatronics systems
2. To do programming for Mechatronics system
3. To use hydraulic and pneumatic actuation systems for developing circuits for industrial automation
4. To simulate of control systems using IT tools

Course Contents

List of Experiments to be conducted is as follows.

(At least 6 experiments from the list given below)

1. Study of basic principles of sensing and actuation techniques used in Mechatronics systems
2. Study of Electro-pneumatic Logic Trainer kit, and experiments on Electro-pneumatic circuits
3. Experiments on Ladder programming for Mechatronics system (Bottle filling plant)
4. Experiments using Microcontroller kit Interfacing of HEX-KEYBOARD
5. Experiments using Microcontroller kit Interfacing of LCD Display, ADC, DAC & STEPPER MOTOR
6. Introduction to remote sensing/control
7. Experiments on Control System using MATLAB
8. Experiments on mathematical model using SIMULINK
9. Experiments on DC Servo Position control system

Term Work:

The term work will comprise of following

1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Examination (MCQ)
4. Oral Examination

PC-BTM562 Dynamics of Machinery Laboratory
Course Pre-requisites: PC-BTM512

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

1. Understand fundamentals involved in working of machines.
2. Understand construction and principle of working of different machine components and sub-assemblies.
3. Provide the necessary tools to systematically synthesize a system and arrive at a critical shapes and dimensions.
4. Provide understanding of vibration systems in mechical engineering.

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

1. To examine construction and analyze motion of mechanical subsystems such as clutches, breaks, dynamometers, governors, gyroscope, gear trains.
2. To analyze static and dynamic balancing of rotor and reciprocating mass systems.
3. To examine SDOF vibration system
4. To investigate motion for damped and undamped vibration systems.

Course Contents

List of Experiments:

1. Study of Clutches, Brakes and Dynamometers
2. Experiments on Governors and Gyroscope
3. Experimental determination of natural frequency of simple and compound pendulum
4. Experimental determination of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel.
5. Experimental and theoretical investigation of whirling of shaft (i.e. comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory)
6. Experimental investigation of viscous and coulomb damping, prediction of system parameters (spring stiffness, damping coefficient) from damped oscillations.

Term Work:
The term work will comprise of following

1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Examination (MCQ) based on topics mentioned in latest GATE syllabus
4. Oral Examination

PCC–BTM564 Thermal Systems Laboratory
Course Pre-requisites: PC-BTM514

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

- Understand working of compressors.
- Understand working of nozzles and steam turbines.
- Get knowledge about working of steam generators
- Understand performance parameters and working of gas turbines.

Course Outcome:
Upon successful completion of the course, students should be able to
1. To know effect of parameter like delivery pressure on the volumetric efficiency of reciprocating air compressor
2. To understand effect of inlet pressure and back pressure on mass flow rate through C-D Nozzle
3. Get working knowledge of steam generators and its accessories
4. To understand torque speed and power speed characteristics of gas reaction turbine.

Course Contents
Any six experiments out of listed below.

- Trial on air compressors.
- Trial on experimental gas turbine
- Experiment on mass flow rate of air through orifice plate or nozzle.
- Study of steam turbines.
- Study of boilers mountings and accessories
- Study of experiments on heat balance sheet of boiler.
- Study of experiments on calorific value at constant pressure and constant volume.
- Determination of dryness fraction

Term Work:
The term work will comprise of following
1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Examination (MCQ) based on topics mentioned in latest GATE syllabus
4. Oral Examination

PC-BTM565 Computer Aided Machine Drawing Laboratory
Course pre-requisites: Engineering Graphics

Course Objective:
In this course students will:

1. Learn to understand drawing, which includes clear spatial visualization of objects and the proficiency in reading and interpreting a wide variety of production drawings.
2. Learn drafting skills depending upon job function, to perform day to day activities i.e. communicating and discussing ideas with supervisors and passing instructions to subordinates also knowledge of computer aided drafting is essential part.

Course Outcome:

Upon successful completion of this course, students should be able:

1. To create and compose engineering drawings for standard machine components on CAD Software.
2. To sketch free hand proportionate illustrative representation of common machine components.
3. To assemble various standard machine components on CAD Software.
4. To plot assembly and detail production drawings with bill of Material.

Course Contents:

Practical Work based on modules of PC-BTM515 course:

1 Sheet on Intersection of curves minimum two problems on CAD software.
1 Sheet on auxiliary views (one problem) on AutoCAD.
1 Sheet on free hand sketches of each topic from module 2 and calculating limits, fits and tolerances.
1 Sheet on details and assembly drawings of any one topic from module 3
1 Sheet on preparation of details and assembly drawings of any one topic from module 4
1 Sheet on preparation of assembly of detail drawings of any one topic from module 5
1 Sheet on preparation of details of assembly drawings of any one topic from module 6 with fits and tolerances.
1 Sheet on preparation of details and assembly drawings of any one topic from module 7 with fits and tolerances and exporting the file for 3d printing.

MC- BT003 Health Safety and Environment
Course pre-requisites: Engineering sciences

Course Objective:

The objective of this course is to sensitize the student to the ever-increasing environment problems and make them aware of the fundamentals of occupational safety and health along with prevailing laws in the world and India.

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

1. explain fundamentals of occupational health and safety and environmental issues
2. describe laws and regulations pertaining to health, safety and environment
3. propose specifications to comply with norms of environment engineering
4. discuss prevention of environmental pollution

Course Content:

Module No.	Details	Hrs.
01	**Introduction to Occupational Safety and Health (OSH)**: Need and Significance, Accidents and Their Effects, Theories of Accident, Roles and Professional Certifications for Safety and Health Professionals, Stress and Safety, Safety and Health Training	**04**
02	The Factories Act Basics and origin of the act, the inspecting staff, health, safety, disclosure of information, Special provisions	**04**
03	**Hazard Assessment, Prevention, and Control:** Mechanical Hazards and Machine Safeguarding, Fire Hazards and Life Safety, Ethics and Safety, Environmental Safety and ISO 14000	**04**
04	**Introduction to Environmental Engineering:** Adverse effects of environment, Types of environmental pollution - Water pollution, Air pollution, Solid waste management, Control Strategies of different environmental problems.	**04**
05	**National Legislation for Environment:** Constitutional provisions for safe-guarding the environment, The Environmental (Protection) Act, The Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, The Wild life (Protection) Act, Forest Act, Biodiversity Act	**04**
06	**International Concerns:** Conventions and Treaties-RAMSAR Convention, CITES, Convention on Biological Diversity, Convention to Combat Desertification, Convention on Climate Change.	**04**
07	**Establishing A Safety-First Corporate Culture** Definition, Importance, what a Safety-First culture looks like, steps for establishing a safety-first corporate culture	**04**

Term Work: Minimum (02) mini projects per student

Text Books:

1. Goetsch, David L. "Occupational Safety and Health for Technologists, Engineers, and." (2011).
2. Krishnaswamy J., Daniels R.J.R., Environmental studies, Wiley India Private Ltd. New Delhi (2009)
3. Basak, Anindita. Environmental studies. Pearson Education India, (2009).
4. Erach Bharucha, Textbook of Environmental Studies, University Press
5. MP Poonia, SC Sharma. Environmental Studies, Khanna Publishing House
6. Rajagopalan, Environmental Studies, Oxford University Press

References:

1. Alli, Benjamin O. "Fundamental principles of occupational health and safety." (2001).
2. Gaur, R. C. Basic environmental engineering. New Age International Pvt Ltd Publishers, (2009).
3. ISO 14001:2004(E) - Environmental management systems Requirements with guidance for use, (2004).

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

VA-BTM591 Reverse Engineering and Product Development
Course Pre-requisites: -

Course Objectives:

- Understand the Reverse Engineering (RE) Methodology
- Disassemble products and specify the interactions between its subsystems and their functionality
- Understand RE applications in software engineering

Course Outcome:

1. Describe the theory in Reverse Engineering
2. Apply the theoretical knowledge in Reverse Engg. Process
3. Formulate 3D model from scanned data
4. Use software & hardware related to Reverse engg.

Sr. No.	Details	Hrs.
Module 01	Introduction to Reverse Engineering (RE) Technology & Product Development	01
Module 02	Significance of Reverse Engineering Technology in Automotive & Auto component Industries. Barriers to reverse engg.	02
Module 03	Product Development Sequence & Reverse Engineering (RE) Methodology.	02
Module 04	Contact & Non-Contact data acquisition Techniques in Reverse Engineering. Software for Reverse Engg.	03
Module 05	Perform Reverse Engg. Process & techniques through the Digitizing/Scanning methods, Generating CAD model from scanned data, Post processing, triangulation.	02
Module 06	CASE STUDIES on Reverse Engineering in Various fields	02
Module 07	Application of Reverse Engineering in Aerospace & ship hull craft, Medical Life Sciences, Software industry etc.	02

PRACTICAL:
Term work shall consist of class assignments on each module.

Text Books:

W. Wego, (2011). Reverse Engineering Technology of Reinvention, Taylor and Francis Group, LLC International Standard Book Number-13: 978-1-4398-0631-9

REFERENCE BOOKS

- Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation, Wiley publications
- Reversing: Secrets of Reverse Engineering 1st Edition, by Eldad Eilam

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

PC-BTM605 Manufacturing Planning and Control
Course pre-requisites: PC-BTM306

Course Objectives:
Basically, this course consists of two streams Production Management and Operation Research.

- After learning this Course, the student will understand the Basic concepts, Principles of Production Management and Operation Research
- The student will learn the various Tools and Techniques like Forecasting techniques, Project Network Analysis Techniques, Production scheduling Techniques in detail and will be position to use them suitably.
- The student will also learn some Case studies of materials management, Purchase Management to reinforce their concepts.

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

1. Describe the Basic concepts, Principles of Production Management and Operation Research
2. Apply the various Tools and Techniques like Forecasting techniques
3. Analyse Project Network and to learn and apply Production scheduling Techniques
4. Examine Cases of materials management, Purchase Management to reinforce their concepts

Course Content:

Module No.	MODULE	HRS
01	**Manufacturing Planning and Control System:** Manufacturing transformation process, Manufacturing as competitive advantage. Manufacturing system – components and types. *Types of products. MPC system overview objectives and functions such as planning routing, scheduling, dispatching and follow up. [Self study]* **Forecasting:** Need for forecasting, Types of forecast. Extrapolative methods- Moving average method, Exponential smoothing method, Forecast errors, Linear trend model. Causal methods- Simple regression analysis.	6
02	**Planning Function**: Capacity planning and Aggregate Planning, Master Production Schedule, Shop floor Control.	6
03	**Planning for Material requirements:** *MRP and MRP II [self study],* Inventory control systems, Economic Order Quantity. Buffer stocks. Purchase and Production type of inventory. Quantity discount.	8
04	Concept of JIT. **Scheduling & Sequencing**: Scheduling concept, Scheduling of processes, Gantt chart, *Job shop scheduling, - Comparison of various methods [self study]*.	6

	Sequencing of tasks using, Johnson's rule.	
05	**Project Management**: Concepts of project, planning, monitoring and control, Project management through network analysis, CPM & PERT, *Cost analysis and crashing [self study]*.	4
06	**Advanced Concepts In Production Planning I:** Mathematical programming approaches- Linear programming problem, Formulation, Simplex method for maximization and minimization, *Concept of duality [self study]*	6
07	**Advanced Concepts In Production Planning II**: Assignment model, Transportation model. **Simulation:** Need for simulation, Monte Carlo technique.	6

Term Work:

- The Term work shall comprise of at least six assignments (Problems and Case Studies) covering different topics of the syllabus.
- Examination (MCQ) based on topics mentioned in latest GATE syllabus

Text Book:

1. Thomas E..Vollmann, William L.. Berry, and D. Clay Whybark.*Manufacturing planning and control systems*. Irwin/McGraw-Hill, 1997.
2. Chary, S. N. *Production and operations management*. Tata McGraw-Hill, 1988.
3. Jhamb L.C., *Modernization of Materials Management,* Everest Publishing House, 1999.
4. Taha, Hamdy A. *Operations Research: An Introduction (For VTU)*. Pearson Education India, 1982.

Reference Books:

1) Buffa E.S., Sarin R.K., *Modern production / Operations management*, Wiley, 1987
2) Telsang, Martand. *Industrial engineering and production management*. S. Chand, 2006.
3) Bewoor A., *Manufacturing Process Planning and System Engineering*, Dream-tech Press, 2009
4) Sharma J.K., *Operation Research*, Macmillan, 2009.
5) Narasimhan, Seetharama L. *Production planning and inventory control*. Pearson College Division, 1995.
6) Wayne W., *Operation Research*, Cengage Learning, 1987
7) Shah R., Soni H., *Operation Research*PHI Learning, 2009
8) Panneerselvam, R. *Research methodology*. PHI Learning Pvt. Ltd., 2014.
9) Ebert R.J., Adams E.E., *Production Operation Research*, PHI Learning, 1986.

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

PC-BTM606 CAD/CAM/CIM
Course Prerequisites: Engineering Drawing, Manufacturing Science

Course Objectives

The general objectives of the course are to enable the students to

- Understand the basic analytical fundamentals that are used to create and manipulate geometric models in computer programs.
- To visualize how the components looks like before its manufacturing or fabrication
- To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
- To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc.
- To understand the different types of curves like Bezier curve, B-Spline curve & Graphics Standards
- To understand different Algorithms for optimization of drawing of basic entities
- To understand NC,CNC and DNC technology and Concepts of compute integrated manufacturing (CIM)

Course Outcomes

At the end of the course

1. Students will be able to **explain** the theory in CAD/CAM/CIM
2. Students will be able to **formulate** APT & CNC programs as per the geometry of work piece
3. Students will be able to **solve** analytical problems on Geometrical Transformations, Algorithms, Bezier & B-Spline Curves.
4. Students will be able to **formulate** the programs on Geometrical Transformation Algorithms, Bezier & B-Spline Curves using IT tools like C/C++/MATLAB etc.

Course Contents:

Sr. No.	Details	28Hrs.
Module 01	**INTRODUCTION & ELEMENTS OF INTERACTIVE COMPUTER GRAPHICS** The Design process, Concurrent engineering in Product design & development, CAD System Architecture. Two dimensional computer graphics, vector generation, the windowing transformation, three dimensional Computer graphics, viewing transformation, Line, Circle & Ellipse Algorithm, Visual realism, Hidden line removal & hidden surface removal algorithm, Shading Algorithm.	**04**

Module 02	**TECHNIQUES FOR GEOMETRIC MODELING:** Graphic standards, The parametric representation of geometry, Bezier curves, Cubic Spline curve, B-Spline curve,NURBS, Jupiter Technology, Parametric representation of line, circle, & ellipse constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Feature recognition, Design by feature.	**04**
Module 03	**SELF STUDY** **GROUP TECHNOLOGY, CAPP, and CAQC** Introduction to GT, Part Families, parts Classification & Coding, GT Machine cells, Benefits of GT. Introduction to Computer Aided Process Planning (CAPP), Retrieval type Process Planning Systems, Generative type Process Planning Systems, Benefits of CAPP, Artificial Intelligence in CAPP,PFA, Similarity coefficient matrix. Introduction to Computer Aided Quality Control (CAQC), Computers in QC, Contact Inspection methods, Non Contact Inspection methods, Computer Aided Testing, Integration of CAQC with CAD/CAM	**04**
Module 04	**NC, CNC & DNC TECHNOLOGY:** Introduction to NC,CNC & DNC systems along with its advantages & disadvantages, Computer Aided Part Programming, Adaptive Control, CNC programming concepts, Trends & new developments in NC, Part programmers job, functions of a post processor, NC part programming languages, Elements of a APT language, Constructional details of CNC machines, Feedback devices- Velocity & displacement, Flexible Manufacturing System (FMS), Rapid Prototyping	**06**
Module 05	**TRANSFORMATION, MAINPULATION & DATA STORAGE** Basic Coordinate system, 2D & 3D Transformations, Concatenations, Matrix representation, Problems & Object Oriented Programming on Transformations. Data Structures for interactive modeling, Bill of materials from attribute data, The use of Object Orientation & associatively, Engineering Data Management System (EDMS), Relational Data Base for Design, Object Oriented Database, Structured Query Language, Design information Systems.	**05**

Module 06	**SELF STUDY** **COMPUTER INTEGRATED MANUFACTURING** Introduction, Evolution, Objectives, CIM Hardware and Software, CIM Benefits, Nature and role of the elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, Concept of the future CIM systems, Socio -techno- economic aspects of CIM.	**02**
Module 07	**EMERGING AREAS in CAD/CAM & ITS INTEGRATION SCENARIOS WITH OTHER INFORMATION TECHNOLOGIES** Design for Assembly, Reverse Engineering and Data Capture techniques, Artificial Intelligence in Design & Manufacturing, Representation of Knowledge, and Knowledge base Engineering (KBE). Green Manufacturing, Virtual Manufacturing(VR), Product Life Cycle Management (PLM), CAD-VR Integration, CAD-PLM Integration, Augmented Reality (AR)	**03**

NOTE:

- Module -1 & Module -2 will be for T1
- Module -3 & Module -4 will be for T2

Text Books:

1. "CAD/CAM Computer Aided and Manufacturing" by Mikell P. Groover and Emory W. Zimmers, Jr., *Eastern Economy Edition,PHI*
2. "CAD/ CAM , Theory & Practice" by Ibrahim Zeid, R. Sivasubramanian, *Tata McGraw Hill Publications*
3. "Computer Graphics" by Donald Hearn and M. Pauline Baker, *Eastern Economy Edition*
4. "CAD/CAM Principles, Practice and Manufacturing Management" by Chris McMahon, Jimmie Browne, *Pearson Education*
5. "CAD/CAM/CIM" by P. Radhakrishan, S. Subramanyan, V. Raju, *New Age International Publishers*
6. "CAD/CAM Principles and Applications" by P.N. Rao, *Tata McGraw Hill Publications*
7. "Principle of Computer Graphics" by William .M. Neumann and Robert .F. Sproul, *McGraw Hill Book Co. Singapore.*
8. "Computer Graphics & Product Modeling for CAD/CAM" by S.S.Pande, NAROSA Publication
9. David L. Goetsch, Fundamental of CIM technology ,Delmar publication
10. David Bedworth, Computer Integrated Design and Manufacturing, *McGraw Hill.*
11. "CNC Machines" by B.S. Pabla and M. Adithan, *New Age International Publishers.*

12. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
13. "CNC Technology and Programming", Krar, S., and Gill, A., *McGraw Hill publishers*
14. "Flexible Manufacturing Systems" by H.K. Shivanand, M.M. Benal, V.Koti, *New Age International Publishers*
15. "Automation, Production Systems and Computer Integrated Manufacturing ", Groover M.P., *Prentice-Hall of India Pvt. Ltd*
16. "Mathematical Elements for Computer Graphics", Rogers D F I and Adams J A, *McGraw-Hill.*

REFERENCE BOOKS

1. "Computer Integrated Manufacturing Hand Book" by Eric Teicholz, Joel N. Orr, *McGraw Hill International Editions*

2. "Computer Integrated Manufacturing- An Introduction with Case Studies" by Paul G. Ranky, *Prentice Hall International*

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

PC-BTM611 Refrigeration and Air Conditioning
Course pre-requisites: PC-BTM305, PC-BTM504

Course Objectives:

- Understand fundamentals involved in basic refrigeration and air-conditioning.
- Understand principle of working and construction of air conditioners, refrigerators and other related equipment's.
- Learn about current issues of ODP, TEWI and effects of air-conditioning on global warming.
- Learn about heat load estimation of air conditioning system and issues related to human comfort.

Course Outcomes:

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

1. Understand basic refrigeration cycles like vapour compression cycle, vapour absorption cycle, aircraft refrigeration cycles, refrigeration and air properties.
2. Apply knowledge of working of various cycles mentioned in 1 to evaluate performance of devices working on it.
3. Know about properties of refrigerants, environment friendly refrigerants, properties of air and human comfort.
4. Calculate the cooling / heating load for air conditioning system.

Course Content:

Module No.	Details	Hrs.
01	Introduction to Refrigeration Carnot refrigerator, unit of refrigeration, COP, EER Vapor Compression Refrigeration System • Simple vapor compression cycle • Effect of liquid sub cooling and suction vapor super heating, Use of Liquid vapor heat exchanger (LVHE). Actual VCR cycle. • Multi-pressure Systems Overview of Applications • House hold refrigerator • Window and Split air conditioners • Air conditioning of Multi-storied buildings • Green Buildings • Aircraft Refrigeration	06

02	Components • Desirable properties of refrigerants, Thermodynamic, Chemical and Physical properties, Designation system for refrigerants. ODP, GWP, TEWI, Secondary refrigerants • Types of Compressors, Condensers, Evaporators, Expansion devices, Controls – Safety Controls and Operating Controls	03
03	Psychrometry • Psychrometric properties, chart and processes. • Bypass factor, ADP, Adiabatic mixing of two air streams • RSHF , RADP, CADP, GSHF, ESHF • Cooling Towers, Types, Approach, Range, Efficiency, Components and maintenance	05
04	• Cooling Load estimation, Design of summer and winter air-conditioning systems.	04
05	Air Distribution Systems • Friction chart for circular ducts. Equivalent diameter of a circular duct for rectangular ducts. • Static pressure regain and equal friction drop methods of duct design. • Air Filters, Fans and blowers.	04
06	Human Comfort- • Effective temperature, Comfort chart, Comfort zone, • Methods of improving Indoor Air Quality(IAQ)	02
07	Vapor Absorption Refrigeration. • Ammonia Water • Water/Lithium Bromide system-Single Effect, Double Effect Electrolux refrigeration system	02

Text Books

1. Arora, Chandra Prakash. *Refrigeration and air conditioning*. Tata McGraw-Hill Education, 2000.
2.Dossat, R. J., and Thomas J. Horan. *Principles of refrigeration*, 2002.
3.Stoecker, W. F., and J. W. Jones. *Refrigeration and air conditioning*, Mc GrawHill Book Co, New York, 1982.

References Books

1. Ananthanarayanan, P. N. *Basic refrigeration and air conditioning*. Tata McGraw-Hill Education, 2013.
2. Handbook, A. S. H. R. A. E. "Fundamentals." *American Society of Heating, Refrigerating and Air Conditioning Engineers, Atlanta* 111 (2001).
3. Handbook, Shan K. Wang, "Handbook of Air Conditioning and Refrigeration", Mc Graw Hill Book Co., New York, 2000.

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

PC-BTM612 Machine Design

Course pre-requisites: PC-BTM302, PC- BTM406, PC-BTM412, PC-BTM415, PC-BTM512

Course Objectives:

The primary objective of this course is

- To analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts
- To define the detailed design procedure of simple machine elements as well as to apply the effect of different loading on it.
- To understand the detailed design procedure of the different types of joints and the effect of theories of failure on it.
- To understand the analysis of shafts and the effect of theories of failure.

Course Outcomes*:*

Upon successful completion of the course, students should be able

1. To formulate and analyze stresses and strains in machine elements subjected to static and fluctuating load conditions
2. To design and evaluate adequacy of standard/custom-built machine elements such as shafts, belts, chains, bolted/welded joints and springs to fulfil desired specifications and satisfy failure criteria
3. To examine and identify role of material selection, manufacturing requirements, aesthetic and ergonomic needs in design of machine elements
4. To demonstrate ability to plan and prescribe design of simple machine elements through engineering drawing and calculation report.

Course Content:

Module No.	Details	Hrs.
01	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Design Standards, I.S. codes, Preferred Series and numbers. Material properties and their uses in design, Manufacturing considerations in design: tolerances, types of fits, selection of fits, Design considerations of casting and forging. Theories of failures, Factor of safety	04
02	Design against static Loads: Cotter joint, knuckle joint. Power Screw– Design of Screw Presses.	04
03	Design against Fluctuating Loads, Variable stresses: reversed, repeated, fluctuating stresses Fatigue Failure- Static and fatigue stress concentration factors, Endurance limit- estimation of endurance limit Design for finite and infinite life- Soderberg and Goodman design criteria, Fatigue design under combined stresses.	06
04	Design of shaft- power transmitting, power distribution, shafts (excluding crank shaft) under static and fatigue criteria. Keys–Types of Keys and their selection based on shafting condition. Couplings–Classification of coupling. Selection of Standard Bush Pin coupling.	08
05	Design of springs- Helical compression, tension springs under static and variable loads Design of Laminated Springs.	06

06	Design of Belts –Flat and V belt with Pulley construction, timing belts and pulleys, Selection of Standard Roller chains.	06
07	Bolted and Riveted Joints – eccentrically loaded bolted and riveted joints Welded Joints – Design of single transverse, double transverse parallel fillet, eccentrically Loaded welded joint	08

Term Work:

Term work shall comprise of

1. Exercises on the above topics in the form of design calculations with sketches and or drawings.
2. At least four A2 size drawing sheets shall be submitted.
3. MCQ based on topics mentioned in latest GATE syllabus

Text Books:

1. Bhandari, V. B. *Design of machine elements*. Tata McGraw-Hill Education, 2010.
2. Shigley, Joseph E., Charles R. Mischke, and Richard G. Budynas. *Mechanical engineering design*. McGraw-Hill,, 2004.
3. Robert, L. Norton. "Machine Design An Integrated Approach." (2006).
4. **Recommended Data Books**
    a. V. Bhandari, *Machine Design Data Book*, McGraw Hill Education (2017)
    b. Mahadevan K., Reddy K.B. *Design Data Handbook for Mechanical Engineering in SI and Metric Units*, CBS (2013)
    c. *PSG Design Data Book*, PSG College, Coimbatore (2012)

Reference Books:

1. Spottes, M.F.,Terry E. S., and Lee E.H. *Design of machine elements*. Vol. 2. Pearson Education India, 2004.
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
3. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.

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

PC-BTM614 Internal Combustion Engine
Course pre-requisites: PC-BTM305

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

1. Understand fundamentals involved in internal engine combustion technology.
2. Understand construction and working principle of different types of engines and able to calculate work done and various efficiencies.
3. Test the performance of IC engines and plot their characteristics curves.

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

1. Describe the constructional details and thermodynamics of I C Engine
2. Apply the knowledge for testing and analyzing the engine performance parameters
3. Analyze engine performance, fuel properties, and exhaust constituents of S I and C I Engines
4. Evaluate the requirements of a modern engine for better economy and emissions.

Course Contents:

Module No.	Details	Hrs.
1	**Constructional Features of Reciprocating I.C. Engines**. Types of engines - Stationary, Automotive, and Marine engines.	03
2	**Carburetion** - Theory of Carburetion, Simple carburetor, various systems of actual Carburetor, Ignition System - Battery and Magnetic Ignition Systems. Electronic Ignition System. Combustion: Combustion phenomenon in S.I. Engines, Ignition delay, Petrol Injection - MPFI etc.	04
3	**C. I. Engines:** Requirement of Fuel Injection Systems, Types of fuel injection system viz. Common rail, individual pump, distributor and unit injector systems. High pressure fuel injection pump, Types of Nozzles. Necessity of Governor in Diesel engines. **Combustion:** Combustion phenomenon in C.I. Engines, Stages of combustion, Delay period.	06
4	**Supercharging /Turbo charging:** Objectives of Supercharging / Turbo charging. Effect of Supercharging / Turbo charging on power output and efficiency of the engine. **Performance Characteristics of S.I. & C.I. Engines:** Effect of load and speed on mechanical, indicated, brake thermal and volumetric efficiencies. Brake mean effective pressure and Brake specific fuel consumption, Heat balance test.	06
5	**Exhaust Gas Analysis and Air Pollution:** Necessity of exhaust gas analysis. Constituents of exhaust gas. **Fuels of I.C. Engines**: Requirements of fuels.	03

6	**Engine Lubrication**: Types of lubricants used in I.C. Engines. Properties of Lubricants. **Engine Cooling**: Systems of Cooling - Air, Water-cooling.	**03**
7	**Non-Conventional fuels for I.C. Engines**. CNG, LPG, Hydrogen, Bio-fuels, alcohol etc. Air Pollution due to engine exhaust.	**03**

Term Work / Laboratory Work:
At least 2 assignments from each module

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."

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

PC-BTM656 CAD/CAM/CIM Laboratory
Course Prerequisites: Engineering Drawing, Manufacturing Science

Course Objectives

The general objectives of the course are to enable the students to

- Understand the basic analytical fundamentals that are used to create and manipulate geometric models in computer programs.
- To visualize how the components looks like before its manufacturing or fabrication
- To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
- To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc.
- To understand the different types of curves like Bezier curve, B-Spline curve & Graphics Standards
- To understand different Algorithms for optimization of drawing of basic entities
- To understand NC,CNC and DNC technology and Concepts of compute integrated manufacturing (CIM)

Course Outcomes

At the end of the course

1. Students will be able to **formulate** the programs on Geometrical Transformation
2. Students will be able to **Implement** various Algorithms for applications of CAD/CAM
3. Students will be able to **Develop** Bezier & B-Spline Curves using IT tools like
4. Students will be able to **Generate** CNC programs for simple components

List of experiments:

1. 3D Modeling & Parametric on Advanced CAD Package
2. Assembly using Advanced CAD Package
3. C++/JAVA Program for DDA Algorithm
4. C++/JAVA Program for Bresenhams Algorithm
5. C++/JAVA Program for Circle Algorithm
6. C++/JAVA Program for Bezier Curves
7. C++/JAVA Program for B-SPline Curves
8. C++/JAVA Program for 2D Transformations
9. C++/JAVA Program for 3D Transformations
10. CNC Programs simulation for simple objects using any Simulation software (3 Programs)

TERMWORK:

- Assignments will be based on each module of theory course
- Miniproject/MCQ

PC-BTM661 Refrigeration and Air Conditioning Laboratory
Course pre-requisite: PC-BTM611

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

- Understand fundamentals involved in refrigeration and air-conditioning
- Understand construction and principle of working of compressors, air conditioners, and refrigerators.
- Learn about current issues of ODP, TEWI and effects of air-conditioning on global warming.
- Learn about air-conditioning processes.

Course Outcomes:

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

1. Know the working of refrigerators, air-conditioners and other equipment's used in HVAC.
2. Know working of various devices used in refrigerators and air conditioners.
3. Know use of refrigerants and importance of human comfort.
4. Calculate COP of refrigerators, heat pumps and air-conditioners.

Course Contents:

List of Experiments to be conducted is as follows. (At least 6 experiments to be performed)

Experiments:

1) Experiments to find COP for equipment's like Split air conditioner, domestic refrigerator
2) Experiments on Air and water Heat Pump, Benchtop Cooling Tower
3) Experiments involving the study of humidification dehumidification, heating and cooling, Adiabatic Mixing of two air streams.
4) Visit report- Cold storage plant / ice plant or air-conditioning site visit.

Term Work:

The term work will comprise of following

1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Oral Examination
4. MCQ based on topics mentioned in latest GATE syllabus

PC-BTM664 Internal Combustion Engine Laboratory
Course pre-requisites: PC-BTM614

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

1. Understand fundamentals involved in internal engine combustion technology.
2. Understand construction and working principle of different types of engines and able to calculate work done and various efficiencies.
3. Test the performance of IC engines and plot their characteristics curves.

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

1. Describe the constructional details of I. C. Engine
2. Apply the knowledge for testing and analyzing the engine performance parameters
3. Analyze engine performance, fuel properties, and exhaust constituents of S I and C I Engine
4. Evaluate the requirements of a modern engine for better economy and emissions

Course Contents
List of Experiments to be conducted is as follows.
1) Study of carburetor.
2) Study of ignition system.
3) Study of fuel injection system.
4) Morse Test on petrol engine.
5) Speed Test on petrol or/and diesel engine.
6) Load Test on diesel engine (engines).
7) Heat Balance test on diesel or petrol engines.

Term Work:
The term work will comprise of following
1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Oral Examination
4. Mini Presentation on small topic of the syllabus
5. MCQ based on topics mentioned in latest GATE syllabus

VA-BTM691 CNC Programming
Course pre-requisites: Manufacturing Science

Course Objectives:
The objective of this course is to:

- Learn working principle of CNC turning and CNC milling machine.
- Learn about different hardware component and systems

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

1. Explain basic construction, hardware components and working of CNC machines.
2. Formulate CNC program using G code and M code and run its simulation.
3. Execute a dry-run cycle before actual execution of CNC program.
4. Modify the CNC program, and its execution for variety of jobs.

Course Content:

Sr. No.	Description	Duration (hrs.)
1	Introduction to CNC Technology, CNC Architecture, Mechanical Elements of CNC Machines, Conveyors Electric Drives & Servomotors Control Elements & Feed Back Devices System Software & PLC	2
2	ATC, APC, Tool Magazine and Tooling for CNC Machines	2
3	Practical on CNC Lathe Machine How G-codes Work	2
4	Practical on CNC Machine How M- codes, Work	2
5	Programming on CNC System for Turning Centre	2
6	Programming on CNC System for Machining Centre	2
7	Practical job Performed on CNC Lathe Machine like Facing, Turning, Grooving, Threading, and Drilling.	2
8	Practical job Performed on CNC milling Machine like plain milling, side milling, pocket milling, Grooving, Threading, and Drilling.	2

Recommended Books:

- Peter Smid. CNC Setup for Milling and Turning: Mastering CNC Control Systems, Industrial press ***Inc.*****, 2007.**

Term work:
Assignment based on above topics.

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

PE-BTM511 Finite Element Methods for Mechanical Engineers
Course pre-requisites: Strength of Materials, Engineering Mathematics

Course Objectives:
1. To explain the finite element method its fundamentals and general steps.
2. To understand the underlying theory, assumptions and modeling issues in FEM.
3. To study the formulation of elemental characteristics matrices.
4. To provide hands on experience using finite element software to model, analyze and design systems of mechanical engineering.

Course Learning Outcomes:

After successful completion of the course the student should be able to
1. Formulate numerical model for a given system.
2. Obtain solution for given problems.
3. Solve mechanical engineering problems using FEA techniques.
4. Carry out FE analysis using commercial software.

Course Content:

Sr. No.	Details	Hrs.
Module 01	Introduction to FEM- DOF, elements, nodes and interpolation. Brief History. Applications of FEM in various fields. Advantages and disadvantages of FEM. FEA procedure. Types of Differential Equations used in various engineering fields, Primary and Secondary Variables and types of Boundary Conditions. Matrix Algebra Matrix operations, Gauss Elimination Method to get inverse of a Matrix.	6
Module 02	Formulation Techniques: Galerkin and other Weighted Residual Methods	6
Module 03	Formulation Techniques: Variational Methods, Reyleigh-Ritz Method	6
Module 04	One dimensional Elements and computational procedures. Bar and Beam element. Stiffness Matrix, Assembly of Stiffness matrix. Loads-mechanical and thermal. Boundary Conditions.	8
Module 05	Two dimensional elements and computational procedure. Interpolation and shape functions. Three nodded triangular element, four nodded rectangular element, four nodded quadrilateral element, and Isoparametric elements.	8
Module 06	Numerical Integration and Gauss quadrature, solution to the problem.	4
Module 07	Error, Error estimation and convergence.	4

Course Project

In course project students shall integrate and apply the knowledge gained during the fundamental courses of Mechanical Engineering. The projects will be developed by teams of maximum two students (using any analysis software) and shall consist problem definition, model preparation, appropriate selection of elements, mesh generation, post processing, simulation and validation of results.

Term Work/Practicals:

- Term work shall consist of minimum **03** assignments (one on each module)
- Hands on practice on finite element software for 1D and 2D problem.

Text Books: .

1) P. Seshu. *Textbook of Finite Element Analysis*, Prentice Hall, 2003
2) Logan, *Finite Element Method*, CL Engineering, Fifth Edition, 2010.
3) Reddy J. N. *Finite Element Method*, McGraw Hill Education, Third Edition, 2005

References:

1) R.D. Cook. *Concepts & Applications of Finite Element Analysis*.
2) Bathe, K.J., *Finite Element Procedures in Engineering Analysis*, Prentice Hall of India.
3) C.S. Krishnamoorthy. *Finite Elements Analysis*, Tata McGraw Hill
4) S.S. Rao. *The Finite Element Method in Engineering*, 4th Edition, Academic Press, Elsevier
5) Desai and Abel. *Introduction to Finite Elements Methods*, CBS Publication.

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

PE-BTM512 Automation of Engineering Drawings
Course pre-requisites: Engineering Graphics

Course Objectives

1. To gain a thorough understanding of drawing, which includes clear spatial visualization of objects and the proficiency in reading and interpreting a wide variety of production drawings.
2. To acquire certain degree of drafting skills depending upon job function, to perform day to day activities i.e. communicating and discussing ideas with supervisors and passing instructions to subordinates also knowledge of computer aided drafting is essential part.

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

1. To explain internal representation of graphical entities as a database record in AutoCAD drawings
2. To write code using Programming language (AutoLisp, Visual Lisp or equivalent) for automation of engineering drawing.
3. To create parameterized part drawings using Programming language.
4. To plot production drawings of the parts created using Programming language.

Course Contents:

Module No.	Details	Hrs.
01	Introduction to Programming language for drafting	06
02	Data Structures for handling graphical entities	06
03	Part Drawing 1 creation with Programming language	06
04	Part Drawing 2 creation with Programming language	06
05	Part Drawing 3 creation with Programming language	06
06	Generate variations of drawings created using Programming language	06
07	Controlling plotting parameters using Programming language	06

Term Work:

At least 3 Part Drawing plotted on A4 sheet.

Text Books:

1. Reinaldo N. Togores, Controlling AutoCAD from Visual LISP (AutoCAD expert's Visual LISP Book 2), Amazon Asia-Pacific Holdings Private Limited

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

PE-BTM513 Design Thinking
Course pre-requisites: Basic Sciences and Engineering Sciences

Course Objectives:

1. Learn how to blend the perspectives of marketing, design overview, and engineering into a systematic approach to delivering innovation.

Course Outcomes:
Upon successful completion of the course, students should be able to
1. Discuss the design thinking process
2. Identify and assess customer opportunities to generate and evaluate new product and service concepts
3. Design services and customer experiences
4. Evaluate economics of product development

Course Contents:

Module No.	Description	Hrs.
1	Process of Design Thinking, role of innovation, applications of design thinking to practical cases.	**06**
2	Product development process, customer and market need analysis, writing of need statements	**06**
3	Product concept development, role of creativity, different techniques of creative thinking, use of sketching and CAD in concept development	**06**
4	Design of services and customer experience, services experience cycle	**06**
5	Produce development economics, financial aspects of product development project	**06**
6	Product lifecycle assessment, design for environment	**06**
7	Product knowledge management, Working in teams	**06**

Term work/Tutorial
1. Assignments on each module
2. Case studies on applications of Design Thinking
3. Seminar on recent advances in Design Thinking
4. Mini project to develop a product using knowledge from all modules

Recommended Books:
1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business (2009)
2. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Bloomsbury Publishing India Private Limited (2011)

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

PE-BTM514 Introduction to System Modelling and Analysis
Course pre-requisites: Kinematics and Dynamics of Machinery

Course Objectives:

After this course students will be able to:

1. Understand what is a model, types of models, purpose of models
2. Understand the need for quantification and understand the limits of quantification
3. Be able to transform loose facts into an insightful model, to be used as input for requirements discussions and system design and verification
4. Be able to use scenario analysis as a means to cope with multiple alternative specifications and or designs
5. Apply problem-driven light-weight simulations and understand their value and purpose in early design decisions

Course Outcomes:

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

1. Apply mathematical modelling for mechanical Elements, systems, hydraulic/pneumatic element and systems.
2. Describe transfer function representation
3. Analyse system response and stability.
4. Compute transient response of first and second order system.

Course content:

Mod. No.	Description	Duration (hrs)
1	Mathematical modeling of mechanical elements – inertia, stiffness and damper	6
2	Mathematical modeling of mechanical systems for simple mechanical systems	6
3	Mathematical modeling of hydraulic and pneumatic elements and system	6
4	Transfer function representation, block diagram, State variable representation, matrix equation.	6
5	Numerical methods and some solution methods.	6
6	System response and stability – Static and dynamic stability	6
7	Transient response of first and second order system – Steady state response – step response, ramp response, stability of system.	6

Term work:

- Assignment based on each of the module.
- Mini Project and/or Seminar

Recommended Books:

1. Vu, Hung V., and Ramin S. Esfandiari. *Dynamic systems: modeling and analysis*. McGraw-Hill Science, Engineering & Mathematics, 1997.
2. Ellis, John Ronaine. *Vehicle dynamics*. Random House Business, 1969.
3. Kobayashi, Hisashi, and Brian L. Mark. *System modeling and analysis: Foundations of system performance evaluation*. Pearson Education India, 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

PE-BTM515 Knowledge Based Engineering
Course pre-requisites: Any one programming language

Course Objectives:
Students will be able to understand the basics of Knowledge Based Engineering (KBE). They will be able to represent the knowledge on the form of logic & rules & will further apply the knowledge to deveop the application

Course Outcomes:

1. Describe the concepts of KBE
2. Apply the theory concepts to an application
3. Convert information in the form of logic & rules
4. Develop an application using KBE concepts

Course Content:

Sr. No.	Details	Hrs.
Module 01	What is knowledge Based Engineering (KBE). Organizational challenges & Value addition	06
Module 02	Elements of Knowledge Based System, Knowledge Representation, Knowledge representation methods.	06
Module 03	Knowledge Representation Issues: Representations And Mappings, Approaches To Knowledge Representation. knowledge Based Engineering (KBE), KBE Methodology	06
Module 04	Knowledge Base integration, Knowledge Based Engineering in CAD, Product Development, Computer Aided Process Planning (CAPP), KBE & Product Life Cycle Management (PLM)	06
Module 05	CASE STUDIES & Applications of knowledge Based Engineering (KBE) in Design, Manufacturing & other fields	06
Module 06	Business Challenges, Programming tools & skills	06
Module 07	Future of knowledge Based Engineering (KBE)	06

TERM WORK:
Term work shall consist of class assignments on each module.

Text Books:

REFERENCE BOOKS

1 “Artificial Intelligence” -By Elaine Rich And Kevin Knight (2nd Edition) Tata Mcgraw-Hill
2. Artificial Intelligence: A Modern Approach, Stuart Russel, Peter Norvig, PHI
3 Introduction to Prolog Programming By Carl Townsend.
4. “PROLOG Programming For Artificial Intelligence” -By Ivan Bratko(Addison-Wesley)
5. “Programming with PROLOG” –By Klocksin and Mellish

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

PE-BTM516 Smart Product Development
Course pre-requisites: General Mechanical Engineering Knowledge

Course Objectives

1. To give opportunity to the budding engineers to develop their engineering skills and innovative thinking ability.
2. To understand the process of building engineering products.

Course Outcomes:

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

1. To explain the process of developing engineering products from concept to fabrication and testing
2. To discuss different methods available for innovative product design.
3. To implement theoretical knowledge for designing products with smart features.
4. To build physical prototype from initial product idea.

Course Contents:

Module No.	Details	Hrs.
01	Introduction to systematic process for design and development of new product. Nature of 'smart' product features	06
02	Understanding different techniques available for generating innovative solutions to product design problem	06
03	Smart product development: Stage 1 – develop multiple design solutions	06
04	Smart product development: Stage 2 – Analysis of solutions and selection of one solution based on pre-defined criteria	06
05	Smart product development: Stage 3 – preparation of calculation report and engineering drawings	06
06	Smart product development: Stage 4 – Fabrication of prototype	06
07	Smart product development: Stage 1 – Testing of prototype	06

Term Work/Practicals:

- Maintaining journal book with record of idea generation, calculations, sketches, drawings.
- Demonstration of final prototype built by the student

Text Books:

1. Roger Woods (Editor), Karen Rafferty (Editor), Julian Murphy (Editor), Paul Hermon (Editor). *Engineering Innovative Products: A Practical Experience,* Wiley India, 2014.

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

PE-BTM517 Synthesis of Mechanisms
Course pre-requisites: Kinematics and Dynamics of Machinery

Course Objectives

1. To develop their engineering skills to build mechanisms to perform required motion.
2. To provide knowledge about design and analysis of mechanisms.

Course Outcomes:

At the end of the course the students shall be able to

1. Apply the graphical and analytical techniques commonly used in the synthesis of mechanisms.

2. Formulate and solve problems of analysis and synthesis of mechanisms using modern IT tools.

3. Explain and discuss the theory and methodologies employed for design of mechanisms.

4. Synthesize mechanisms with 3 and 4 accuracy points.

Module No.	Detail syllabus	Hrs.
1	Type Synthesis, Number Synthesis, Dimensional Synthesis Type synthesis, Number synthesis, Dimensional synthesis, Accuracy points, Spacing of of accuracy points, Chebyshev polynomials.	06
2	Four Bar Coupler Point Curve: Four bar linkage, coupler curve equation, double points and symmetry, Roberts-Chebyshev theorem	06
3	The Euler Savary Equation and Cubic of Stationary Curvature: The Euler Savary equation and the Inflection circle, The cubic of stationary curvature.	06
4	Linkage Synthesis with Three Accuracy Points (Geometric Methods): Concept of poles, relative poles, pole triangle of four bar and slider crank mechanism. Application in position generation, function generation problems	06
5	Linkage Synthesis with Three Accuracy Points (Algebraic Method) Fredeinstain displacement equation of four bar linkage for three accuracy points, Crank-follower linkage synthesis angular velocities and acceleration Linkage Synthesis with Three Accuracy Points: Complex Number Method	06
6	Linkage Synthesis with Four Accuracy Points (Geometric Methods): Concept of opposite pole quadrilateral, Center point curve, Circle point curve, Application in position generation problems.	06
7	**Static force analysis of plane mechanisms** Static force analysis, two and three-force member, Four force member, Static force analysis with friction- in four bar chain mechanism and slider crank mechanisms.	06

Term work:

Assignment containing numerical problem based on above topics

Recommended Books

1. Mallik, Asok Kumar, Amitabha Ghosh, and Gunter Dittrich. Kinematic analysis and synthesis of mechanisms. CRC Press, 1994.

Reference Books:

1. Beyer, Rudolf. "The kinematic synthesis of mechanisms." (1963).
2. Tao, Deh Chang. Applied linkage synthesis. Addison-Wesley Pub. Co., 1964.
3. Hartenberg, Richard Scheunemann, and Jacques Denavit. Kinematic synthesis of linkages. McGraw-Hill, 1964.
4. Tesar, Delbert. Graphical Procedures for Kinematic Synthesis of Mechanisms. University of Florida, 1975.

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

PE-BTM518 Mechanical Vibrations
Course pre-requisites: Dynamics of Machinery

COURSE OBJECTIVES

1. To develop skill to model a mechanical system as a single or multi-degree of freedom vibration problem.
2. To provide knowledge of analytical and experimental methods of vibration analysis

COURSE OUTCOMES

The student should be able to –

1. Model a physical system using various principles.

2. Estimate response for the given system.

3. Evaluate response for the given system.

4. Justify parameters required for vibration control.

Course Content

Module no.	Description	hrs
1	Unit I: SDOF Systems – Arbitrary Excitation One degree of freedom systems- harmonic excitation – An Overview; Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function	**06**
2	Unit II: MDOF Systems – Free and Forced Vibrations Multi degree of freedom systems, Free, damped and forced vibrations of two degree of freedom systems, Eigen values and Eigen vectors, normal modes and their properties, mode summation method.	**06**
3	Unit III: Vibrations of Continuous Systems and Numerical Methods Continuous Systems, Introduction to vibrations of strings, bars, shafts and beams; Mathematical model for vibration of Euler beam and its solution – natural and forced vibration, Mode shapes and natural frequencies, forced vibration of beams carrying concentrated harmonic forces. Numerical and computer methods in vibrations: Rayleigh, Rayleigh-Ritz and Holzer's method.	**06**
4	Forced single degree of freedom vibration system Analysis of linear and torsional systems subjected to harmonic force and harmonic motion excitation (excluding elastic damper). Force and motion Transmissibility.	**06**
5	Equivalent single degree of freedom Vibration system. Conversion of multi –springs, multi masses, multi dampers into a single spring mass and damper with linear or rotational co-ordinate system	**06**

6	Vibration measuring instruments Principle of seismic instruments, Vibrometer, accelerometer, sensors used in measurement. Introduction to FFT analyzer	**06**
7	Introduction to condition Monitoring and Fault diagnosis. Multi degree of freedom Vibration systems Lagrange Method, Exact and approximate solution methods	**06**

Term work:
Assignment containing numerical problem based on above topics

Text Books

1. G. K. Grover, Mechanical Vibrations, Nem Chand & Bros, Eighth Edition, 2009

2. Graham Kelly, Fundamentals of Mechanical Vibration, Tata McGraw Hill, 2000

3. P.L. Ballaney, Theory of Machines, Khanna Publishers, 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

PE-BTM531 Digital Manufacturing

Course Pre-requisites: Conversant with 3D Modelling software like CATIA/PRO-E, Knowledge of Layout, Simulation etc.

Course Objectives:

The students will be able to grasp the basic idea of digital manufacturing. The students will be able to create the virtual environment & simulate the same. They will also understand the robotic simulation and insert virtual manikins & avatars

Course Outcomes:

1. Describe the theory related to Digital Manufacturing
2. Create Virtual Environments of any facility like shop-floor etc.
3. Demonstrate the technology for new applications
4. Compare digital & Actual Layout

Course Content:

Sr. No.	Details	Hrs.
Module 01	**FUNDAMENTALS OF DIGITAL MANUFACTURING:** Definition of digital manufacturing, Architecture of Digital Manufacturing System. Role of Digital Manufacturing in Automotive & Auto Component Industries	06
Module 02	**DIGITAL FACTORY AND VIRTUAL MANUFACTURING:** Introduction, Scope, Methods and Tools Used in Virtual Manufacturing, Benefits. Virtual factory simulation.	06
Module 03	**HARDWARE & SOFTWARE** Hardware & software technologies used in Digital Manufacturing, Conversion of CAD Model to VR Model	06
Module 04	**VIRTUAL REALITY AND VIRTUAL ENVIRONMENTS:** The historical development of VR: Flight simulation, Virtual environments, Requirements for VR, benefits of Virtual reality. Creation of Virtual Environments, 3D Factory & simulation	06
Module 05	**VIRTUAL COMMISSIONING** Virtual Commissioning, Validation	06
Module 06	**R&D** Research & Development status of Digital Manufacturing	06
Module 07	**Research & Development Status of Digital Manufacturing** Bionic Manufacturing, Holonic Manufacturing, Biological Manufacturing	06

TERM WORK:

- Assignments Based on each Module and or Practicals based on any Digital Manufacturing software

Text Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", Springer, 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

PE-BTM532 Introduction to Composite Material Technology
Course pre-requisites: Manufacturing Science, Material Science

Course Objectives:

The objective of this course is to:

- Explain types of composite materials and their applications
- Describe manufacturing processes for composite materials
- Discuss mechanical properties of composites

Course Outcomes:

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

1. explain types of composite materials and identify its applications to mechanical engineering systems
2. discuss constituents of different types of composites
3. describe manufacturing processes for composite materials
4. define simple mechanical properties of composites

Course contents:

Sr. No.	Description	Duration (hrs.)
1	**Overview of composite materials** Historical background, Classification based on structure and matrix, Advantages and limitations, industry applications	06
2	**Composite materials** Reinforcement fibers, whiskers, polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC),	06
3	**Composite Science** Material and microstructure parameters of layered and phased composites, micro and macro approaches to study and prediction of structure property relations.	06
4	**Introduction to micromechanics** Anisotropy of composites, anisotropic elastic constants, failure criteria under multiaxial loading, interlaminar failure mechanism	06
5	**Composite manufacturing processes** Manufacturing of reinforcement fibers and whiskers, preparation of fillers, additives and pigments for PMC, manufacturing of matrix polymers, manufacture of metallic matrices, processing of ceramics, manufacture of foams, honeycombs and adhesives.	06
6	**Composite post processing operation** Machining, cutting, polishing, welding of thermoplastic PMC, bonding, riveting and painting	06
7	**Composite product design** Material considerations in composite product design, material design of thermal, optical, acoustic, electrical design requirements, design exercise for design of simple structural element such as tension bar and ring.	06

Term work:

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

Recommended Books:

1. K.K. Chawla, Composite Materials – Science & Engineering, Springer-Verlag, New York, 1987.
2. Analysis and Performance of Fiber Composites, Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, Wiley, 2006
3. Handbook of Composites, George Lubin, Van Nostrand, Reinhold Co., 1982

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

PE-BTM533 Introduction to Computer Integrated Manufacturing
Course pre-requisites: Manufacturing Science

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the basic Manufacturing models and Metrics.
2. To identified Elements of an automated system – Levels of Automation.
3. To create Logical steps in Computer Aided Process Planning.
4. To understand the cellular manufacturing.
5. to understand the component and application of flexible manufacturing system (FMS) and automated guided vehicle system (AGVS)
6. To understand industrial robotics and application in manufacturing.

Course Outcomes:

Upon successful completion of the course, students should be able

1. Describe the Basic concepts, and application of Computer Integrated Manufacturing.
2. To create different Logical steps in Computer Aided Process Planning according to different manufacturing requirement.
3. Analysis of automated flow line & line balancing.
4. To apply industrial robotics in various manufacturing process.

Course Content:

Module No.	Details	Hrs.
1.	INTRODUCTION Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production	06
2.	PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.	06
3.	CELLULAR MANUFACTURING Group Technology(GT), Part Families – Parts Classification and coding	06

	– Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems	
4.	FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.	06
5.	ANALYSIS OF AUTOMATED FLOW LINE & LINE BALANCING General terminology and analysis, Analysis of Tranfer Line without storage upper bound approach, lower bound approach and problems, Analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with simple problem, Partial automation-with numerical problems, flow lines with more than two stages, Manual Assembly lines, line balancing problem.	06
6.	CNC MACHINING CENTERS Introduction to CNC, elements of CNC, CNC machining centers, part programming, and fundamental steps involved in development of part programming for milling and turning.	06
7.	INDUSTRIAL ROBOTICS Robot Anatomy and Related Attributes – Classification of Robots-Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.	06

Term Work:
Assignments based on the above topics.

Texts/References:

1. Groover, M. P., Automation production systems, and computer-integrated manufacturing, second edition, Prentice-Hall of India, New Delhi, 2001.
2. Vajpayee, S. K., Principles of computer-integrated manufacturing, Prentice-Hall of India, New Delhi, 2005.

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

PE-BTM534 Lean and Green Manufacturing
Course pre-requisites: Manufacturing Sciences

Course Objectives-

- To introduce the concepts and practices of Lean and Green
- To make the students aware of Lean and Green assessment tools.
- To enable the students to apply the Lean and Green concepts in various fields.

Course Outcomes-

1. Students will learn the basic concepts of Lean manufacturing
2. Students will be able to explore the wastes in organizations as per the Lean principles
3. Students will be able to develop the New Process using the VSM
4. Students will learn basics of green manufacturing and identify the best practices used in the manufacturing environment

Course Contents:

Sr. No.	Description	Hrs.
01	**Module I: Introduction to Lean and Green Manufacturing** Evolution of Lean; Objectives of lean and Green manufacturing; key principles; implications of lean and Green manufacturing, Concept of Lean; Toyota's foray in Lean;	06
02	**Module II: Lean System Design - Value Stream Management** Definition of Value and value stream; Definition of waste - 3 Ms Muda, Mura, Muri - 7 Types of Muda; Value Stream Mapping (VSM) Types; TAKT Time	06
03	**Module III: Tools/Techniques/Methodologies/Practices for Lean System Implementation** **(A)Flow Stage:** Work place organization (5S principles); Concept of Kaizen/ continuous improvement; Single Minute Exchange of Die Pokayoke; Prevention & Detection Types; Maintenance - Preventive, Time Based and Condition Based; total productive maintenance; Autonomous Maintenance; Poke Yoke; Process Stability – Losses, 7 Major Losses Reduction-Overall Equipment Effectiveness (OEE) **(B) Pull stage:** **Just In Time Manufacturing (JIT):** Introduction - elements of JIT - uniform production rate - pull versus push method- Kanban system: Types of Kanbans and Practical Application, case studies;	06
04	**Module IV: Lean and Green Metrics and Assessment** Identify Lean and Green Metrics; Steps involved in Goal Setting; Corporate Goals; Lean Assessment- Framework/Models of Lean and Green assessment, Global Prizes/Awards for sustainable lean and Green implementation.	06
05	**Module V: Lean Sustenance**	06

	Human Development for sustainable Lean implementation; Involvement of Employees, Cultural Change; Reviews; Recognition; Improving Targets and Benchmarking the best practices; Road map.	
06	**Module VI: Applications of Lean and Green in Different Sectors** Lean and Green New Product Development, Lean Software Development – CMMI Level 4 (Quality Improvement) and Level 5 (Quality Optimization), Lean and Green Construction, Lean Healthcare, Lean in Education system etc. A case study on application of Lean in any sector.	06
07	**Module VII: Reconciling Lean with Other Systems** Lean and Green Manufacturing, Barriers for Green manufacturing , Green Supplier Development, Critical success Factors for Green Manufacturing	06

Term Work:
Assignments based on the above topics.
Case study Preparation [Minimum 2 case studies]

Reference Books:

1. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, Productivity and Quality Publishing Pvt Ltd, 2002.
2. Taiichi Ohno, Toyota, “Production System Beyond Large-Scale production”, Productivity Press (India) Pvt.Ltd., 1992.
3. Green Manufacturing: Fundamentals and Applications (Green Energy and Technology) 2012th Edition, by David A. Dornfeld (Editor), Springer Publications
4. Green Manufacturing Processes and Systems, by J. Paulo Davim (Editor), Springer Publications
5. Don Tapping, Tom Luyster and Tom Shuker, “Value Stream Management”
6. Tom Luyster, “Your Lean Future State”
7. Kenichi Sekine, “One-Piece Flow”, Productivity Press, Portland, Oregon, 1992.
8. Mike Rother and Rick Harris, “Creating Continuous Flow”
9. Rick Harris, Chris Harris & Earl Wilson, “Making Materials Flow”
10. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, John Wiley and Sons Inc., 2003.
11. Alan Robinson, “Continuous Improvement in Operations”, Productivity Press, Portland, Oregon, 1991.
12. Poke - Yoke, "Improving Product Quality by Preventing Defects", Productivity Press, 1992.

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

PE-BTM535 Non-Destructive Testing
Course pre-requisites: Manufacturing Science

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

1. Understand different types of non-destructive testing methods.
2. discuss industrial applications of non-destructive testing.
3. explain use of equipment of non-destructive testing
4. suggest appropriate non-destructive testing methods for specific industrial situation.

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

1. describe different types of non-destructive testing methods.
2. explain industrial applications of non-destructive testing and use of international standards such as ASQ, ASME, and ANSI.
3. select appropriate non-destructive testing method for industrial scenario
4. perform simple non-destructive testing procedures.

Course Content:

Module No.	Details	Hrs.
01	**Introduction to NDT** NDT Versus destructive testing, various types of manufacturing defects, different non-destructive testing methods with their relative advantages and limitations, industrial applications of NDT	06
02	**Visual Testing (VT)** Aided and unaided visual inspection, advantages and limitations of VT, qualification and certification requirements for VT, inspection tools for VT, direct and remote VT	06
03	**Liquid Penetrant Testing (PT)** principles of working for visible and fluorescent PT, preparation/pre-cleaning of test objects prior to beginning the inspection, steps in conduct of PT testing, interpretation and evaluation of the indications	06
04	**Magnetic Particle Testing (MT)** Principles of Magnetic Particle Testing, magnetization and its types, types of magnetizing current, methods of demagnetization, dry and wet MT, portable, mobile and stationery equipment for MT, interpretation and evaluation of indications, differentiate between surface and subsurface indications.	06
05	**Ultrasonic Testing (UT)** Basic principles of ultrasonic testing, equipment for UT, different types of transducers, importance of calibration in UT, basic testing procedure, straight beam and angle beam testing, different scans (A-scan, B-scan and C-scan)	06

06	**Radiography Testing (RT)** Basic principles of radiographic testing, advantages and the limitations of RT, x-ray, gamma ray and their sources, equipment and procedure for RT, film processing and interpretation, computed and digital radiography	06
07	**Eddy Current Testing (ET)** Basic principles of eddy current Testing, generation of eddy currents, eddy current sensing elements, probes, instrumentation, procedure for RT and interpretation of test	06

Term Work / Laboratory Work:
Journal work shall consist of experiments (at least 05) and assignments (one on each Module).

List of Experiments

1. Experiment on VT
2. Experiment on PT
3. Experiment on MT
4. Experiment on UT
5. Demonstration of RT by site visit to industry
6. Demonstration of ET by site visit to industry

Text Books:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

Reference Books:

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
3. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

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

PE-BTM536 Product Life Cycle Management (PLM)
Course pre-requisites: Manufacturing Sciences

Course Objectives-

- Provide insight of PLM
- Understand technologies enabling PLM
- Understand the integration scenarios of PLM
- Understand the workflow processes involved in PLM
- Understand the concept of PLM enabled Concurrent Engineering.

Course Outcomes-

- Describe the basic concepts of PLM
- Apply the theory knowledge in practice
- Compare PLM with Concurrent Engineering
- Discuss integration of PLM with other ICT systems

Detailed Syllabus:

Sr. No.	Description	Hrs.
Module 01	**INTRODUCTION** Product Data Management (PDM), Definition of PLM, Need to migrate to PLM, Benefits, and Concept of Product Life Cycle, Components of PLM, Evolution of PLM, Significance of PLM in Indian industries.	06
Module 02	**FRAMEWORK OF PLM.** Process oriented framework, PLM & Concurrent Engineering, Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company's PLM vision,	06
Module 03	**TECHNOLOGIES ENABLING PLM** Jupiter Technology, Computer Aided Design (CAD), Computer Aided Engineering(CAE), ALIAS, DFA, Virtual Reality etc.	06
Module 04	**Components of PLM:** Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration), Information authoring tools (e.g., MCAD, ECAD, and technical publishing) etc.	06
Module 05	**Knowledge Management in PLM** Managing knowledge in PLM, Intellectual Property rights (IPR), Decision making, slicing and dicing of data, Document Management, Product Configurators	06
Module 06	**Implementation Issues of PLM** Implementation Process, Challenges in implementation, Legacy system integration, Management Approach, implementation status in industries.	06
Module 07	**PLM Integration** PLM+CRM Integration, PLM+MES integration, PLM+ERP integration, Multi CAD integration	06

Term Work:

- Assignments based on the each Module
- Case study based on Industry with Presentation

Recommended Books:

Text Books:

- Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
- Antti Saaksvuori, Anselmi Immonen , Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
- Stark, John, . Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004. ISBN 1852338105
- Kari Ulrich and Steven D. Eppinger , Product Design & Development, McGraw Hill International Edns, 1999.

References

- Relevant recent technical articles, research papers , key note addresses, etc.

Examination syllabus:

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

PE-BTM537 Tool Engineering
Course pre-requisites: Manufacturing Sciences

Course Objectives:
The objective of this course is to:

- As a result of having learned this module 1, the students will be able to understand mechanics metal cutting, different factors influencing machining phenomenon, Tool life, Economic consideration for process adoption.
- As a result of having learned this module 2, students will be able to analyze the requirements of tool design for an case and design cutting tools like single point cutting tool, drill, milling cutter etc.
- As a result of having learned this module 3, the students will be able to understand the concept of measurement of forces in machining in different operations. They will also understand the criteria for selection of the cutting fluid.
- As a result of having learned this module 4, the students will be able to get introduced and develop the knowledge and skills for rolling and forming operations.
- As a result of having learned this module 5, the students will understand fundamental of forging process, its mechanism and die design principles.
- As a result of having learned this module 6, the students will develop the knowledge and skills to design press tools for blanking, piercing and non-cutting operations.
- As a result of having learned this module 7, the students will be able to introduce and develop the knowledge related to forming of sheet metal.

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

1. To explain metal cutting principles and important analytical aspects of machining process.
2. To select and design Cutting tools for various machining processes and specify the effects of machining environment on machining mechanism.
3. To explain mechanism of operation for rolling, forging of metal and significance of design of rolling and forging dies.
4. To understand effect and use of different sheet metal forming and working processes for different applications.

Course contents:

Sr. No.	Description	Duration (hrs.)
1	**Metal cutting fundamentals:** Mechanics of machining –geometry of cutting tools, chip formation, cutting forces and power requirements, wear and tool life, Economics of Metal Cutting parameters affecting machining cost, Tool life for minimum cost max productivity	06
2	**Design of cutting Tools:** Design of cutting Tools Types of tools, Tool geometry, Tool signature, Design of single point cutting tool, Design of Drill, Reamer, Broach, Milling Cutter	06

3	**Characterization of cutting process:** Measurement of cutting Forces, Types of tool dynamometers, Coolants types of coolants, choice of coolants, Effects of coolants on various cutting parameters, cutting fluids, machine-ability	06
4	**Rolling of metals:** Principles of rolling, Characteristic of rolling, Rolling mills and their types, Rolling parameters, Principles of roll pass design, Calculation of design parameters for rolls Forging, Extrusion, Rotary Swaging Processes, types, advantages, limitations and applications.	06
5	**Forging of metals:** Classification of forging processes, open-die forging & spread law, closed die-forging & die design, forging equipments, weight calculation of initial material in forging, forging defects Die Design for drop Forging and press Forging	06
6	**Sheet metal working:** Operations, Introduction of sheet metal working, Press, Classification of presses, Selection of presses, Difference between Hydraulic and Mechanical Press, Types of Cutting operations and non cutting operation, Different elements of die set assembly, Design of dies like simple die, progressive die, compound die, combination die, Bending die, Drawing die, Forming die	06
7	**Sheet metal forming:** Introduction and Classification of Metal Forming Processes, Advantages and Limitations, Stress strain relations in elastic and plastic deformation, concept of flow stresses, deformation mechanisms, Hot and Cold Working Processes and It's Effect on Mechanical Properties. **Principle, process parameters, equipment's and application of the following processes:** spinning, stretch forming, plate, V and edge bending, Curling, Ironing, Roll Bending, Metal Spinning. Press brake forming, explosive forming, Hydro forming, electro hydraulic forming, and magnetic pulse forming. High Velocity forming of metals and High energy Rate forming.	06

Recommended Books:

1. 1.S. Kalpakjian & S.R. Schmid, "Manufacturing Engineering and Technology, fourth edition", PEARSON
2. G. Boothroyd & W.A. Knight, " Fundamental of Machining and Machine Tools, third edition", CRC.
3. Milton C. Shaw, "Metal Cutting Principles", OXFORD University Press
4. O.P. Khanna, "A Textbook of Production Technology", Dhanpat Rai Publications
5. Cyril Donaldson, George H. LeCain , Tool Design, TATA McGraw Hill,2012
6. W A J Chapman ,Workshop Technology Part 1,2,&3 , Edward Arnold, 01-Jan-1972
7. B. L. Juneja&Sekhon, Fundamentals of Metal Cutting and Machine Tools, New Age Intl.
8. V.D. Kodgire, "Material Science and Metallurgy", Everest Publishing House - 25 th. Edition – 2009.
9. HMT Banglore, Tata McGraw-Hill Education, 2001
10. Hajra Choudhary, S.K. and Hajra Choudhary A.K. ,Elements of Workshop Technology, Vol. II, Media Promoters, Mumbai. Shaw, M.C. (2005)
11. Jain R.K. & Gupta S.C."Production Technology " : Khanna Publisher, New Delhi, ; 8th Edition

Practical work:

1. Experiments on given set-up for different tool material, workpiece, cutting conditions, chip morphology study, tool geometry.
2. Industrial visit report (format should be provided by teacher)
3. Seminar presentation on the topic related to any one of the topics.

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

PE-BTM538 Industrial Management and Entrepreneurship
Course pre-requisites: All courses till Sem- V

Course Objectives:

The objectives of this course are:

1. **To explain**, **discuss** and **illustrate** Global principles of Management, conepts, functions and techniques of specific domains of Management such as Human Resource Management, Engineering Economics, Cost Accounting, Financial Management etc. applicable to an Industry or an Enterprise.
2. **To explain and illustrate** quanititative tools and techniques in specific functional areas of Management such as Engineering Economics, Cost Accounting, Financial Management etc. applicable to an Industry or an Enterprise.
3. **To explain and exemplify** scope, potential, procedues, methodolgy for Enterpreneurship Development and Mamagement of an Enterprise.
4. **To explain and illustrate** overview, concepts, structure and integration of ERP Systems in an Indusrty or an Enterprise.

Course Outcomes:

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

1. **To explain, discuss and exemplify** the Global principles of Management, concepts, functions and techniques of specific domains of Management such as Human Resource Management, Enginnering Economics, Cost Accounting, Financial Management etc. applicable to an Industry or an Enterprise.
2. **To explain and apply** quanititative tools and techniques in specific functional areas of Management such as Engineering Economics, Cost Accounting, Financial Management etc. applicable to an Industry or an Enterprise and thus, **evaluate, compare and decide** optimum solution of a managemet problem.
3. **To explain and illustrate** scope, potential and steps for Enterpreneurship Development and Mamagement of an Enterprise.
4. **To explain and discuss** overview, concepts, structure and integration of ERP Systems in an Indusrty or an Enterprise and **develope** understanding for Role of IT in Industry/ Enterprise for decision making and business management with customer satisfaction

Course Contents:

Module No.	Details	Hrs.
1.	**Global Principles of Management:** Management:-Science,Theory and Practice, Evolution of Management Thought, Management -Social Responsibilty and Ethics.Planning- Objectives, Strategies, Policies and Process, Organising-Structure and Process,Decision Making-Search, Evaluation,	06

	Quantitative/Qualitative Analysis and Selection of Alternatives, Programmed and Non Programmed Decisions.Control- System, Process and Techniques, Role of IT.	
2.	**Human Resource Management:** Importance,Staffing and Selecion Function, Managerial Performance Appraisal, Formulation of Career Strategy, Manager Developmemt- Approaches,Process and Techniques, Leadership, Motivation and Morale – Significance and Theories, Dynamics of Change Management, Stress Management,Work Groups Management, Management of Organizational Conflicts and Negociations , Inter Personal Behaviour, Transactional Analysis.	06
3.	**Engineering Economics and Cost Accounting:** Costing and Cost Accounting, Concepts, Types and Elements of Cost, Depreciation Analysis- Causes and Methods, Break-Even Analysis and its Managerial Applications for Safety Margin, Price Change, Cost Change, etc., Profit-Volume (P/V) Analysis, Marginal Costing,Standard Costing- Significance, Advantages and Limitations, Estimated Cost, Variance Analysis- Types and its Computation. Cost of Production and Cost Curves, Law of Demand and Demand Curve, Law of Supply, Price Dertermination under Perfect Competition Market Structure, Cost Control and Cost Reduction-Features, Techniques, Difference and Areas of Application.	06
4.	**Financial Management:** Concepts, Goals and Key Activities, Valuation Concepts- Time Value of Money,Future and Present Value of a Single Amount or an Annuity, Risk and Return of a Single Asset and Portfolio, Relation between Risk and Return, Capital Budgeting- Process, Basic Principles, Investment Criterion, Net Present Value, Internal Rate of Return, Acounting Rate of Return, Pay Back period, Discounted Pay Back,Profitability Index, Risk Analysis- Sensitivity Analysis, Scenario Analysis, Break-Even Analysis, Financial Statements and Analysis- Balance Sheets, Income Statement, Funds/Cash Flow Statements, Profit and Loss Account, Financial Ratios, Comparative Analysis, Du Pont Analysis.	06
5.	**Enterpreneuship and Economic Development:** Need, Scope, Philosophy, Alternative Theories, SSI Development- Indian Scenario, Risk Taking, Ceativity and Enterpreneurship, Intrapreneuring and Enterpreneurship,. Enterprise Launching- Policy Reforms and Government Initiatives, Enterprenual Support Systems, Industrial Reforms and Emerging Opportunities, in India, Product Selection, Market Survey, Planning a Small Scale Industry/ Enterprise, Energy Requirement and Utilization, Plant Location and Layout, Project Report Preparation.	06
6.	**Enterpreneurship and Enterprise Management:** Management of a Small Business Firm, Management of Funds - Capital Strucure Planning, Long Term Financing and Working Capital - EBIT-EPS Analysis, Assessment of Debt Capacirty, Financing Choices, Institutional Structure, Direct/Indirect Financial	06

	Assistance, Finanncing Policies, Norms, Schemes, Activities and Procedures, Project Appraisal, Export Finance, Sales and Marketing Management, Marketing Problems and Strategies, Quality Management, Pollution Control, Important Labour Laws, Rules for Taxes and Excise Duty, Insurance Coverage, Problems of Sickness of an Enterprise.	
7.	**Enterprise-wide Resource Planning:** ERP Overview- Concepts and Evolution, of ERP Systems, Structure, Critical Components and Architecture of ERP, Best ERP Practices, Overview of Functional Modules like- Manufacturing and Purchase Module, Sales and distribution Modiule, Finance Module etc., Implementation of ERP- Steps involved, Tangible and Intangible benefits, Future of ERP, Challeneges in implementation, ERP Audit, ERP Systems in India, Success and failure of ERP Systems in India- Case Studies, Integration of ERP with other ICT such as CRM, PLM, WMS and MES etc.	06

Term Work:

Assignments based on Course contents comprising theoretical concepts and analytical solution of numerical problems. Technical presentations, Seminar and Group Discussions based on topics in various modules of Course contents, Case Studies, New/ Latest Practices and Trends etc. Required attendance in Lectures and Tutorials, involvement in acdemic activities related to course and overall conduct carry weigthage in assessment of Term Work.

Text Books :

1.Weihrich Heinz , and Koonz Harold, *Management A Global Perspective*, 10th Edn., McGraw Hill International Edition,1993.
2.Khanna, O.P., *Industrial Engineering and Management*, Dhanpart Rai Publications,
3.Sekaran Uma.,Organisational Behaviour, 2nd Edn.,Tata McGraw Hill Publishing Company Limited, New Delhi, 2004.
4.Mishra Sasmita, *Engineering Economics and Costing*, 2nd Edn., PHI Learning Pvt. Ltd.,Nw Delhi, Eastern Economy Edition, 2014.
5.Chandra Prasanna., *Fundamentals of Financial Management*, 3rd Edn, Tata McGraw Hill Education,New Delhi, 2011.
6.Saini, J.S., and Rathore, B.S., *Enterpreneurship Theory and Practice*, Wheeler Publishing, New Delhi,2001.
7.Brady, J., Monk, E., and Wagner, B., *Concepts in ERP*, Thomson Learning, 2005.

Reference Books:

1.Dr.Shejwalkar, P.C., Dr.Ghanekar Anjali, and Prof. Bhivpathaki , D.P., *Principles and Practice of Management*, 14th edn., Everest Publishing House, 2005.
2.Flippo, Edwin B., *Personnel Management*, Mc Graw Hill, New York, 1984.
3.Ross, S.A., Westerfield, R., and Jordan, B.D., *Fundamentals of Corporate Finance*, Tata McGraw-Hill Education, 2008.
4.Brigham, E.F., and Ehrhardt, M. C., *Financial Management: Theory & Practice*, Cengage Learning, 2013.
5. Drucker, Peter F., *Innovation and Enterprenuership*, Harper Collins India ,2015.
6. Kuratko, Donald F.,*Introduction to Enterpreneurship*, International edn of 8th Revised educational edn., South-Western Educational Publishing,OH, 2009.
7..Leon Alexis, *Enterprise Resource Planning*, McGraw-Hill Education, 2014.

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

PE-BTM539 Additive Manufacturing
Course Pre-requisites: Applied Physics, Manufacturing Processes, Kinematics of Machinery

Course Objectives:
1. To study the fundamentals of additive manufacturing technologies.
2. To study basic concepts of additive manufacturing and their application in product development.
3. To study different working materials and systems used in additive manufacturing techniques
4. To study layering techniques in additive manufacturing systems

Course Outcomes:
At the end of the course the students shall be able to
1. Describe working principles of additive manufacturing techniques
2. Select proper additive manufacturing techniques for specific technical applications.
3. Select an appropriate material and tools to develop a given product using additive manufacturing machine.
4. Design layering technique for additive manufacturing

Course Content:

Sr. No.	Syllabus	Hrs
1.	**Additive manufacturing (AM)** • Historical Development • Applications: Design, Planning, Manufacturing and Tooling • Applications: Automotive, Jewelry, Bio-Medical and aerospace • Fundamentals of Additive Manufacturing, Design Process • Additive Manufacturing Process Chain	4
2.	**Subsystems of additive manufacturing Machine** • Generalized Subsystems of additive manufacturing machines o Optical System o Mechanical Scanning System o Computer Interfacing hardware, DAQs, Signal Flow, 3D Model to AM Prototype • Introduction to 3D Modeling Softwares (Auto-CAD, PROE, CATIA, IDEAs etc.) • Slicing and Scan Path Generation Algorithms • Data Conversion and Transmission • File Formats, IGES, STL • Preprocessing and Post-processing	6
3.	**Liquid Based Additive Manufacturing Systems** • Materials • Stereolithography • Solid Ground Curing • Solid Object UV (Ultra-Violet) Printer • Two Laser System • Micro-stereolithography.	6
4.	**Solid Based Additive Manufacturing Systems** • Materials • LOM (Laminated Object Manufacturing) System	6

	• FDM (Fuse Deposition Modeling) System • Multi-Jet Modeling (MJM) System • Model Maker and Pattern Master • Shape Deposition Manufacturing Process	
5.	**Powder Based Additive Manufacturing Systems** • Materials • SLS (Selective Laser Sintering) • (3DP) Three-Dimensional Printing • (LENS) Laser Engineered Net Shaping • (MJS) Multiphase Jet Solidification • (EBM) Electron Beam Melting	6
6.	**Advances in Additive Manufacturing Systems and Case Studies** • Advances in RP: Resolution & Accuracy issues, Integrated Hardening Process, Two Photon Process for Micro/Nano Fabrication, Reverse Engineering Process and Applications.	6
7.	Case Study: Wind-Tunnel Testing with RP Models Case Study: Investment Casting with RP Case Study: Fabrication of microlens arrays Case Study: Fabrication of Scaffolds for medical applications	6

Tutorial/Term Work

1. Assignments based on each module.
2. Seminar based on recent advances in the subject
3. At least one Case study
4. Development of slicing and scanning program for additive manufacturing technique

Reference Books:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid Prototyping Principles and Applications", World Publishing Co. Pte.Ltd.
2. James O. Hamblen, and Michael D. Furman, "Rapid Prototyping of Digital Systems", Kluwer Academic Publishers.
3. Kenneth G. Cooper, "Rapid Prototyping Technology Selection and Application", 2001, Marcel Dekker Inc, New York.
4. Ali Kamrani, EmadAbouel Nasr, "Rapid Prototyping Theory and Practice", 2006, Springer Inc.
5. BopayaBidanda, Paulo J. Bartolo, "Virtual Prototyping and Bio Manufacturing in Medical Applications", 2008, Springer Inc.
6. I. Gibson, D.W. Rosen, and B. Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", 2010, Springer Inc.

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

PE-BTM540 Advanced Manufacturing Processes

Course Pre-requisites: Manufacturing Processes

Course Objectives:

Objective of this courses is to introduce to students the principles of working, constructional details, design feature performance characteristics of various advanced manufacturing processes.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To understand the basic principles of various advanced manufacturing processes.
2. Select various advanced manufacturing process used in industries.
3. Selection of cost-effective type of manufacturing process for different domestic and industrial applications. Selection and analysis of different chip less manufacturing processes.
4. Compute merits and demerits of manufacturing process in selection of end product. Able to understand the concept of green manufacturing and environment friendly system.

Course Content:

Module No.	Details	Hrs.
1.	**Advanced mechanical machining process:** Introduction need for advanced machining process. Characteristics of AMP, classification of Advanced machining process, process selection. Ultrasonic machining(USM): machining set up, mechanics of cutting, parameter analysis, process capability applications. Abrasive jet machining (AJM), abrasive water jet machining (AWJM).	6
2.	**Advance chemical and thermal machining processes:** electrochemical machining, electrochemical grinding, electrochemical honing, Chemical Machining electric discharge machining, wire cut EDM, Electron beam machining, laser beam machining.	6
3.	**Advanced casting processes:** metal mould casting: low and high pressure, Continuous casting, squeeze casting, vacuum mould casting, Evaporative pattern casting, ceramic Shell casting.	8
4.	**Advanced welding process:** details of electron beam welding (EBW), laser beam welding(LBW) , ultrasonic welding (USW)	6

5.	**Advance metal forming processes:** details of high energy rate forming(HERF) process, electro-magnetic forming, explosive forming, electro hydraulic forming, stretch forming, counter roll forming.	6
6.	**Micro-machining processes:** molecular dynamics at atomistic scale, diamond micro-machining and grinding, ultrasonic micromachining, micro-EDM, laser beam micro-machining, micro-ECM, electron beam micromachining, focused ion-beam techniques, abrasive micro-finishing techniques.	6
7.	**Microforming techniques:** laser micro-bending, micro-deep drawing and micro-extrusion. Microwelding and joining techniques.	6

Tutorial/Term Work

1. Assignments based on each module.
2. Seminar based on recent advances in the subject

References:

1. "Materials and Processes in Manufacturing" (8th Edition), E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi (ISBN 0-02-978760).

2. "Manufacturing Science" A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.

3. "Nontraditional Manufacturing Processes", G.F. Benedict,Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7).

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

PE-BTM551 Advanced Heat Transfer
Course pre-requisites: Heat and Mass Transfer

Course Objectives:
Upon successful completion of the course, the students should be able to:
Identify different mode of heat transfer occurring in thermal system.

1. Analyze steady and transient conduction problem.
2. Learn the fundamentals of conductive and convective heat transfer
3. Understand the methods of analyzing a heat exchanger.

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

1. Understand different modes of heat transfer and estimate the heat transfer by using classical laws.
2. Apply the knowledge of mathematics, science and heat transfer to develop mathematical models.
3. Analyze heat exchange through radiation.
4. Analyze and evaluate heat transfer in context with conduction, convection and heat exchangers

Course Contents:

Module No.	Details	Hrs.
1	**Basic Concepts:** Heat Conduction Fundamentals, Heat Conduction Equations, General Boundary Conditions.	04
2	**Conduction:** Examples of Conduction Problems, Heat Conduction Equations in Cylindrical and Spherical Coordinates, Two-Dimensional Steady State Conduction, Transient Conduction in Plates, Cylinders, Spheres.	08
3	**Fundamental of Free Convection:** Basic Statements and Equations of Free Convection, Free-Convective Boundary Layer, Outer and Inner Flow Regions, Combined Forced and Natural Convection,	07
4	**Fundamental of Forced Convection:** Forced convection correlation for single phase flow, **Analysis of Convection Heat Transfer,** Boundary Layer Fundamentals, Evaluation of Convection Heat Transfer Coefficients, Dimensional Analysis,	07
5	**Heat Exchangers:** Basic design of heat exchangers. Heat Exchanger Fouling, Industrial heat exchangers design, All Automotive Heat Exchanger design likes radiators, oil coolers, EGR Coolers, Inter-coolers used in supercharging, Air conditioning heat exchangers, Heat Exchanger performance, Cooling Tower Fundamentals.	08
6	**Boiling and Condensation:** Heat Transfer in condensation, Condenser arrangements, Condenser sizing, Introduction to pool and convective boiling	04
7	**Thermal Radiation:**	04

	Determination of the heat flux of radiation, Thermal radiation of gases, Emissivities of technical surfaces, Heat transfer between two surfaces, Industrial applications of heat transfer due to radiation.	

Term Work / Laboratory Work:
At least 2 assignments from each module

Text Books:
1. Holman, J. P. "Heat transfer, Eighth SI Metric Edition." (2001)
2. Incropera and Dwitt, *Fundamentals of Heat and Mass Transfer,* Wiley India (2010)
3. Kreith, Frank, Raj M. Manglik, and Mark S. Bohn. *Principles of heat transfer* Cengage learning, (2012)
4. Arora C. P. ,*Heat and Mass Transfer*., Dhanpatrai and Co. (2014)
5. Nag P.K.,*Heat and Mass Transfer* , Tata McGraw Hill (2014)
6. Ozisik M.N., *Heat Transfer*, McGraw Hill (2010)
7. Rajput, R. K. "„Heat and Mass Transfer‟, pub." *Tata McGrawhill*(2009).

References:
1) Heat Transfer - Schaums Series - Mc Graw Hill International.
2) Welty, James R. "Engineering heat transfer." *New York, John Wiley and Sons, Inc.*(1974).
3) Hsü, Shao-ti. *Engineering heat transfer*. Van Nostrand, 1963.
4) Eckert and Drake, *Heat and Mass Transfer*, (2010)

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

PE-BTM552 Hydraulic Machinery
Course pre-requisites: Fluid Mechanics

Course Objectives:
The objective of this course is to:

- learn the working principle of hydroelectric power plant
- learn about the working principle, construction and parameters of analysis of different hydo-turobomachines,
- learn similarity principle of model and prototype ,
- understand working and construction features of pumping machines- positive displacement and rotodynamic pumps,
- learn about pump and pumping system

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

1. To explain the working of a hydro power plant, different hydro prime movers and pumps,
2. To do simple calculation pertaining to performance of different power generator and pumping system,
3. To analyze hydro turbine / pump for a given application
4. To select hydro turbine / pump for a given application

Course contents:

Module No.	Description	Duration (hrs.)
1	**Hydro Electric Power Plant:** Elements of a hydro power plant, types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Impulse momentum theory. Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done.	03
2	**Impulse Turbine:** Components of a Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. Performance curves	05
3	**Reaction Turbines:** Types of reaction turbines - inward and outward flow, radial mixed and axial; elements of the turbine, estimation of various parameters. Francis Turbine – construction, working and performance, Kaplan Turbine – construction, working and performance,	06
4	**Similarity:** Similarity relations in turbines, definition of unit quantities and specific quantities, selection of turbines. Prediction of results of prototypes from the model test. Cavitation in turbines - causes, effects and remedies, Thoma's cavitation parameter	04

	σ. Use of σ Vs specific speed graphs. Determination of safe height of installation for the turbine. Characteristics of turbines, governing of turbines.	
5	**Pumps:** Introduction, Classification of pumps - positive displacement and non - positive displacement. Positive - Displacement pumps: Types and applications, general features of rotary pumps like gear pumps, vane pumps, screw pumps, etc., General feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel.	06
6	**Centrifugal Pump:** Types - radial flow , mixed flow and axial flow, Priming of pumps, components of the pump, Euler's equation and velocity triangles, Correction factors for the head, design constant, head constant, flow constant etc., Types of blade profiles, aerofoil theory of axial flow pumps Pressure recuperating devices, Radial thrust and axial thrust and methods used to balance them. Trouble shooting in centrifugal pumps, self priming pumps, submersible pumps, Selection of pumps.	06
7	**Pumping System:** Concept of system and system characteristics, Series and parallel operation of pumps. System curve for branch network. Determination of operating point. Similarity relations and affinity laws, characteristics of pumps. Cavitations and NPSH (NPSHA, NPSHR), Determination of available and required NPSH. Boiler feed pump, Pumping systems in petroleum industries.	06

Hydraulic Machinery Laboratory Experiments

List of Experiments: Any six experiments (at least three from each pump and turbine) from the following list of experiments:

1. Study of hydro-electric power plant.
2. Estimation of Impact of jet
3. Constant head test on Impulse turbine.
4. Constant head test on medium head medium specific speed reaction turbine
5. Constant head test on low head high specific speed reaction turbine
6. Constant speed test on Impulse turbine.
7. Constant speed test on medium head medium specific speed reaction turbine
8. Constant speed test on low head high specific speed reaction turbine
9. Load test on centrifugal pump
10. Constant speed test on centrifugal pump
11. Performance of centrifugal pumps in series and parallel
12. Load test on positive displacement pump.
13. Study of cavitations in hydraulic machines

Term Work:

The term work will comprise of following

1. Journal of laboratory experiments.
2. At least one assignment on each module of the theory course.
3. Examination (MCQ)
4. Oral Examination
5. Case study on system of Hydraulic Machinery

Recommended Books:

1. Lal, Jagdish. *Hydraulic machines*. Metropolitan Book Company, 1961.
2. Vasandani, VP Dr. *Hydraulic Machines: Theory and Design*. Khanna Publishers, 1996.
3. Church, Austin Harris. *Centrifugal pumps and blowers*. Robert E. Krieger, 1972.
4. Rao B.C.S., *Fluid Mechanics and Machinery*, McGraw Hill, 2009.
5. Gupta, S. C. *Fluid mechanics and hydraulic machines*. Pearson Education India, 2006.
6. Douglas J., Gasiorek J., Swaffield J., Jack L., *Fluid Mechanics*, Prentice Hall, 2006.

References:

1. Lazarkiewicz, S. ,Troskolansky AD, *Impeller Pumps*, 1965.
2. Stepanoff, Alexey J. "Centrifugal and axial flow pumps." (1948).
3. Karassik, Igor J., Joseph P. Messina, Charles C. Heald, and Paul Cooper. *Pump handbook*, Vol. 3, McGraw-Hill, 1976.
4. Nechleba, Miroslav. "Hydraulic turbines, their design and equipement." (1957).

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

PE-BTM553 Introduction to Aerodynamics
Course pre-requisites: Thermodynamics, Fluid Mechanics

Course Objective:

- Learn about standard atmosphere.
- Learn about flow without friction and its applications.
- Learn about viscous flow and boundary layer phenomena.
- Learn about aerodynamics of airfoils, wings and bodies like cylinder and spheres.

Course Outcome:

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

1. have knowledge of inviscid flow and its measurement systems,
2. understand viscous flow and boundary layer,
3. apply knowledge of viscous flow phenomenon to airfoils and wings,
4. have a knowledge of aerodynamics of cylinders and spheres.

Course Content

Module No.	Description	Hrs.
1.	**The standard Atmosphere**: The standard atmosphere, Absolute altitude, Geometric altitude, Geopotential altitude, Hydrostatic equation, Construction of standard atmosphere, Definition of pressure, temperature and temperature altitudes.	06
2.	**Inviscid Flow:** Flow with no friction, Continuity equation, Momentum equation, Energy equation, Equation for isentropic flow.	06
3	**Applications:** Speed of sound, Low speed subsonic wind tunnels, Measurement of airspeed in incompressible, compressible and supersonic flow.	06
4	**Viscous Flow:** Flow with friction, Boundary layer concept, laminar and turbulent boundary layer, Transition from laminar to turbulent flow, Flow separation.	06
5	**Airfoils:** Nomenclature, Aerodynamic coefficients, Experimental data, Obtaining lift coefficients from pressure coefficient, Compressibility corrections, Critical Mach number, Drag-divergence number, supersonic speeds, Lift, Wave drag.	06
6	**Wings:** Finite wing, Induced drag, Change in lift slope, Swept wings, Flaps,	06
7	**Aerodynamics of bodies:** Aerodynamics of Cylinders and spheres, Circulation and Kutta-Joukowsky theorem.	06

TERM WORK:
Term work shall consist of class assignments on each module.

Recommended books:
1. John D Anderson Jr. Introduction to flight, McGraw-Hill, New York, 5th Edition.
2. John D Anderson Jr. Fundamentals of Aerodynamics, McGraw-Hill, New York 5th Edition.
3. E. L. Houghton and P. W. Carpenter, Aerodynamics for Engineering students, Elsevier, 6th Edition.

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

PE-BTM554 Compressible Fluid Flow
Course pre-requisites: Fluid Mechanics

Course Objectives:
This covers several unique features and concepts related to compressible behavior of fluid flow. The are many mechanical system which works on this principle. The objective of the course is to impart knowledge of compressibility and its impact on system's performance. The knowledge will useful to those who wish work in this domain (particularly high speed flows).

Course Outcomes:
Upon completion of this course, students should be able to:
1. Solve a range of compressible-flow problems often encountered in engineering practice
2. Apply thinking and problem-solving techniques to practical problems using fluid mechanics and thermodynamics.
3. Apply computer programs (MATLAB, EXCEL etc.) to compressible-flow problems.
4. Demonstrate practical design skills such as design of supersonic nozzles and wind tunnels.

Course Contents:

Module	Description	Hrs.
1	**Fundamental Concepts:** Concept of compressibility- Ideal gas, speed of sound, Mach number, Governing equations: mass, momentum, energy and entropy equations; Illustrations of few applications where compressible flow study is applicable.	04
2	**One Dimensional Isentropic Flow Through Variable Area**: Isentropic relations; One-D compressible adiabatic duct flow, critical properties; Converging nozzles, choking, converging-diverging nozzles, rocket nozzles;	06
3	**Flow Through Normal Shocks**: Development of shock wave, Governing equations, Prandtle Meyer relation, Property changes across shocks, Tables and charts for normal shock waves	06
4	**Flow Through Oblique Shocks**: Nature of flow, Fundamental relations, Rankine- Hugoniot Equation, Variation of flow parameters, Gas table for oblique shocks;	06
5	**One Dimensional Duct Flow with Heat Transfer** Rayleigh flow and equations, *T-s* diagrams, choked Rayleigh flow;	08
6	**One Dimensional Duct Flow with Friction** Fanno Flow Equation, Choked Fanno Flow, Comparison and Summary of 1-D flows;	06
7	**Wind Tunnel:** Fundamentals of wind tunnels, types of wind tunnels, Design of wind tunnels. Application in compressible flow study;	06

TERM WORK:
Term work shall consist of class assignments on each module.

Recommended Books:

1. Fox and McDonald, "*Introduction to Fluid Mechanics*", John Wiley & Sons, 8ed.
2. Frank M. White, "*Fluid Mechanics*", McGraw Hill, 7ed.
3. John David Anderson, "Modern compressible flow: With historical perspective", McGraw Hill
4. S M Yahya, "Fundamentals of compressible flow", New Age Publication
5. V Babu, "Fundamental of gas dynamics, Wiley
6. Shapiro A H, "The Dynamics And Thermodynamics Of Compressible Fluid Flow", Ronald Press

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

OE-BTM611 Computational Methods
Course pre-requisites: Engineering Mathematics

Course Objectives:
With the development of powerful computer, now it has become easier to design and develop complex engineering system with its help. Numerical techniques are brain behind this capability. The objective of this course is to equip students with such techniques of computation so that they can understand and solve real life problems.

Course Outcomes:
Upon successful completion of the course, students should be able to
1. understand the basic concept of modeling, numerical computation and associated errors.
2. apply numerical techniques of common mathematical tools to solve real life problem.
3. analyze and compare different techniques with reference to errors, convergence and accuracy.
4. demonstrate potential to develop code which can be used with available programming resources.

Course Contents:

Module	Description	Hrs.
1.	**Exposure to Numerical Software** Introduction to MATLAB and numerical programming through it, Using EXCEL worksheet in numerical computation.	04
2	**Fundamentals of Modeling and Error**: Fundamentals of mathematical modeling - needs and limitations. Mathematic modeling of simple engineering systems Significance of analytical and numerical methods in engineering analysis. Error analysis; significant figures, accuracy and precision, Error definitions, Round-off and truncation error	04
3	**Numerical Solution of Systems of Linear Algebraic Equation:** Direct Methods: Matrix inversion, Gauss Elimination, LU Decomposition, TDMA Nature of iterative solution, Role of eigen values in convergence, Successive under relaxation, Iterative Methods - Jacobi, Gauss Siedel, Effect of rounding off on iteative solution and ill-conditioned system.	04
4	**Numerical Solution of Systems of Non-linear Equations:** Roots of equations: Bisection, False position, Secant, Newton- Raphson methods. Problems based on real-life application.	04
5	**Numerical Integration and Differentiation:** Newton-Cotes Integration Formulas - Trapezoidal rule, Simpson's rule, Finite Difference Methods - Forward difference, Backward difference and Central Difference	04
6	**Numerical Solution of Ordinary Differential Equation:** Explicit and Implicit Marching Method, Modified Euler's Method, Runge- Kutta Methods - RK-II and RK-IV,	04

	ODE System: Initial value problem, Boundary value problem, Predictor-corrector methods -Adams Method, Adams-Bashforth-Moulton Method, Milne's Method, Adams-Moulton Method , Stiff ODE System	
7	**Curve Fitting;** Regression - Least- square regression Interpolation - Newton's divided difference polynomials, Lagrange's polynomials, Spline interpolation;	04

Term Work:

The term work shall comprise of problems and case studies covering different topics taken from course studied in the semester. Assignment shall consist of programmes written in pseudo code, any programming language or MATLAB.

Recommended Books:

1. Sastry, S S. Introductory methods of numerical analysis. PHI Learning Pvt. Ltd., 2012.
2. Chapra, Steven and Canale. Numerical methods for engineers. New York: McGraw – Hill, 7ed.
3. Applied numerical analysis : Curtis Gerald

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

OE-BTM612 Introduction to Nanotechnology
Course pre-requisites: Applied Physics, Applied Chemistry

Course Objectives

1. To acquaint learner with fundamental multidisciplinary nature of nanotechnology
2. To study applications and implementation of nanotechnology

Course Outcomes: Learner will be able to

1. Discuss basics of nanotechnology
2. Identify various nanostructured materials
3. Illustrate properties of nanomaterials
4. Illustrate characterization techniques for nanomaterials

Modules	Detailed Content	Hrs.
01	**Introduction to Quantum mechanics, Nanostructural Materials and Low dimensional structures:** Basic principles of Quantum mechanics (why and how classical mechanics fails), probability amplitude, wave functions, Nano clusters and Nano crystals.	4
02	**Two-Dimensional Nanostructures: Thin Film:** Introduction, Fundamentals of Film Growth, Vacuum Science, Physical Vapor Deposition (PVD) i.Evaporation, ii. Molecular beam epitaxy, iii. Sputtering; Chemical Vapor Deposition (CVD), i. Types of chemical reactions, ii. Reaction kinetics, iii. Transport phenomena, iv. CVD methods, v. Diamond films by CVD; Atomic Layer Deposition (ALD), Electrochemical Deposition, Sol-Gel Films, Solution growth, Electrochemical deposition, Electrophoretic deposition, Template filling, Electrospinning, Lithography.	4
03	**Special Nanomaterials and applications:** Introduction; Carbon Fullerenes and Nanotubes: Carbon fullerenes, Fullerene- derived crystals, Carbon nanotubes; Micro and Mesoporous Materials: Ordered mesoporous materials, Random mesoporous materials, Crystalline porous materials (zeolites); Core-Shell Structures: Metal-oxide structures, Metal-polymer structures, Oxide-polymer structures	4
04	**Types of nano particles and applications** Nanocontainers, Nanoshells, Nanohorns, Nanowires, Nanosprings, Nanorods, Nanofilters, Nanopens, Nanopencils, Nanopipettes, Nanoplotter, Nanobalance, Nanobeads, Nanoguitar	4
05	**Characterization of Nanomaterials** Introduction, Structural Characterization, X-ray diffraction (XRD), Small angle X-ray scattering (SAXS), Scanning electron, microscopy (SEM), Transmission electron microscopy (TEM), Scanning probe microscopy (SPM) Gas adsorption. Chemical Characterization, Optical spectroscopy, Electron spectroscopy, Ionic spectroscopy.	4

06	**Properties of Nanomaterials** Physical Properties: Thermal stability and lattice constant, Mechanical properties, Optical properties, Electrical conductivity, Ferroelectrics and dielectrics, Superparamagnetism, Emission spectroscopy, luminescence spectroscopy.	**4**
07	**Application of nano chemistry** Semiconductor and Microelectronics including MEMS, Optical Magnetic including memory, readwrite, flash, bubble memories etc. Mechanical including Nanocomposites, thermal barriers etc.Biomedical including Pharmacology, Virology etc.	**4**

Tutorial

1. Assignments on each module
2. Case studies on applications of nanotechnology
3. Seminar on recent advances in nanotechnology

Recommended Books:

1. Introduction to nanotechnology, Charles P Poole Jr and Frank J Owens, Wiely
2. Introduction to Nanosciences and Nanotechnology, Chattopadhyay K K, Banerjee A N, PHI Learning
3. Nanotechnology: The science of small, Shah K A and Shah M A, Wiely
4. Nanotechnology, Rathi R K, S Chand
5. Nano: The essentials Understanding Nanosciences and Nanotechnology, TMH
6. Nanotechnology, Lynn E Foster, Pearson
7. Micromanufacturing and Nanotechnology, Mahalik N P, New Age International
8. Handbook of Nanoscience, Engineering, and Technology, William A Goddard, Donald Brenner, Sergey Edward Lyshevski, Goddard III, CRC Press
9. Hanbook of Nanotechnology, Bharat Bhushan, 3rd Edition, Springer

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

OE-BTM613 Entrepreneurship Development and Start Up
Course pre-requisites: General Engineering

Course Objectives:
In this Course Students will:
1. Know different aspects of Entrepreneurships, Business models.
2. Demonstrate the idea generation techniques, Planning of Marketing process, prototyping methods,
3. Apply engineering knowledge to develop prototype of their ideas and innovations.
4. Demonstrate different aspects of Techno-Economic Feasibility, Intellectual Property Rights and Institutional Support for Start-Ups

Course Outcomes:
Upon successful completion of the course, students should be able to:
1. Know different aspects of Entrepreneurships, Business models.
2. Demonstrate the idea generation techniques, Planning of Marketing process, prototyping methods,
3. Apply engineering knowledge to develop prototype of their ideas and innovations.
4. Demonstrate different aspects of Techno-Economic Feasibility, Intellectual Property Rights and Institutional Support for Start-Ups

Module No.	Course Contents	Hrs
1	**Entrepreneurship:** Introduction to Entrepreneurship, Need for Entrepreneurship, Types of Entrepreneurs, Types of Leaders, Entrepreneurship Development.	4
2	**Idea generation & Creativity:** Invention and Innovation, Types of Innovations, Idea Generation techniques: Brain storming. SCAMPER Technique, Morphological Matrix; Evaluation Strategies.	4
3	**Market Research and Planning:** Purpose of market research, Techniques of Market Survey, Procedure of market research and research process, Limitations of Market Survey.	4
4	**Prototyping & Rapid Prototyping:** Roles of Prototyping, Phases of Prototyping**,** Fundamentals of Rapid Prototyping, Benefits of Rapid Prototyping, Classification of Rapid Prototyping,	4
5	**Intellectual Property Rights:** Fundamentals of IPR, Legislations on IPR in INDIA, International Organization and Treaties, Types of IPRs: Patents, Trademarks, Copyrights, Trade Secret	4
6	**Techno-Economic Feasibility Analysis:** Types of Analysis: Economic Feasibility, Marketing Feasibility, Financial Feasibility, Technical Feasibility.	4
7	**Institutional & Financial Support for Start-Ups:** Government Policies for small scale industries, Different financial institutions for small scale industries and Incentives by government schemes. International Schemes	4

Term Work/Tutorial:

Tutorials will consist of one Assignment on each module and Case Studies.

Reference Books:

1. "Entrepreneurship Development", S. Anil kumar, New Age International Publishers.
2. "Entrepreneurial Development", S. S. Khanka, S. Chand & Company Ltd.
3. "Entrepreneurship Development", A. Nirjar, Word-Press.
4. "Rapid Prototyping, Principles and Applications", Chua C. K., Leong K. F. and Lim C. S., World Scientific Publishing Company Ltd.
5. Intellectual Property Rights", Neeraj Pandey and Khushdeep Dharni, PHI Learning Pvt. LTd.
6. Intellectual Property Rights, Texts and Cases", Dr. R. Radhakrishnan and Dr. S. Balasubramanium, Excel Books.

Sr. No.	**Examination**	**Module**
1.	**Test – I**	Module 1, 2
2.	**Test – II**	Module 3, 4
3.	**Endsem**	Module 1 to 7

OE-BTM614 Introduction to Optimization Methods
Course pre-requisites: Engineering Mathematics

Course Objectives:

1. To introduce tools and techniques for optimization to engineering applications
2. To understand the formulation of design equations for engineering systems.
3. To understand algorithms and methods used for optimization

Course Outcomes:

At the end of the course the students shall be able to

1. Explain different approaches to optimize engineering systems.
2. Create programs based on different optimization algorithms using IT tools, such as Minitab, MATLAB, etc.
3. Calculate optimum solution to linear and non-linear problems.
4. Apply the numerical and optimization understanding for finalizing design of engineering systems.

Course content:

M. No	Description	Hrs
1	Need for optimization and historical development, classification and formulation of optimization problem, objective function and constraints	06
2	Calculus based methods, function of single, two and multiple variables, Hessian matrix formulation, Kuhn-Tucker condition	06
3	Linear programming (LP) based methods, standard form of LP problem, graphical method for two variables, simplex algorithm, examples for transportation and assignment problems	06
4	Enumerative schemes, Random search algorithms	06
5	Integer programming, integer linear programming, mixed integer programming	06
6	Evolutionary algorithms, Genetic algorithms, Nature inspired optimization methods	06
7	Use of software tools for solving linear optimization problems	06

Term work:

- Assignments containing numerical problems based on each module.
- Seminar based on recent advances in subject.
- At least one case study based on any one optimization method.
- Mini-project based on course content

Text Books:

1. Rao, Singiresu S., and S. S. Rao. *Engineering optimization: theory and practice*. John Wiley & Sons, 2009.
2. Deb, Kalyanmoy. *Optimization for engineering design: Algorithms and examples*. PHI Learning Pvt. Ltd., 2012.

Reference Books

1. Mital, K.V., 1996. *Optimization methods in operations research and systems analysis*. New Age International.
2. Taha, Hamdy A. *Operations Research: An Introduction (For VTU)*. Pearson Education India, 1982.

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

OE-BTM615 Project Management
Course pre-requisites: Nil

Course Objectives:

1. To understand knowledge areas and tool – techniques for efficient Project Management.
2. Understand the role of Project Management in an organization.
3. Develop an insight as to how Project Management tool/techniques are used strategically for the betterment of organization.
4. To improve management skills

Course Outcomes:

Upon successful completion of the course, students should be able

1. To describe the basic concepts in Project Management.
2. To describe the various tools and Techniques in Project Management.
3. To apply the various concepts and Tools in & Project Management for Industrial cases
4. To investigate the factors for improving the process and Managing the Project successfully.

Course Content:

Module No	Details	Hrs
1	**Introduction:** Introduction to Project Management, the triple constraint, Stakeholders, Project Management Knowledge Area, tools and techniques, Role of a Project Manager, job description, Suggested Skills, Importance of people and leadership skills.	**04**
2	Project Management: Overview, Organizational Structure, Project vs Operational Work, Organizational influences on Project Management, Project Life Cycle, Phases and Nature of Mechanical Engineering projects, Trends affecting Mechanical Engineering Project Management, Globalization, Outsourcing, and Virtual Teams.	**04**
3	Project Time Management, Defining and Sequencing Project Activities and Dependencies, Developing Schedule, Gantt Chart, Critical Path Method, Project Uncertainty – PERT, Critical Chain Method, Resource loading and Resource Leveling, Schedule Controlling.	**04**
4	Project Cost Management, Estimating Techniques, Earned Value Management, Project Quality Management, Planning Quality, Performing Quality Assurance, Quality Control – Tools and Techniques	**04**
5	Project Resource Management, Development of Human Resource Plan, Project Organizational Chart and Responsibility Assignment, Multi project Scheduling and Resource Allocation	**04**
6	Project Communication Management, Identifying Stakeholders, Planning Communication, Project Risk Management, Identifying Risks; Common Sources of Risk in Mechanical Engineering Projects, Qualitative Risk	**04**

	Analysis: Probability and Impact Matrix, Quantitative Risk Analysis: Decision Trees, Planning Risk Response	
7	Project Procurement Management Plan Procurements, Conduct Procurements, Administer Procurements, SLA	**04**

Term work

1. Assignments based on above modules
2. Seminar based on recent advances in the course
3. At least one Case study conducted at industry
4. MCQ on each module

Teaching Methods:

1. The course will use the following pedagogical tools:
2. Discussion on concepts and issues of Project Management in an organization.
3. Case discussion covering a cross section of gaining strategic advantage by applying Project Management tools and techniques.
4. Projects/ Assignments/ Quizzes/ Class participation etc.

References:

1. Meredith, Jack R., and Samuel J. Mantel Jr. Project management: a managerial approach. John Wiley & Sons, 2011.
2. Lewis, James P. Project Planning, Scheduling & Control, 4E. McGraw-Hill Pub. Co., 2005.
3. Larson, Erik W., and Clifford F. Gray. "Project management: The managerial process." (2011).
4. Meredith, Jack R., and Samuel J. Mantel Jr. Project management: a managerial approach. John Wiley & Sons, 2011.

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

OE-BTE601 Project Management

Course pre-requisites: Basics of Electrical Engineering, Basics of statistics and mathematics, general knowledge about working of organizations

Course Objectives:

1. Get familiarized with basics of project management, its organization and project management framework.
2. Learn five important project management process groups, namely: initiating, planning, executing, monitoring & control, closing and ten important project management knowledge areas.
3. Understand the relationship between project management process groups and knowledge areas.

Course Outcomes: Students will demonstrate the ability to

1. Explain basics of Project Management, its organization and project management framework.
2. Perform project management process group and knowledge area mapping.
3. Solve a case study using step-by-step process of managing projects and explain why each step is necessary.

Course Contents

Unit	Contents	Hrs.
1	**Introduction** • Basics of project management, operations management and organizational strategy, • Project management framework, organizational structures, • Project Management Processes – Initiating, Planning, Executing, Monitoring & Control, Closing.	03
2	**Project Integration Management** • Integrated change control, Developing project management plan and project charter, • Project selection, corrective action, preventive action, defect repair, change control board, • Cost benefit analysis, Net present value, internal rate of return, payback period, present value, economic value added, • Opportunity costs, sunk costs, law of diminishing returns, working capital, depreciation. **Project Scope Management** • Scope baseline, WBS, Project scope statement, WBS dictionary, benefits and uses of WBS • Requirement documentation, requirements traceability matrix, requirements management plan	04
3	**Project Time Management** • Schedule baseline, schedule compression, Network diagram, • Precedence Diagramming Method (PDM), Three point estimating, analogous estimating, parametric estimating, • Schedule management plan, resource optimization, Critical path method, Program Evaluation Review Technique (PERT). **Project Cost Management** • Earned value measurement, Earned value monitoring, cost baseline, cost budget, Cost management plan,	09

	• Reserve analysis, contingency reserve, management reserves, cost risk, • Variable / fixed costs, direct / indirect costs, life cycle costing, value analysis, control thresholds, cost of quality, Return of Interest (RoI), and discounted cash flow. **Project Quality Management** • Seven basic quality improvement tools – control chart, Pareto diagram, Cause and effect diagram, flow chart, scatter diagram, histogram. Use of s-curve in project monitoring. • Quality assurance tools and techniques – Affinity diagram, tree diagrams, process decision program charts, matrix diagrams, prioritization matrices, network diagrams.	
4	**Project Human Resource Management** • Role of PM, sponsor, stakeholders, functional manager, portfolio manager, program manager, • HR management plan, recognition and reward systems, team building, stages of team formation and development, team types. • Conflict Management, • Responsibility Assignment Matrix (RAM), RACI Chart, • Motivation theory, Management and Leadership styles, **Project Communication Management** • Communication models, channels, method, communication blockers.	04
5	**Project Risk Management** • Risk management plan, risk response strategies, threats, opportunities, risk register, contingency plans, fallback plans, residual risks, secondary risks, • Risk types and categories, SWOT analysis, **Project Procurement Management** • Procurement management plan, types of agreements and contract types, advantages and disadvantages of each contract type, • PM's role in procurement, procurement documents : RFP, IFB, RFQ, RFI, • Types of procurement, procurement negotiations, centralized / decentralized contracting, contract interpretation, price, profit, cost, target price, sharing ratio, ceiling price	06
6	**Project Stakeholder Management** • Stakeholder analysis, stakeholder register, stakeholder expectations, stakeholder engagement, • Power and interest grid, stakeholders engagement assessment matrix	03
7	**Professional and Social Responsibility** • Project management traits in professional and social responsibility, • Code of Ethics and Professional conduct w. r. t. responsibility, respect, fairness, honesty. **Project Management Case Study / Activity**	05

Text/ Reference Books:

1. Gower Handbook of People in Project Management, Dennis Lock and Lindsay Scott, Routledge Publishers, NY, USA, 2016.
2. Project Management – Essentials You Always Wanted to Know, Kalpesh Ashar, Vibrant Publishers, 2012.
3. Projects: Planning, Analysis, Selection, Financing, Implementation and Review, Prasanna Chandra, McGraw Hill India, 2014.
4. A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Ed., Project Management Institute, USA.
5. Project Management: Processes, Methodologies and Economics, 2nd Ed., Avraham Shtub,

J. F. Bard, S, Globerson, PH Inc., USA.
6. Project Management Handbook,, 2nd Ed., David Cleland, Wiley, 1988.

Sr. No.	Examination	Modules
1	Test 1	1,2, Part of 3
2	Test 2	Part of 3,
3	End Semester	01-07

OE-BTE602 Artificial Intelligence
Course pre-requisites: -

Course Outcome: Students will demonstrate the ability to

1. Develop a basic understanding of AI building blocks presented in intelligent agents
2. Choose an appropriate problem solving method and knowledge representation technique
3. analyze the strength and weaknesses of AI approaches to knowledge – intensive problem solving
4. Design models for reasoning with uncertainty as well as the use of unreliable information

Module	Details	Hours
1	Introduction to Artificial Intelligence (AI) History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI	04
2	Intelligent Agents Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Age	04
3	Problem solving 1 Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening(DFID), Informed Search Methods: Greedy best first Search ,A* Search , Memory bound edheuristic Search.	07
4	Problem solving 2 Local Search Algorithms and Optimization Problems: Hill-climbing search Simulated annealing, Local beam search, Genetic algorithms. Adversarial Search: Games, Optimal strategies, The minimax algorithm, Alpha-Beta Pruning.	07
5	Knowledge based Agents, The Wumpus World, The Propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining, Knowledge Engineering in First-Order Logic, Unification, Resolution, Introduction to logic programming (PROLOG), Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Inference in belief network.	10
6	Planning and Learning The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning, Learning: Forms of Learning, Inductive Learning, Learning Decision Tree, Expert System: Introduction, Phases in building Expert Systems, ES Architecture, ES vs Traditional System.	06
7	Applications Natural Language Processing(NLP), Expert Systems.	04

Text/Reference Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach "Second Edition" Pearson Education.
2. SarojKaushik "Artificial Intelligence" ,Cengage Learning.
3. George F Luger "Artificial Intelligence" Low Price Edition , Pearson Education., Fourth edition.
4. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
5. Elaine Rich and Kevin Knight "Artificial Intelligence" Third Edition
6. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
7. Hagan, Demuth, Beale, "Neural Network Design" CENGAGE Learning, India Edition.
8. Patrick Henry Winston , "Artificial Intelligence", Addison-Wesley, Third Edition.
9. Han Kamber, "Data Mining Concepts and Techniques", Morgann Kaufmann Publishers.
10. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press

Sr. No.	Examination	Modules
1	**Test 1**	**1,2, Part of 3**
2	**Test 2**	**Part of 3,4, Part of 5**
3	**End Semester**	**01-07**

OE-BTC611 Human Resources Development and Organizational Behavior
Course pre-requisites:

Course Objectives:
The learning objectives of this course are:

1. to develop a systematic and planned approach through which the efficiency of employees is improved.
2. development of the integrated use of training, organization, and career development efforts to improve individual, group, and organizational effectiveness.
3. To understand the key competencies that enable individuals in organizations to perform current and future jobs through planned learning

Course Outcomes:
At the end of this course students will be able:

1. to set the future goals and objectives for the entire organization and for self.
2. to apply integrated use of training, organization, and career development efforts
3. to understand the importance of key competencies that enable individuals in organizations to grow.

Module No.	Content	Hrs.
1	Introduction to Human Resource Development: Emergent of HRD, Critical roles, challenges, HRD Process Model: identification of needs and Design and development of HRD programmes, Process Model: Methods of Implantation, Evaluation of programmes.	5
2	HRD interventions: Mentoring for employee development: Role of mentoring in development, Employee counseling for HRD: Overview of counseling programmess, employee assistance programme, stress management, employee wellness and health promotion, Competency framework of HRD: steps in competency mapping.	6
3	Career Planning, management, and development: Career development stages and activities, role of individual and organization in career planning, Organizational Learning, and learning organizations.	5
4	The future of HRD and Ethics: Research, practice and education of HRD for innovation and talent development and management, Role of HRD in developing ethical attitude and behavior and development, Ethical problems with HRD roles.	5
5	Organizational Behavior: Introduction, What is organizational Behavior? Diversity in Organizations, Attitudes and Job Satisfaction, Emotions and Moods, Personality and Values, Perception and Individual Decision Making, Motivation Concepts.	5
6	Foundations of Group Behavior: Understanding Team work, Communication, Leadership, Power and Politics, Conflict and Negotiation, Foundations of Organization Structure, Organizational Culture, Human Resource Policies and Practices, Organizational Change and Stress Management.	5
7	Case Studies: Based on survey done with various industries	5

References:

1.Werner and DeSimone (2006). Human Resource Development. Thomson Press, Network.
2. David Mankin (2009). Human Resource Development, Oxford University Press: Delhi.
3. Rosemary Harison (2000). Employee Development. University Press: Hyderabad.
4. John P. Wilson (2005). Human Resource Development. Kogan Page.
5. Stephen P. Robbins and Timothy A. Judge (2013) Organizational behavior, Copyright © 2013, Pearson Education, Inc., publishing as Prentice Hall

OE-BTC613 Watershed Development and Management
Course pre-requisites:

Course Objectives:
The main objectives of the course are

1. To explain the concept of watershed and its management.
2. To study watershed hydrology and its behavior.
3. To describe erosion process.
4. To summarize the engineering measures for soil and water conservation

Course Outcomes:
At the end of the course the students shall be able to

1. Apply the engineering measures for soil and water conservation
2. Develop watershed management plan

Module No	Details	Hrs.
1	Components of watershed and need of watershed management; Principal factors influencing watershed operations; Delineation of watersheds; Engineering surveys; Data requirement	**4**
2	Watershed hydrology, water resources assessment in watershed, hydrological cycle; Surface water assessment- rainfall-runoff analysis; Groundwater assessment, infiltration and its measurement	**4**
3	Watershed Behavior- Physical elements of watershed, effects of land use changes on hydrological cycle components, watershed experiments, Land capability classification; Erosion process- factors affecting erosion, types of erosion, soil erosion models	**6**
4	Engineering measures for soil and water conservation- Contour bunding, graded bunding, bench terracing, land leveling and grading; Small storage structures- Types and design data requirement, loose boulder dams, gabions, check dams and their design criteria	**6**
5	Rainwater harvesting, direct and indirect methods, filter design, planning and design; Layout and execution; Impact assessment, operation and maintenance issues	**6**
6	Watershed management plan- Methodology of planning a watershed, identification of watershed problems, socio-economic issues.	**6**
7	Case studies: Application of Remote sensing and GIS in watershed management	**4**

References:

1. Das, G., “Hydrology and Soil Conservation Engineering”, Prentice Hall.(2002)
2. Debarry, P. A., “Watershed: Processes, Assessment and Management”, John Wiley.(2004)

3. Lyon, J. G., "GIS for Water Resources and Watershed Management", Taylor and Francis.(2003)
4. Schwab, G.O., Fangmeier, D.D., Elliot, W. J., Frevert, R. K., "Soil and Water Conservation Engineering", John Wiley.(2002)
5. Suresh, R., "Soil and Water Conservation Engineering", Standard Publishers.(2006)

OE-BTC614 Artificial Intelligence Techniques

Course pre-requisites:

Course Objectives:

Course Outcomes:

Module No.	Content	Hrs.
1.	**Introduction to Soft computing techniques-** soft computing techniques, importance, types of soft computing techniques, advantages and limitations**.**	3
2	**Fuzzy logic**: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations- Membership Functions-Features of Membership functions-Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification-Deffuzzification methods- Fuzzy logic controller, applications to water resources engineering	5
3	**Artificial Neural Networks**: Basic concepts- Biological foundations, ANN models, Types of activation function,Neural network Architectures-Single layer feed forward network-Multilayer feed forward network, Perceptron networks-Back Propagation networks-Radial base function network, applications to water resources engineering, applications to water resources engineering	6
4	**Fundamentals of genetic algorithms and Genetic programming:**Intuition behind Genetic Algorithms, Biological Inspiration, What is Genetic Algorithm?, Steps Involved in Genetic Algorithm, Initialization, Fitness Function, Selection, Crossover, Mutation, Application of Genetic Algorithm, Feature Selection, Difference between GA & GP, applications to water resources engineering	6
5	**Model Trees:** Introduction, model trees, CART, Building initial tree, Standard deviation reduction, Pruning the tree, Smoothing, M5 algorithm and M5P algorithms.	5
6	**Support Vector Machine:** Margins: Intuition, functional and geometric margins, the optimal margin classifier, Lagrange duality, Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions, Kernals, applications to water resources engineering.	5
7	Case studies: case studies on FL, ANN, GA, GP ,MT, SVM	6

References:

1.S.Rajasekharan, G.A.VijayalakshmiPai, *Neural Network, Fuzzy Logic andGeneticAlgorithms Synthesis and Applications,* Prentice Hall India.

2. S.N.Sivanandam, S.N.Deepa, *Principles of Soft Computing*, Wiley India.

3. Timothy J Ross, *Fuzzy logic with Engineering Applications*, McGraw Hill, NewYork.

4. S.Haykins, *Neural Networks a Comprehensive foundation*, Pearson Education.

5. D.E.Goldberg, *Genetic Algorithms in Search Optimization and Machine Learning*,Pearson Education.

6. Breiman, L., Friedman, J.H., Olshen, R.A. & Stone, C.J. (1984). Classification and regression trees. Belmont CA: Wadsworth.

http://www.genetic-programming.org/

OE-BTC615 Numerical Computations
Course pre-requisites: Engineering Mathematics

Course Objectives:

With the development of powerful computer, now it has become easier to design and develop complex engineering system with its help. Numerical techniques are brain behind this capability. The objective of this course is to equip students with such techniques of computation so that they can understand and solve real life problems.

Course Outcomes:

1. Upon successful completion of the course, students should be able to
2. understand the basic concept of modeling, numerical computation and associated errors.
3. apply numerical techniques of common mathematical tools to solve real life problem.
4. analyze and compare different techniques with reference to errors, convergence and accuracy.
5. demonstrate potential to develop code which can be used with available programming resources.

Course Contents:

Module	Description	Hrs.
1.	**Exposure to Numerical Software** Introduction to MATLAB and numerical programming through it, Using EXCEL worksheet in numerical computation.	06
2	**Fundamentals of Modeling and Error**: Fundamentals of mathematical modeling - needs and limitations. Mathematic modeling of simple engineering systems Significance of analytical and numerical methods in engineering analysis. Error analysis; significant figures, accuracy and precision, Error definitions, Round-off and truncation error	04
3	**Numerical Solution of Systems of Linear Algebraic Equation:** Direct Methods: Matrix inversion, Gauss Elimination, LU Decomposition, TDMA Nature of iterative solution, Role of eigen values in convergence, Successive under relaxation, Iterative Methods - Jacobi, Gauss Siedel, Effect of rounding off on iteative solution and ill-conditioned system.	06
4	**Numerical Solution of Systems of Non-linear Equations:** Roots of equations: Bisection, False position, Secant, Newton- Raphson methods. Problems based on real-life application.	06
5	**Numerical Integration and Differentiation:** Newton-Cotes Integration Formulas - Trapezoidal rule, Simpson's rule, Finite Difference Methods - Forward difference, Backward difference and Central Difference	06

6	**Numerical Solution of Ordinary Differential Equation:** Explicit and Implicit Marching Method, Modified Euler's Method, Runge- Kutta Methods - RK-II and RK-IV, ODE System: Initial value problem, Boundary value problem, Predictor-corrector methods -Adams Method, Adams-Bashforth-Moulton Method, Milne's Method, Adams- Moulton Method , Stiff ODE System	08
7	**Curve Fitting;** Regression - Least- square regression Interpolation - Newton's divided difference polynomials, Lagrange's polynomials, Spline interpolation;	06

Term Work:

The term work shall comprise of problems and case studies covering different topics taken from course studied in the semester. Assignment shall consist of progra`mmes written in pseudo code, any programming language or MATLAB.

Recommended Books:

Sastry, S S. Introductory methods of numerical analysis . PHI Learning Pvt. Ltd., 2012.

Chapra, Steven and Canale. Numerical methods for engineers . New York: McGraw – Hill, 7ed.

Applied numerical analysis : Curtis Gerald

OE-BTC616 Engineering System and Development
Course pre-requisites: -

Course Objectives:

(i) to introduce the basic principles of engineering for a developing society,
(ii) to develop an ability to formulate problem, analyze, solve and report to the stakeholders, and
(iii) to practice the ability to design, conduct and report field-work in a particular discipline of engineering contributing to the development

Course Outcomes:

At the end of the course the student will be able to:

(i) understand the basic principles of engineering for a developing society,
(ii) formulate problem, analyze, solve and report to the stakeholders, and
(iii) design, conduct and report field-work in engineering contributing to the development of the society.

Course content:
Module 1. Engineer and Society: Basics of Engineering Profession, engineering services, understanding the values of equity, efficiency and sustainability.
Module 2. The Engineer as a change agent: Interdisciplinary, the need for design and synthesis
Module 3. Development Indices: Human Development Index (HDI) and Organization for Economic Co-operation and Development (OECD) indices, The data needed to compute these, Core values of equity, efficiency and sustainability, Paradigms of development.
Module 4: Role of Engineer as a change agent: Understanding Rural and Urban divide and its economy, Wholesale vs. Retail markets, the role of knowledge, practices, science and technology.
Module 5: A Sectoral Engineering System. Example: Drinking water, Irrigation, Electricity, Diesel pumps, non-conventional energy, solar system, community services, water pipe networking, education, health services, road networking, road development, drainage system, energy audit, telecommunication, small scale industries, agricultural sector, effect of seasonal variation on development, understanding service and manufacturing sector, understanding local and global scenario, any other as per engineering sector (Civil, Mechanical, Electrical, Computer, Agricultural, Health etc.)
Module 6: Project through case studies (Rural/Urban): Framing the project, Understanding the demand, needs analysis, Studying the options available, measurement of social and economic parameters as inputs, The activities and the analysis, picking case-study, analyzing, solving and reporting solutions to the stakeholders.

References:

https://unfoundation.org

http://www.undp.org

http://hdr.undp.org

http://www.oecd.org

http://unnatbharatabhiyan.gov.in

http://www.ctara.iitb.ac.in

https://sustainabledevelopment.un.org