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

COURSE CONTENTS

(Final Year B.Tech. in Mechanical Engineering)

Year: 2018-19

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2018-19

List of Courses

PCC-BTM701 Machine Design–II
Course pre-requisites: PCC-BTM602

Course Objectives:

The objectives of this course are

- To develop an ability to apply knowledge of mathematics and engineering related to different machine parts.
- To analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts
- To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
- To develop an ability to identify, formulate, and solve engineering problems.
- To understand the detailed design procedure of bearings as well as the effect of stresses 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.
- To understand the theory behind the selection of material for the different machine parts.

Course Outcomes*:*

Upon successful completion of the course, students should be able

1. To design and evaluate adequacy of standard/custom-built machine elements such as spur/helical/bevel/worm gears, rolling element/journal bearings, mechanical seals and cams to fulfil desired specifications and satisfy failure criteria
2. To integrate knowledge of mechanical engineering to develop design of basic system such as multistage gearbox
3. To explain and discuss design of mechanical systems such as centrifugal pump and snatch block.
4. To apply knowledge of CAD tools for developing engineering drawings for simple system such as multistage gearbox.

Course content:

Module No.	**Details**	**Hrs.**
Module 01	Design of spur, helical, bevels and worm gears.	10
Module 02	Two stage Gear box consisting of spur and helical gear pair: design approach through system design, gear box housing layout and housing design	02
Module 03	Selection of rolling contact bearings based on constant /Variable Load & speed conditions (includes deep groove ball bearing, cylindrical roller, taper roller and self-aligning bearing)	04
Module 04	Design of hydro dynamically lubricated bearings (Self-contained) Introduction to hydro Static bearings Selection of Mechanical Seals	06
Module 05	Design of radial cam with translating roller follower system.	06

Module 06	Design of Brakes: Disk, shoe and drum type. Design of lever arm Design of clutches: Single and multi-plate with springs, pressure and friction plate selection	08
Module 07	Introduction to design of multi-component systems: External gear Pump design, Design of main component of gear pump – Motor selection, Gear design, Shaft design and bearing selection, Casing and bolt design, Suction and delivery pipe.	06

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) Design and detailed assembly drawing on A2 drawing sheets of Min. **two** design problem, from the module 1, 4, 5 and 6
3) Course project*

***Course Projects-** There will be a course project where the students will be able to apply and integrate the knowledge gained during the course. The projects will be developed by teams of Two to Four students and will consist of design of any system having min. 5 to 6 components.

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. Maitra, Gitin M. *Handbook of gear design*. Tata McGraw-Hill Education, 1994.
3. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
4. 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

PCC-BTM702 Renewable Energy Sources and Utilization
Prerequisites: PCC-BTM504

Course Objectives:

To understand the importance of renewable energy and its utilization to satisfy the ever increasing thermal and electrical energy needs of humankind. At the same time be aware of the environmental aspects of these resources.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To apply the fundamental knowledge of heat transfer and fluid mechanics for harnessing renewable energy sources like solar, wind and other sources.
2. To calculate and analyze energy production from liquid flat plate collectors, concentrated collectors, photovoltaic cells and wind energy.
3. To identify and select appropriate renewable energy technology to meet the demand.
4. To identify techniques in extraction and utilization of ocean and geothermal energy.

Course contents:

Sr. No.	Description	Duration (hrs.)
1	**ENERGY REQUIREMENT - OF INDIA AND THE WORLD:** 06 Present energy scenario, conventional energy sources- World's Production and reserves, India's production and reserves. Demand side management of energy. Need and role of renewable energy.	6
2	**SOLAR ENERGY I:** Terrestrial and extra-terrestrial solar radiation. 10 Instruments for measurement of solar radiation. Analysis of liquid flat plate collector, Use of selective coatings to enhance performance. Selection of suitable system to satisfy hot water requirements of any application. Concentrating collectors, solar ponds, solar distillators, solar cooker, solar air heaters, solar driers, solar thermal power system, solar energy storage (Focus on design for specific needs), Solar refrigeration and air-conditioning. Economics of Solar systems.	10
3	**SOLAR ENERGY II:** Photovoltaic energy conversion, solar cells, Selection of PV system to match application.	03
4	**WIND ENERGY:** History, principle of wind power, Betz model. Wind maps, Site selection for wind farms. Wind mills- Design parameters of components, Electrical Power Generation Subsystem. Operational issues, Newer designs of windmills. Application of wind energy.	06
5	**HYDRO-POWER: P**rospects of small hydropower, mini and micro power systems, hydropower conversion devices-Turbine, status of mini and micro hydel in India. **OCEAN ENERGY:** Types of ocean energy sources, OTEC cycles closed and open. Comparison with normal thermal power cycles. Ocean waves-wave motion, Wave energy conversion devices. Tidal Power-	08

	Formation and causes of tides, site selection, turbines selection.	
6	**GEOTHERMAL ENERGY:** History and future, origin and types of geothermal energy regions, dry rock and hot Aquifer analysis, vapor dominated and liquid nominated geothermal systems, operational and environmental problems.	03
7	**BIOMASS ENERGY:** Various forms of biomass as a potential energy 08 source, , Bio-fuel production processes, Gasifiers, principle, construction and design, Types of bio gas plants individual and community biogas plants, Sizing of biogas plants, energy plantation. **CHEMICAL ENERGY SOURCES:** Fuel cells-principle, classification, advantage and disadvantage, application and recent development.	08

Recommended Books:

Text Books:

1. Sukhatme, K., and Suhas P. Sukhatme. *Solar energy: principles of thermal collection and storage*. Tata McGraw-Hill Education, 1996.
2. Tiwari, Gopal Nath. *Solar energy: fundamentals, design, modelling and applications*. Alpha Science Int'l Ltd., 2002.
3. G.D. Rai, Non-conventional Energy Sources. Khanna Publishers.

References

1. Kishore, V. V. N., ed. Renewable energy engineering and technology: principles and practice. The Energy and Resources Institute (TERI), 2010.
2. Boyle, Godfrey. Renewable Energy: Power for a Sustainable. Oxford University Press, USA, 1996.
3. Twidell, John, and Tony Weir. Renewable energy resources. Routledge, 2015.
4. Goswami, D. Yogi, and Frank Kreith, eds. Handbook of energy efficiency and renewable energy. Crc Press, 2007.
5. Tripathi A.K., Multiple Choice Questions on Renewable Energy, 2001.

Term work:

Term work shall consist of a selection of any 5 experiments given below:

1. Measuring solar radiation using Pyranometer.
2. Measuring length of shadow and comparing with calculated length with reasons for difference.
3. Performance of solar liquid flat plate collector, plotting in Hottel Whillier Bliss format.
4. Use of Box type cooker and compare with concentrating type Sievert Cooker.
5. Solar PV panel-characteristics.
6. Measuring performance of Wind Turbine available in SPCE.
7. Survey of energy use in households

And a mini project involving fabrication of working model of device to extract energy of the wind or wave energy.

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

PCC-BTM703 Finite Element Method
Course Prerequisites: BS-BTM301, BS-BTM401, PCC-BTM506

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:

- Term work shall consist of minimum **03** assignments (one on each module)
- Hands on practice on ANSYS 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

PEC-BTM704 Industrial Engineering and Project Management
Course pre-requisites: PCC-BTM605

Course Objectives:

1. To understand knowledge areas and tool – techniques for efficient Industrial Engineering & Project Management.
2. Understand the role of Industrial Engineering & Project Management in an organization.
3. Develop an insight as to how Industrial Engineering & Project Management tool/techniques are used strategically for the betterment of organization.
4. To understand how it helps in customer focus, innovation, quality management, speeding up the processes and improvement in productivity in an organization.

To understand the Life cycle and phases of project management.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To describe the basic concepts in Industrial Engineering & Project Management.
2. To describe the various tools and Techniques in Industrial Engineering & Project Management.
3. To apply the various concepts and Tools in Industrial Engineering & 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	**Industrial Engineering:** 1.INTRODUCTION Introduction to industrial engineering, history and contribution to industrial engineering, industrial engineering approach, techniques of industrial engineering, objectives of industrial engineering, system approach and industrial engineering, definition and concept of productivity, productivity measures, factors influencing productivity, productivity improvement techniques.	04
2	2. WORK STUDY & ERGONOMICS Work Study: Definition and objectives, importance and advantages, work study procedure. Method Study: Definition and objectives, scope and steps involved in method study, job selection, recording techniques, critical examination, development and selection of improved method, motion economy principles, installation and maintenance of proposed method. Work Measurement: Definition and objectives, techniques of work measurement, steps involved in work measurement, types of elements, time study equipments, performance rating and allowances, computation of standard time, predetermined motion time standards(PMTS)	08

3	*Self-study mode* ERGONOMICS: Definition and objectives of human engineering, man machine systems and their aspects and relationship with productivity, human factors affected by environment, methods to improve work environment. Evaluation of cultural fit on mergers and acquisitions of business enterprises.	-
4	ADVANCE CONCEPTS IN INDUSTRIAL ENGINEERING Need of computers in industrial engineering, development of integrated systems, sharing of data and information, advantages of integrated systems, principles of integrated system design, MRP-I, MRP-II, JIT, BPR, SCM, EPR, Lean manufacturing, Green Manufacturing, Agile manufacturing, etc.	04
5	(A) **Project Management:** 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. Project Management to the Mechanical Engineering context, Organizational Structure, Project Life Cycle, Phases and Nature of Mechanical Engineering projects, Trends affecting Mechanical Engineering Project Management, Globalization, Outsourcing, and Virtual Teams.	08
6	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.	08
7	Project Cost Management, Estimating Techniques, Earned Value Management, Project Quality Management, Planning Quality, Performing Quality Assurance, Quality Control – Tools and Techniques, Project Resource Management, Development of Human Resource Plan, Project Organizational Chart and Responsibility Assignment, Multi project Scheduling and Resource Allocation, Project Communication Management, Identifying Stakeholders, Planning Communication, Project Risk Management, Identifying Risks; Common Sources of Risk in Mechanical Engineering Projects, Qualitative Risk Analysis: Probability and Impact Matrix, Quantitative Risk Analysis: Decision Trees, Planning Risk Response, Project Procurement Management, Planning and conducting procurement	10

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

Teaching Methods:

1. The course will use the following pedagogical tools:
2. Discussion on concepts and issues on Industrial Engineering and Project Management use of in an organization.

3. Case discussion covering a cross section of gaining strategic advantage by applying Industrial Engineering and Project Management tools and techniques.
4. Projects/ Assignments/ Quizzes/ Class participation etc.

Text books:

1. Weihrich, Heinz, and Harold Koontz. *Management: A global perspective*. Tata McGraw-Hill, 2005.
2. Niebel, Benjamin W. Freivalds, Andris Benjamin W. Niebel, and AndrisFreivalds. *Methods, standards, and work design*. 2003.
3. Mundel, Marvin Everett. *Improving productivity and effectiveness*. Englewood Cliffs, NJ: Prentice-Hall, 1983.
4. Chase, Richard B., and Nicholas J. Aquilano. *Production and operation management*. R d Irwin, 1973.
5. Barnes, Ralph M. "Motion and time study ." (1949).
6. Sham H.S., *Work Study and Ergonomics*, Dhanpatrai & Sons, 2000.
7. Meredith, Jack R., and Samuel J. Mantel Jr. *Project management: a managerial approach*. John Wiley & Sons, 2011.
8. Lewis, James P. *Project Planning, Scheduling & Control, 4E*. McGraw-Hill Pub. Co., 2005.

Reference book

1. Larson, Erik W., and Clifford F. Gray. "Project management: The managerial process." (2011).
2. I.L.O. *Introduction to Work Study*, I.L.O., 1986.
3. Meredith, Jack R., and Samuel J. Mantel Jr. *Project management: a managerial approach*. John Wiley & Sons, 2011.

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

PEC-BTM707 Business Process Reengineering and Total Quality Management
Course Prerequisites: PCC-BTM605

Course Objectives

The objectives of the course are to

- Understand the role of Business Process Reengineering technique in an organization.
- Develop an insight as to how BPR tool/techniques are used strategically for the betterment of organization
- To understand how it helps in customer focus, innovation, quality management, speeding up the processes and improvement in productivity in an organization.
- To understand the Total Quality Management concept and principles and the various tools available to achieve Total Quality Management.
- To understand the statistical approach for quality control.
- To create an awareness about the ISO and QS certification process and its need for the industries.

Course Outcomes

Upon successful completion of the course, students should be able

1. To understand the various concepts, philosophies, principles in BPR and TQM
2. To understand and apply various tools and techniques used in BPR and TQM
3. To apply statistical quality control tools for process improvements
4. To investigate the factors affecting Successful implementation of BPR and TQM in given cases

Course content:

Module No	Details	Hrs
1	**BPR:** Introduction to BPR, Concept, Need for Reengineering, Benefits, guiding principles, BPR and performance Improvement, Pitfalls in BPR, Myths of BPR.	6
2	BPR implementation methodology, Success factors of BPR, Barriers to BPR	4
3	BPR in Manufacturing industry, BPR and IT, BPR and relevant technologies, BPR and ERP	6
4	**TQM:** Definition of quality, Dimensions of quality, Quality costs, Basic concepts of total quality management, Principles of TQM, Quality statements, Deming Philosophy, Juran trilogy, Crossby's Philosophy, PDCA cycle	6
5	5S, Kaizen, Benchmarking, Benchmarking process, Quality Function Deployment (QFD), House of quality, Taguchi quality loss function, Total Productive Maintenance (TPM), FMEA, Stages of FMEA	6
6	The seven tools of quality, Statistical fundamentals, Measures of central tendency and dispersion, Population and sample, Normal curve, Control charts for variables and attributes, Process capability, Concept of six sigma.	8

7	Need for ISO 9000 and other quality systems, ISO 9000:2000 quality system, Elements, Implementation of quality system, Documentation, Quality auditing, TS 16949, ISO 14000, Concept , Requirements and Benefits	6

Teaching Methods:

The course will use the following pedagogical tools:

A Discussion on concepts and issues on BPR use of in an organization.

B Case discussion covering a cross section of gaining strategic advantage by applying BPR tools and techniques.

C Projects/ Assignments/ Quizzes/ Class participation etc.

Text book:

1. Radhakrishnan, R., and S. Balasubramanian. *Business Process Reengineering: Text and Cases*. PHI Learning Pvt. Ltd., 2008.
2. Dey, B. R. *Business Process Reengineering & Change Management*. John Wiley & Sons, 2004.
3. Besterfield, Dale H. "Total Quality Management. 2003."
4. Jain, Jain PL. *Quality Control and Total Quality Management*. Tata McGraw-Hill Education, 2001.

Reference book:

1. Khoong, Chan Meng, Henry J. Johansson, Patrick McHugh, A. John Pendlebury, and William A. Wheeler. "Business Process Reengineering: Breakpoint Strategies for Market Dominance." (1997): 112-114.
2. Grover, Varun, and William J. Kettinger, eds. *Business process change: Concepts, methods, and technologies*. IGI Global, 1995.
3. Feigenbaum, A. V. A. V. *Total quality control*. 1983.
4. Narayana, V., and N. S. Sreenivasan. "Quality Management–Concepts and Tasks." *New Age International* 3 (1996).
5. Bounds, Gregory M. *Beyond total quality management: Toward the emerging paradigm*. McGraw-Hill College, 1994

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

PEC-BTM708 Computational Fluid Dynamics
Pre-requisites: PCC-BTM305, PCC-BTM403, PCC-BTM501

Course Objectives:

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

- differentiate between modeling and simulation,
- know numerical techniques of discretization and solving linear algebraic and PDE equations
- to write governing equation and boundary condition of a heat and flow problem – do complete CFD analysis of a heat and flow problem using software

Course Outcomes:

On successful completion of the course students will be able to

1. To describe need of modeling and simulation and its overall methodology of execution.
2. To solve a system of linear algebraic equation using standard direct and iterative technique.
3. To examine and formulate a thermal and fluid flow problem using numerical techniques.
4. To analyze outcome of thermal and fluid flow problems

Course Contents:

Module	Description	Hrs.
1	**CFD Fundamentals:** Modeling and Simulation Computational Fluid Dynamics - its Scope, Application, advantages and disadvantages. Overall methodology of CFD analysis -Preprocessing, Solver, Post processing.	04
2	**Mathematical Description of Physical Phenomenon:** Concept of mathematical modeling, Basic conservation equation In differential and Integral form, General thermal and flow boundary condition, Mathematical nature of partial differential equation used in thermo-fluid analysis.	06
3	**Numerical Solution of Linear Algebraic Equation:** Direct Method – Matrix inversion, Gauss Elimination, LU decomposition. Iterative Method- Features of iterative techniques, Jacobi and Gauss Seidel Method, Relaxation method (SUR and SOR). Stability and convergence, Ill-conditioned system of equation and condition number.	06
4	**Numerical Modeling of Heat Conduction:** Steady One and two dimensional Conduction, Unsteady One and two Dimensional Conduction, Stability restrictions.	06
5	**Numerical Modeling of Convection-Diffusion:** Numerical treatment of convective terms- FOU, SOU, QUICK, Power law scheme. Steady One-dimensional and Two Dimensional Convection- Diffusion, Unsteady One-dimensional Convection-Diffusion, Unsteady Two- dimensional Convection-Diffusion	08

6	**Incompressible Fluid Flow:** Governing Equations, Complexities in solving flow problems, Determination of Pressure for Viscous Flow, SIMPLE, SIMPLER and PISO Algorithm	06
7	**Turbulence Modeling:** Introduction to Turbulence Modeling, Basic Theories of Turbulence Reynolds Time-Averaged Equations for Turbulent Flow, Different turbulence models.	06

Term Work:
Term work shall consist of minimum **06 (Six)** assignments/tutorials

Recommended Books:

1. Versteeg H.K. and Malalasekera.W: " An introduction to computational fluid dynamics-The finite volume method", Prentice Hall
2. Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., "Computational Fluid Mechanics and Heat Transfer", Hemishphere Publishing Corporation,.
3. Subas, V.Patankar, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation
4. Muralidhar, K. and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House.
5. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd.

a. Niyogi.P. Laha M.K., Chakrabarty S.K.: "Introduction to Computational Fluid Dynamics". Pearson Education, India.

6. Fletcher, C.A.J."Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer-Verlag

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

PEC-BTM709 Process Equipment Design and Piping Engineering
Pre-requisites: PCC-BTM302, PCC-BTM602

Course Objectives:

The objective of this course is to:

- Learn reading and interpretation of essential design documents such as P&ID and equipment data sheets.
- Prepare student to obtain sizes of important process equipment and piping components subjected to different types of loading.
- Make students able to handle stress/thermal analysis of pressure and piping components using advanced methods such as finite element method.

Course Outcomes:

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

1. Explain and interpret essential design documents such as PFD, P&ID, Data Sheets and Technical Specifications.
2. Calculate size of major process equipment and piping components using theoretical formulae, rules of international design codes/standards as well as IT tools.
3. Design of pressure vessels, heat exchangers and piping as part of engineering system of process plant.
4. Explain and apply the knowledge of piping engineering such as reading pipe layout, compatibility of materials for service and fabrication, selection of fittings and supports, and features of different international codes associated to piping engineering.

Course contents:

Sr. No.	Description	Duration (hrs.)
1	**Introduction:** Role of process equipment/ piping engineer in Chemical industry, organization and working of EPC company, Interpretation of process diagrams such as P&ID, Design codes and standards such as ASME BPVC, ASME B31.1/31.3, IBR, IS2825.	4
2	**Materials of Construction and Fabrication** Material classification and selection of material for various industrial processes, Preparation of Material Specification Sheets. Review of fabrication, inspection and testing methods.	4
3	**Design of pressure components** such as shell, head, cone for internal pressure loading. Design of cylindrical shells against external pressure; design of stiffener rings.	8
4	**Advanced design topics** such as nozzle reinforcement calculation, bolted flange design, selection of gaskets. Elementary stress analysis of pressure parts using finite element methods.	8

5	**Design of supports** for tall vertical vessels; skirt support subjected to wind and seismic loads. **Elementary heat exchanger design**. Tubesheet thickness calculations, baffle plate design	6
6	**Design of Pipes and Pipe Fittings** Pipe specification, Calculations for pipeline sizing, Pressure drop in pipelines, Design and selection of piping components such as straight pipe and bends.	6
7	**Pipe Supports** Study and selection of various types of pipe supports. Design considerations, supporting span of overhead pipelines. **Piping Flexibility** Introduction to piping flexibility analysis.	6

Recommended Books:

1. Brownell, Lloyd E., and Edwin H. Young. *Process equipment design: vessel design*. John Wiley & Sons, 1959.
2. Harvey, John F., and H. Saunders. "Theory and design of pressure vessels.", Van Nostrand Reinhold Company, 1987.
3. MW Kellogg Co. *Design of Piping Systems*. Wiley, 1961.

Reference Books:

1. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 and 2, ASME, 2017.
2. ASME B31.3 Process Piping, ASME, 2016.
3. Mahajan, Kanti K. "Design of process equipment: selected topics.", Pressure Vessel Handbook Pub, 1992.

Term work:

- Assignment based on each module.
- Report of visit to a process industry plant.

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

PEC-BTM725 Introduction to Cryogenics
Pre-requisites: PCC-BTM305, PCC-BTM501

Course Objectives:

The objective of this course is to:

1. **To explain** history, developments, pre-requisite principles, scope and applications of Cryogenic Engineering as a science of generation, retention and distribution of low extreme low temperature.
2. **To explain** and **illustrate** fundamental concepts and principles in the domain of behavior of engineering materials and fluids at cryogenic temperatures.
3. **To explain** and **illustrate** fundamental concepts and principles in the domain of cryogenic insulation, vacuum technology and safety aspects in Cryogenic Engineering.
4. **To explain** and **illustrate** fundamental principles, detailed features of arrangements, operation of various cryogenic cycles for liquefaction of gases and evaluate and compare performance parameters of practical cryogenic cycles and liquefactions systems with critical components involved.

Course Outcomes:

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

1. **To explain** and **discuss** the history, developments, principles as well as scope and applications of Cryogenic Engineering.
2. **To explain** and **discuss** fundamental concepts and principles in the domain of behavior of engineering materials and fluids at cryogenic temperatures and **apply** to practical cryogenic systems to **evaluate** and **compare** their performance parameters.
3. **To explain** and **discuss** fundamental concepts and principles in the domain of cryogenic insulations, vacuum technology and safety aspects and **apply** to practical cryogenic systems to
   evaluate and **compare** their performance parameters.
4. **To explain** and **discuss** fundamental principles, detailed features of arrangements and operations of various cryogenic cycles for liquefaction of gases and **apply** to practical cryogenic systems to **analyse**, **evaluate** and **compare** their performance parameters.

Course Contents:

Module No.	Details	Hrs.
1.	**Introduction to Cryogenic Engineering:** Introduction, Historical background, Developments, Scope of application, Present areas involving Cryogenic Engineering, Role of Cryogenic Engineers, Principles of Thermodynamics, Heat Transfer, Momentum Transfer, Cooldown.	04
2.	**Low Temperature Properties of Engineering Materials: Properties of Solids:-**Mechanical Properties, Thermal Properties, Electrical and Magnetic Properties of solids including metals and non-metals (insulators), Design considerations, Material selection criterion for Cryogenic Applications. **Cryogenic Fluids:-** P-V-T Behaviour of a Pure substance, T-s and T-h	06

	diagrams of a Pure substance, Properties of cryogenic fluids:- Fluids other than Hydrogen and Helium, Hydrogen , Helium.	
3.	**Gas Liquefaction Systems-I:** Introduction, System performance parameters, The thermodynamically ideal system, Production of low temperatures:- Joule-Thompson effect, Adiabatic expansion. Simple Linde-Hampson system, Pre-cooled Linde- Hampson system, Linde dual pressure system, Cascade system, Claude system, Kapitza system, Heylandt system. Liquefaction systems for LNG, Comparison of liquefaction systems.	08
4.	**Gas Liquefaction Systems-II:** Liquefaction systems for Neon and Hydrogen:- Pre-cooled Linde-Hampson system for Neon and Hydrogen, Claude system for Neon and Hydrogen, Helium refrigerated Hydrogen liquefaction system, Ortho-Para Hydrogen conversion. Liquefaction systems for Helium:-Collins Helium liquefaction system, Simon Helium liquefaction system. Critical components of liquefaction systems:-Heat Exchangers, Compressors and expanders, Losses for real machines and effect on system performance, Effect of heat transfer to system.	08
5.	**Cryogenic Insulations:** Introduction, Heat transfer, Concept of apparent thermal conductivity, Different types of cryogenic insulations:-Expanded foam insulations, Gas-filled powders and fibrous insulations, Vacuum insulation, Evacuated powder and fibrous insulations, Opacified-powder insulations, Multilayer insulations, Comparison of insulations. Composite insulation, Adhesives and other materials, Placement of cryogenic insulation.	06
6.	**Vacuum Technology:** Importance of vacuum technology in cryogenic, Flow regimes in vacuum systems, Conductance in vacuum system, Components of vacuum system, Differrent types of vacuum pumps:- Mechanical vacuum pumps, Difussion pumps, Ion pumps, Cryopumping, Getters and sorption pumping, Vacuum gauges, Vacuum valves.	06
7.	**Safety Aspects with Cryogenic Systems:** Introduction, Physiological hazards, Suitability of materials and construction techniques, Explosions and flammability, Excessive pressure gas, Special considerations for Hydrogen and Oxygen gas, General safety principles, Safety checklist.	04

Term Work:

At least one Assignment on each Module comprising analytical solution of numerical problems, Technical presentations based on Course contents, Analysis and Presentations on Reserch and Developmemnt work in the field of Cryogenic Engineering. Required attendance in Lectures and Tutorials, involvement in acdemic activities related to course and overall conduct carry weigthage in assessment of Term Work.

Text Book:

1. Barrron, Randall F, *Cryogenic Systems*, 2nd ed, Oxford University Press, New York, 1985.

Reference Book:

1. Flynn, Thomas M 2005, *Cryogenic Engineering*, 2nd edn, CRC Press, New York, 2005.

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

PRJ-BTM798 Project Stage I
Course pre-requisites: Recommended – all courses till semester VI

Course Outcomes:

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

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

Course content:

Sr.no.	Description	Hrs./week
1	Student shall study the topic of project work in terms of data collection, analysis, and inferencing. The student shall prepare an interim report and shall present a seminar on the work done at the end of semester.	**2 (contact) + 6 (self-study)**

VAC-BTM771 Introduction to Research Methodology
Course Pre-requisites: Basic statistics

Course Objectives:

1. To learn research methodology
2. To learn research methodology tools and techniques
3. To learn research report writing

Course Outcomes:

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

1. understand the basics of Research Methodology
2. understand the Tools and techniques in Research Methodology
3. use the knowledge of data collection methods
4. write the research report

Course Contents:

Sr. No.	Details	Hrs.
Module 01	Definition of research: Research – Definition; Types of Research methods Pure and applied research. Descriptive and explanatory research, Qualitative and quantitative approaches	01
Module 02	Research procedure: Formulating the Research Problem, research design including sample Design, Sample size. Considerations in selecting research problem	02
Module 03	Literature survey, Guidelines for Literature survey	02
Module 04	Data Collection methods: Interview, experimental methods, case study	03
Module 05	Regression Equation and Curve fitting	02
Module 06	Hypothesis tests: z test , F test , t Test, Chi Sq test	02
Module 07	Outcome of research: Preparation of the Report on conclusions reached. Testing validity of research outcomes. Suggestions and recommendations, identifying future scope.	04

PRACTICAL:

Term work shall consist of one assignment on each module.

Text Books:

1. Kothari C R, Research Methodology, Wiley Eastern
2. Research Methodology: A Step-by-Step Guide for Beginners by by Ranjit Kumar

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

VAC-BTM772 Introduction to Nanotechnology
Course Pre-requisites: BS-BT105, BS-BT205

Course Objectives

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

Course Outcomes:

Upon successful completion of the course, the students should 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.	**2**
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.	**2**
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	**1**
04	**Types of nano particles and applications** Nanocontainers, Nanoshells, Nanohorns, Nanowires, Nanosprings, Nanorods, Nanofilters, Nanopens, Nanopencils, Nanopipettes, Nanopens, Nanoplotter, Nanobalance, Nanobeads, Nanoguitar	**2**
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,	**2**
06	**Properties of Nanomaterials** Physical Properties: Thermal stability and lattice constant, Mechanical properties, Optical properties, Electrical conductivity, Ferroelectrics and	**2**

	dielectrics, Superparamagnetism, Emission spectroscopy, luminescence spectroscopy.	
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.	**2**

Term Work: Term work shall consist of one assignment on each module.

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

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

PC-MTMD101 Advanced Stress Analysis

Refer to Course Contents for M.Tech. in Machine Design

PCC-BTM801 Design of Mechanical System
Course Prerequisites: PCC-BTM602, PCC-BTM701

Course Objectives:
On successful completion of the course, students should be able to

- Understand the basics of material handling equipment like elevators, conveyors and EOT cranes.
- Design the main components of the belt conveyor system.
- Understand the designing aspects of centrifugal pumps, vane pumps and gear pumps.
- Understand pressure vessels and its design.

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

1. create mechanical design of entire systems such as EOT crane, belt conveyor, centrifugal pump, gear pump and pressure vessel by integrating knowledge of mechanical engineering courses
2. compare and evaluate available design alternatives and to select the most suitable one to fulfil technical requirements of the system
3. discuss and review the design features and requirements of different mechanical systems
4. demonstrate ability to design and evaluate a complex mechanical system to meet real-life needs with appropriate considerations such as economic, environmental, social, ethical, manufacturability, sustainability, health, safety, legal and cultural through completion of course design project

Course content:

Sr. No.	Description	Duration (hrs.)
1	Introduction to material handling equipment, i.e. hoists, cranes, elevators, conveyors etc.	4
2	Design of EOT crane for: Snatch Block assembly, Rope drum assembly, Overhead travelling mechanism assembly.	8
3	Design of belt conveyors-- Power requirement, selection of belt, design of tension take up unit, idler pulley etc.	6
4	Design of screw conveyor	6
5	Introduction to centrifugal pump and positive displacement pump such as gear pump, vane pump, etc. Design of main components of centrifugal pump - Motor selection, Suction and delivery pipe, Impeller, Impeller shaft, Volute casing. (system design approach)	6
6	Design of Gap Frame Mechanical Presses (Sheet metal Punching, Blanking applications) OR Design of Hydraulic Circuits for machine tool operations	8
7	Introduction to pressure vessel design.	4

Term Work:

The term work shall consist of

1. Design project: The design project shall consist of two imperial size sheets - one involving assembly drawing with a part list and overall dimensions and the other involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances.

A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file.

2. Assignments based on above topics.

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. Basu, Saroj Kumar, and D. K. Pal. *Design machine tools*. New Delhi etc: Oxford a. IBH publ. co, 1989.
2. Mehta, N. K. *Machine tool design*. Tata McGraw-Hill Education, 2012.
3. PATIL, SP. *Mechanical System Design,* JAICO students Ed., 2014.
4. Rudenko, Nikola Ďeodos′evich, and Nikolaĭ Feodos′evich Rudenko. *Materials handling equipment*. Peace Pubs., 1964.
5. Sahu G.K., *Pumps*, New Age International, 2000.
6. Machine Tool Design Handbook, Central Machine Tool Institute, McGraw Hill Education (2017)

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

PCC-BTM802 CAD/CAM/CIM
Course Prerequisites: PCC-BTM306

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 computer integrated manufacturing (CIM)

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

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

Course Contents:

Sr. No.	Details	Hrs.
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.	**05**
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.	**05**
Module 03	**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.	**05**

	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	
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.	**06**
Module 06	**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**

TERM WORK:

Term work shall consist of class assignments, 3D modeling on any advanced CAD Package, C++ Programming for Transformations, Bezier & B-Spline Curves & Algorithms etc, APT Programming & CNC Part Programming on CNC Machine.

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

PCC-BTM803 Industrial Management, Entrepreneurship and ERP
Pre-requisites: Recommended- All courses till Sem- VII

Course Objectives:

The objectives of this course are:

1. To explain and outline Global principles of Management, discuss concepts, functions and techniques of specific domains of Management such as Human Resource, Cost Accounting, Finance etc. applicable to an Industry or an Enterprise.
2. To explain and illustrate quantitative 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 discuss scope, potential and steps of Entrepreneurship Development and Management of an Enterprise.
4. To explain and discuss overview and concepts of ERP Systems in an Industry or an Enterprise.

Course Outcomes:

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

1. To explain and exemplify the Global principles of Management as well as Discuss the concepts, functions and techniques of specific domains of Management such as Human Resource, Cost Accounting, Finance etc. applicable to an Industry or an Enterprise.
2. To explain and apply quantitative 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 decide optimum solution of a management problem.
3. To explain and discuss scope, potential and steps of Entrepreneurship Development and Management of an Enterprise.
4. To explain and discuss overview and concepts of ERP Systems in an Industry or an Enterprise.

Course Contents:

Module No.	Details	Hrs.
1.	**Global Principles of Management:** Management:- Science, Theory and Practice, Evolution of Management Thought, Management -Social Responsibility and Ethics. Planning- Objectives, Strategies, Policies and Process, Organising -Structure and Process, Decision Making-Search, Evaluation, Quantitative/Qualitative Analysis and Selection of Alternatives, Programmed and Non Programmed Decisions. Control- System, Process and Techniques, Role of IT.	06
2.	**Human Resource Management:** Importance, Staffing and Selection Function, Managerial Performance Appraisal, Formulation of Career Strategy, Manager Development- Approaches, Process and Techniques, Leadership, Motivation and Morale – Significance and Theories,	06

	Dynamics of Change Management, Stress Management, Work Groups Management, Management of Organizational Conflicts and Negotiations, Inter Personal Behaviour, Transactional Analysis.	
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 Determination 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, Accounting 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.	**Entrepreneurship and Economic Development:** Need, Scope, Philosophy, Alternative Theories, SSI Development- Indian Scenario, Risk Taking, Creativity and Entrepreneurship, Intrapreneuring and Entrepreneurship. Enterprise Launching- Policy Reforms and Government Initiatives, Entreprenual 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.	**Entrepreneurship and Enterprise Management:** Management of a Small Business Firm, Management of Funds - Capital Structure Planning, Long Term Financing and Working Capital - EBIT-EPS Analysis, Assessment of Debt Capacity, Financing Choices, Institutional Structure, Direct/Indirect Financial Assistance, Financing 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.	06
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 Module, Finance Module etc., Implementation of ERP- Steps involved, Tangible and Intangible benefits, Future of ERP, Challenges 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.

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., Entrepreneurship 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 Entrepreneurship, Harper Collins India ,2015.
6. Kuratko, Donald F., Introduction to Entrepreneurship, International edn of 8th Revised educational edn., South-Western Educational Publishing, OH, 2009.
6.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

PEC - BTM807 Industrial Robotics
Course Prerequisites: PCC-BTM402, PCC-BTM502, PCC-BTM503

Course Objectives:
On successful completion of course, students should able to
1. Understand the anatomy of different ROBOTS
2. Know programming of ROBOTS
3. Develop the ROBOTS in concern with society

Course Outcome:
Upon successful completion of the course, students should be able
1. To describe the basic anatomy of ROBOT
2. To explain programming in ROBOTICS
3. To apply knowledge for development of ROBOT
4. To decide social issues & economics of robotic

Course content:

Sr. No.	Details	Hrs.
Module 01	**1.1 INTRODUCTION:** Automation & robotics, Robotic System & Anatomy Classification, Future Prospects **1.2 DRIVES:** Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators, Power Transmission Systems. **1.3 ROBOT & ITS PERIPHERALS:** End Effecters - types, Mechanical & other grippers, Tool as end effecter **1.4 SENSORS:** Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Uses Vision Systems - Equipment	6
Module 02	**2 MACHINE VISION:** Introduction, Low level & High level vision, Sensing & Digitising, Image processing & analysis, Segmentation, Edge detection, Object description & recognition, Interpretation, Applications	6
Module 03	**3 PROGRAMMING FOR ROBOTS:** Methods, Robot programme as a path in space, Motion interpolation, level & task level languages, Robot languages; Programming in suitable languages Characteristics of robot.	6
Module 04	**4 ROBOT KINEMATICS:** Forward, Reverse & Homogeneous Transformations, Manipulator Path Control, Robot Dynamics.	6
Module 05	ROOT INTELLGENCE & TASK PLANNING: Introduction, State space search, Problem reduction, Use of predictive logic, Means -Ends Analysis, Problem solving, Robot learning, Robot task planning.	6
Module 06	ROBOTIC APPLICATION IN MANUFACTURING: Material transfer, Machine loading & unloading, Processing operations, Assembly & Inspectors, Robotic Cell Design & Control.	6
Module 07	SOCIAL ISSUES & ECONOMICS OF ROBOTICS	6

Term Work:
Term work shall consist of minimum **06** assignments at least one on each module, programming of robots

Text Books

1. Ramamurti, Viswanatha. *Computer aided design in mechanical engineering*. New Delhi: Tata McGraw-Hill, 1987.
2. Paul, Richard P. *Robot manipulators: mathematics, programming, and control: the computer control of robot manipulators*. Richard Paul, 1981.
3. Groover, Mikell P., Mitchell Weiss, and Roger N. Nagel. *Industrial Robotics: Technology, Programming and Application*. McGraw-Hill Higher Education, 1986.
4. N-Nagy, Francis L. "Robotic engineering: An integrated approach: Richard D. Klafter, Thomas A. Chmielewski and Michael Negin Prentice-Hall International, 1989.

Reference Books:

1. Koren, Yoram, and YoramKoren. *Robotics for engineers*. Vol. 168. New York et al: McGraw-Hill, 1985.
2. Engelberger, Joseph F. *Robotics in practice: management and applications of industrial robots*. Springer Science & Business Media, 2012.
3. Grover, D. J. "Computer integrated manufacturing technology and systems: Ulrich Rembold, Christian Blume and Ruediger Dillmann, Marcel Dekker Inc, Cimarron Road, Monticello, NY 12701, USA (1985)
4. Spong, Mark W., and Mathukumalli Vidyasagar. *Robot dynamics and control*. John Wiley & Sons, 2008.
5. Craig, John J. *Introduction to robotics: mechanics and control*. Vol. 3. Upper Saddle River: Pearson Prentice Hall, 2005.
6. Doebelin, Ernest O., and Dhanesh N. Manik. "Measurement systems: application and design." (2007).
7. Beckwith Thomas, G., and N. Lewis Buck. "Mechanical Measurements." (2008).
8. Ogata, Katsuhiko. "Modern Control Engineering, PHI Learning Pvt." *Ltd., New Delhi, India* (2009).
9. Tzafestas, Spyros G. "Intelligent robotic systems." *Electrical engineering and electronics* (1991).

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

PEC-BTM808 Supply Chain Management
Course Prerequisites: PCC-BTM605

Course Objectives

- To learn to apply tools & techniques of Supply Chain Management in real life industrial environment
- To think logically to design the tailor made new techniques which will enhance the effectiveness of the domain of Supply Chain Management.
- To design Tailor made Supply Chain Management for a typical requirement which will face the new challenges.

Course Outcomes

Upon successful completion of the course, students should be able

1. To describe the various concepts in SCM
2. To apply the various Tools and Techniques of Supply Chain Management in real life industrial environment.
3. To analyse the issues in SCM for a given case.
4. To design Tailor made Supply Chain for a typical requirement which will face the new challenges.

Course content:

Sr. No.	Details	Hrs.
Module 01	**1. INTRODUCTION TO SUPPLY CHAIN MANAGEMENT**: Current Business Scenario, Value Matrix Analysis, Evolution of SCM Function, Theme and Pillars of SCM System, How Supply chain works? Participants in the Supply Chain, Supply chain drivers, Supply chain structure	04
Module 02	**2.SUPPLY CHAIN OPERATIONS**: <u>2.1 Planning and Sourcing</u> Demand forecasting, Pricing and Promotional Impacts on demand, CPFR Concepts, CODP Concepts, Consensus Forecasting, Demand and Pricing Optimization <u>2.2 Making and Delivering</u> Product Design, Production Scheduling, Facility Management, Order Management, Delivery Scheduling, Distribution network design, channels of Distribution, Plant and warehouse location.	07
Module 03	**3. MATERIALS MANAGEMENT IN SUPPLY CHAIN** Scope, importance, classification of materials, Procurement, purchasing policies, vendor development and evaluation, Inventory control systems of stock replenishment, Cost elements New Supply Planning Paradigms, VMI, CMI, Green Channel supply, KM Model of Supplier Partnership, Multi-tier Supplier Partnerships Use of computers for materials function.	06
Module 04	**4. LOGISTICS** Logistics Evolution, 8 wings of Logistics, Distribution Network Systems, Warehousing and Inventory Cross-Docs, Multi-Modal Optimization, Inbound and Outbound handling, Containerization, TPL, FPL, MPL Partnering, Reverse Logistics	06
Module 05	**5.TRANSPORTATION:** Individual Freight and passenger modes, intermodal transportation and	05

	third party transportation services, economic social, and political roles of transportation, demand, cost and service characteristics of services, carrier selection and evaluation services, freight rate structure, Private International transportation, Ocean carrier management, port administration and regulation, costing and pricing issues of international transportation, logistics, cost transport mode choice, Dispatch decisions, routing decisions, routing Models, packaging to suit mode of Transport	
Module 06	**6. SUPPLY CHAIN COORDINATION AND USE OF TECHNOLOGY** The "Bullwhip" Effect, Supply Chain Coordination factors, Collaborative Planning, Forecasting, and Replenishment, supported information systems, E-Business and Supply Chain Integration, SCM systems Vendors, Types of Applications, Optimization Modeling, E-Business and Systems Integrations from ERP to SCM, KM, APS Systems, Further integration to CRM	07
Module 07	**7.1 MEASURING PERFORMANCE: SUPPLY CHAIN METRICS** Market Performance Categories, Framework for Performance Measurement, Internal Efficiency Metrics, Demand Flexibility Metrics, Product Development Metrics, Benchmarking and SCM SCORE modeling **7.2 TOTAL DISTRIBUTION COST ANALYSIS**	07

Term Work:

Case Study /Course Project: Report of 10 - 15 pages on any topic from syllabus. Term work shall consist of minimum 06 assignments

Text Books:

1. Mohanty, Ph DRP, and Ph DSG Deshmukh. *Supply Chain Management (Theories & Practices)*. John Wiley & Sons, 2005.
2. Altekar, Rahul V. *Supply chain management: Concepts and cases*. PHI Learning Pvt. Ltd., 2005.
3. Shah, Janat. *Supply chain management: Text and Cases*. Pearson Education India, 2009.

Reference Books:

1. Christopher, Martin, and John Gattorna. "Supply chain cost management and value-based pricing." *Industrial marketing management* 34, no. 2, 2005.
2. Wisner, Joel D., Keah-Choon Tan, and G. Keong Leong. *Principles of supply chain management: a balanced approach*. Cengage Learning, 2014.
3. Shapiro, Jeremy. *Modeling the supply chain*. Nelson Education, 2006.

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

PEC-BTM809 Automobile Engineering
Course Prerequisites: PCC-BTM604

Course Objectives:

- Automobile engineer must be familiar with this course to know commercial considerations, such as economics, marketing, and sales.
- Students must be familiar with different operations of spark ignition engines and compression ignition engines.
- This syllabus is associated with the engine and includes belt drives, air conditioning, and the starting and charging systems.
- Students must be done analysis of both manual and automatic transmissions, driveshaft design, and four- and all wheel-drive systems.

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

1. To explain knowledge regarding analytical design of the complete motor vehicle, Vehicle Body Engineering and current motor vehicle design.
2. To evaluate the vehicle performance and different losses or resistances occur during driving the vehicle
3. To explain the different mechanisms of the vehicle
4. To design the different vehicles, and the components required

Course Contents:

Sr. No.	Details	Hrs.
Module 01	**Introduction**: Classification of automobiles. **Automobile power plant**: constructional features of different types of engines used in Automobiles, their characteristics, study of various engine components and their materials. **Vehicle performance**: Tractive force, Tractive force Vs Vehicle speed, resistance to motion of the Vehicle – Rolling and gradient resistance, power requirement for acceleration and gradeability, maximum acceleration for front wheel drive – Rear wheel drive – four wheel drive Vehicles, selection of suitable real axle and gear ratios. **Maintenance and troubleshooting aspects of**: clutches, gear box, brakes	**08**
Module 02	**Transmission Systems**: Study of Propeller shaft and universal joint, live axle and differential **Steering and front axles**: Steering geometry, Steering requirements, Steering linkages and Steering gears, over Steer and under Steer, cornering power, reversibility of Steering gears, types of front axles their constructions, troubleshooting and remedies	**06**
Module 03	**Suspension systems**: objects of Suspension, basic requirements, types of Suspension, shock absorbers **Wheels and tyres**: requirements of Wheels and tyres, constructional features, types of tyres, application to ride and stability, troubleshooting and remedies. **Electrical system**: study of different types of batteries, study of electronic ignition system, study of charging system, study of starting system. **Lighting system**: types of lamps, Energy demands of lighting system, construction and types of head lamps.	**06**
Module	**Vehicle Body Design**: importance of body design, material for body	**06**

04	constructions – styling forms – coach and bus body style, layouts of passenger cars, bus and Truck bodies. Aerodynamic drag – aerodynamic lifts, pitching moments, side force, yawing moments and Rolling moments. **Basic dimensions**: geometrical relations to driver seat, dimensions of foot and pedal control, passenger seats, vehicle dimensions and visibility. **Chassis types and structure types**: open semi integral pedal and integral Bus structures. **Frames**: function and types loads on frames, load distribution of structure.	
Module 05	**Vehicle vibration and dynamics**: types of vibration, vibration control, effect of vibration on human body, Driver's comfort and passenger's comfort vehicle vibration with single degree of vibration. **Different accessories used in vehicles**: Electric Horn, Wipers, Fuel pump, power operated windows, etc.	**08**
Module 06	**Vehicle maintenance and servicing** : Importance of vehicle maintenance, primitive maintenance, break down maintenance, corrective maintenance, overhaul major and minor, engine and chassis lubrication, types of lubricants. **Recent trends in automobile**: Electronic control module(ECM), Operating modes of ECM (Closed loop and Open Loop), inputs required and output signals from ECM, electronic spark control, air management system, ideal speed control.	**07**
Module 07	**Multipoint fuel injection (MPFI) system and Single point fuel injection, electronic fuel injectors**: principal of operations, construction, working and application of temperature sensors, inductive sensors, position sensors, pressure sensors, knock sensors, hot wire and thin film air flow sensors, vortex flow/ turbine fluid sensors, optical sensors, oxygen sensors, light sensors, methanol sensors, and rain sensors. New developments in sensor technology.	**07**

List of assignments and experiments:

Assignments and laboratory experiments of (any 8)

1. Study of ignition and charging system.
2. Study of starting system, lighting system and battery.
3. Study of suspension system.
4. Study of basic dimension and vehicle layout.
5. Study of computer control engine.
6. Study of wheels and tiers.
7. Study of vehicle maintenance.
8. Study of different drives.
9. Study of steering system.

Term work :

Term work shall consist of minimum eight experiments, assignments.

Text Books:

1. Singh, Kirpal. *Automobile engineering*. Standard publishers, 1994.
2. Giri, N. K. *Automobile mechanics*. 2013.
3. Banga, T. R., and Natthana Siṃha. *A textbook on Automobile Engineering*. Khanna Publ., 1987.
4. Steed W., *Principle of vehicle dynamics*
5. Gupta, R. B. "Automobile engineering." *Satya Prakashan* (1993).

References:

1. Reyat H.S., *The Automobile*, S.Chand and Co., 2004.
2. Pawlowski, Janusz, and Guy Tidbury. *Vehicle body engineering*. Business Books, 1969.
3. King, Dick H. *Computerized engine controls*. Delmar Publishers Inc., 1990.
4. Crouse, William H., and William Harry Crouse. *Automotive mechanics*. Tata McGraw-Hill Education, 1982.
5. Garrett, Thomas Kenneth, Kenneth Newton, and William Steeds. *Motor vehicle*. Butterworth-Heinemann, 2000.

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

PEC-BTM810 Welding Process and Welding Technology
Course Prerequisites: PCC-BTM304, PCC-BTM306, PCC-BTM405

Course Objectives:

The main objectives of the course are

- To introduce the students to the different type of welding and their application.
- To develop an ability to identify, formulate, and solve different type of welding problems.
- To understand the theory behind the selection of filler material for the different welding structure.

Course Outcomes:

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

1. identify and apply which type of welding method is required for different material and structure.
2. design the different weld structure and use of welding standard in design.
3. Analyse heat flow and cooling rate in welding.
4. explain the power source, welding fluxes and coating required while welding.

Course Content

Module No	Details	Hrs
1	Evolution of welding; classification of welding processes; application of welding.	03
2	Design principles of welded structures, Welding symbols, standards and codes.	06
3	Welding methods – shielded metal arc welding, gas tungsten arc welding, gas metal arc welding, flux cored arc welding, submerged arc welding,	08
4	plasma arc welding, electroslag welding, electrogas welding, arc stud welding, synergic and pulsed welding, friction welding, Oxy-fuel gas welding, resistance welding, brazing, soldering.	05
5	Types of power source and their characteristics; Physics of welding arc – characteristics of arc, mode of metal transfer, forces acting on a molten droplet.	08
6	Welding fluxes and coatings - type and classification; Study and analysis of heat flow, cooling rates, models for welding heat sources.	06
7	Testing of welds, types of defect, causes and remedies of defect; NDT of welded joints; fracture and fatigue of welded structures, welding metallurgy, heat treatment of welds, effect of alloying materials.	06

Term work:-

At least 20 (twenty) solved problems/ case studies based on the above syllabus as per the module weightage shall be submitted as term work.

Textbooks/References:

[1] O'Brien, Welding Handbook: Welding Processes, Part 1, Vol. 2, AWS, 2004.
[2] J. F. Lancaster, The Physics of welding, Pergamon, 1986.
[3] R. W. Messler, Principles of Welding, John Wiley and Sons, 1999.

[4] O. Grong, Metallurgical modelling of welding, 2nd Ed, IOM Publication, 1997.
[5] V.M. Radhakrishnan, Welding technology and design, New age, 2002.
[6] J. A. Goldak, Computational welding mechanics, Springer, 2005.
[7] L-E Lindgren, Computational welding mechanics, Woodhead Publishing Limited2007.
[8] Welding handbook by AWS (American Welding Society)

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

PEC-BTM811 Power Plant Engineering
Course Prerequisites: PCC-BTM305, PCC-BTM504, PCC-BTM505, PCC-BTM604

Course Objectives:
The objectives of this course are:

1. **To explain** cost economics involved in different types of power generation plants.
2. **To explain** fundamental principles, detailed features of arrangements, operation and **evaluate** performance parameters of various power generation plants and their combinations.
3. **To explain** impact of power generation plants on environment and methods/ technologies adapted for improving efficiency and reducing the environmental impact.
4. **To develop** understanding for the national and global power generation scenario and to **analyse** a power generation system.

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

1. **To explain, interpret, evaluate and compare** cost economics involved in different types of power generation plants and **apply** for optimum selection of a power generation plant or combination of plants.
2. **To explain** and **compare** principles, detailed features of arrangements, operation and advantages of various power genertaion plants and **evalaute** their performance parameters.
3. **To explain** and assess impact of power generation technologies on environment and **adapt** techniques for improving efficiency and reducing the environmental impact.
4. **To develop** understanding for power generation scenarion in the country with reference to World Power Generation and **apply** the acquired knowledge to **evaluate and compare** the performance parameters of different types of power generation plants or their combinations.

Module No.	Details	Hrs.
1.	**Economics of Power Plants:** Load curve, load duration curve, various factors, and effect of fluctuating load on operation and design of the plant, methods of meeting fluctuating load. Selection of the generating equipment, load sharing, cost of electrical energy. Tariff methods. Performance and operating characteristics of Power Plants.	07
2.	**Hydro Power Plants:** Rainfall, Runoff and its measurement, Hydrograph, Flow Duration Curve, Mass Curve and Reservoir Storage Capacity. Classification of Hydro plants:- Run-off River Plant, Storage River Plant, Pumped Storage Plant.	06
3.	**Fluidized Bed Combustion:** Regimes of Combustion, Circulating and Pressurized Fluidized Bed Combustion (FBC) system, Fluidized Bed Boilers-Features and Classification. Control of Nitrogen oxides.	06
4.	**Nuclear Power Plants:** Introduction to Nuclear Engineering:- Radioactive Decay, Half Life, Fission, Fusion, Nuclear materials. Thermal Fission Reactors and Power Plants:- PWR, BWR, Liquid Metal Reactors, Fast Breeder Reactors, Reactor Control.	06

5.	**Diesel Power Plants:** General Layout, Systems, Advantages and Disadvantages, Applications. **Gas Turbine (GT) Power Plants:** Types, Modifications, Performance Parameters and Comparison, Gas Turbine Material, Fuels, Applications, Current Scenario and Future Scope for GT Power Plants.	06
6.	**Combined Cycle Power Generation:** Thermodynamics of Combined Cycle Plants, GT-ST combinations and plant operation, Cogeneration, Mixed Cycle Power Generation, Benefits. **Combined Power Generation** Base Load and Peak Load Plants. Combination and Co-ordination of different types of Power Plants.	06
7.	**Environmental Impact of Power Plants:** Social and economical issues of power plants, Greenhouse effect, Acid precipitation- Acid Rain and Acid Snow, Dry deposition and acid fog, Thermal pollution, Air Pollution, Radiation from Nuclear Power Plants, Coal storage, In-plant handling of coal, Ash handling systems. Dust collectors. Flue Gas Desulphurization (FGD) methods. Power Generation:- Global and Indian Scenario.	05

Term Work:

At least one assignment on each module comprising analytical solutions of numerical problems based on course contents. Required attendance in Lectures and Tutorials, involvement in academic activities related to the course and overall conduct carry weightage in assessment of Term Work.

Text Books:

1. Nag, P. K., *Power Plant Engineering*. Tata McGraw-Hill Education, 2002.
2. Ei-Wakil, M.M, *Power Plant Technology*, McGraw Hill, 2016, (https://engineeringstudymaterial.net/ebook/power-plant-technology)
3. Domkundwar, A. S., *Power Plant Engineering*, Dhanpat Raj & Sons, India, 2000.
4. Sharma, P. C. *Power Plant Engineering*. SK Kataria and Sons, 2009.
5. Rajput, R. K., *Power Plant Engineering*, Laxmi Publication (P) Ltd, 1995.
6. Dr, Yadav, R., *Steam and Gas Turbines and Power Plant Engineering*, Central Publishing House, 7th Revised edn., 2012.

Reference Books:

1. Morse, Frederick T., *Power plant engineering*, Van Nostrand, 1963.
2. Potter, Philip J. *Power plant theory and design*. Ronald Press Company, 1959.
3. Weisman, Joel, and Eckart Roy. *Modern Power Plant Engineering*, 1985.
4. Bennet, John Donald and Thomson James Robert, *The Elements of Nuclear Power*, 1989.
5. Elliott, Thomas C., *Standard Handbook of Power Plant Engineering*, 1989.

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

PRJ-BTM898 Project II
Course Prerequisites: Recommended – all courses till semester VI

Course Outcomes:

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

Course content:

Sr.no.	Description	Hrs./week
1	Student shall study the topic of project work and define problem statement. The student shall evolve design and/or do experimental study and/or fabricate engineered device to obtain solution to the identified problem. The student shall prepare a report and shall present a seminar on the basis of work done at the end of semester.	**2 (contact) + 12 (self-study)**

VAC-BTM825 Advanced I.C. Engines
Course Prerequisites: PCC-BTM604

Course Objectives:

The students after studying these topics should be able to

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

Course Outcomes:

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

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

Course Content:

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

	types. Lubrication – Types & Layout, Requirement of Lubricants, Oil Filters, Oil Pan, Oil pump types.	
07	**Recent Trends in Design of I C Engine Parts:** Hybrid electric technology, Functional Requirement of intake and Exhaust system, Air Induction, Swirl &Turbulance, Swirl Generation, Air Filter, Intake Manifold, Exhaust Manifold, Turbochargers, EGR, EGR Cooler, Silencer etc, Part design philosophy.	**02**

Term 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." (1988).
9. Thipse, S. S. *Internal Combustion Engines*. Jaico, 2010.
10. Willard, W. Pulkrabek. *Engineering fundamentals of the internal combustion engine.* Prentice Hall. New Jersey (2004).

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

VAC-BTM826 Electric Vehicle Design and Development
Course Prerequisites: ES-BT102, ES-BT202, PCC-BTM503

Course Objectives:

- Student must be familiar with this course to know commercial considerations, such as economics, marketing, and sales.
- Students must be familiar with operation of electric motor AC and DC, torque speed characteristics. motor control electronics, ac dc conversion
- This syllabus covers electric vehicle powertrain, motor control system, battery management system, electric vehicle control unit and electric vehicle chargers.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To explain analytical design of the complete motor vehicle, Vehicle Body Engineering and current motor vehicle design.
2. To evaluate the vehicle performance and different losses or resistances occur during driving the vehicle
3. To explain concepts and theory of electric powertrain of the vehicle
4. To explain different types of chargers, their structure and usage.

Course contents:

Sr. No.	Details	Hrs.
Module 01	**Introduction**: Brief history of electric vehicles and comparative evolution with respect to petroleum vehicles. **High level block diagram:** Main parts of electric vehicles. Motor, controller, battery, battery management system, electric vehicle control unit. **Vehicle performance**: Tractive force, Tractive force Vs Vehicle speed, resistance to motion of the Vehicle – Rolling and gradient resistance, power requirement for acceleration and gradeability, maximum acceleration for front wheel drive – Rear wheel drive – four wheel drive Vehicles.	**02**
Module 02	**Transmission Systems**: Study of Propeller shaft and universal joint, live axle and differential **Steering and front axles**: Steering geometry, Steering requirements, Steering linkages and Steering gears, over Steer and under Steer, cornering power, reversibility of Steering gears, types of front axles their constructions, troubleshooting and remedies	**02**
Module 03	**Wheels and tyres**: requirements of Wheels and tyres, constructional features, types of tyres, application to ride and stability, troubleshooting and remedies. **Lighting system**: types of lamps, Energy demands of lighting system, construction and types of head lamps. **Different accessories used in vehicles**: Electric Horn, Wipers, power operated windows, etc.	**02**

Module 04	**Vehicle Body Design**: importance of body design, material for body constructions – styling forms – coach and bus body style, layouts of passenger cars, bus and Truck bodies. Aerodynamic drag – aerodynamic lifts, pitching moments, side force, yawing moments and Rolling moments. **Chassis types and structure types**: open semi integral pedal and integral Bus structures. **Frames**: function and types, loads on frames, load distribution of structure.	**02**
Module 05	**Vehicle vibration and dynamics**: types of vibration, vibration control, effect of vibration on human body, Driver's comfort and passenger comfort vehicle vibration with single degree of vibration. **Suspension systems**: objects of Suspension, basic requirements, types of Suspension, shock absorbers	**02**
Module 06	**Battery Management System:** Importance of battery management system, battery management system design, onboard chargers, cell balancing, battery life optimization, battery cooling systems **Electric Vehicle Charging:** AC DC Charging, Charger protocols, Charging standards and interfaces (Type2, Chademo), Charging method effect on battery, charging characteristics of battery	**02**
Module 07	**Electric Vehicle Control Unit**: principal of operations, interfacing with many sensors. design protocols, power management calculations, design considerations (vehicle use cases), safety optimization, performance optimization	**02**

List of assignments and experiments:

Assignments and laboratory experiments of (any 8)

1. Study of motor control system.
2. Study of battery management system.
3. Study of suspension system.
4. Study of basic dimension and vehicle layout.
5. Study of electric vehicle control unit.
6. Study of wheels and tyres.
7. Study of electric vehicle chargers.
8. Study of different drives.
9. Study of steering system.

Text Books / Reference Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

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

PC-MTTH201 Design of Heat Exchangers

Refer to Course Contents for M.Tech. in Thermal Engineering