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

COURSE CREDIT SYSTEM

and

COURSE CONTENTS

(B.Tech. in Mechanical Engineering)

Year: 2017-18

List of Courses

SECOND YEAR B.TECH. IN MECHANICAL ENGINEERING

SEMESTER III AND IV

YEAR 2017-18

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2017-18

Courses Offered for Second Year B.Tech. in Mechanical Engineering (Semester III)

Sr. No	Course Name	Code	Course Plan per Week (Hrs)			Credits	In semester Evaluation (Points)		End Semester Evaluation (Points)		End semester weightage (%)	Term work	Total Points
			L	P	T		T-I	T-II	Points	Time (Hrs)			
Theory Courses													
1	Applied Mathematics – III	BTM301	3	-	1	3.5	20	20	100	3	60%	25	125
2	Strength of Materials	BTM302	3	-	-	3	20	20	100	3	60%	-	100
3	Machine Drawing	BTM303	1	-	4	3	20	20	100	4	60%	50	150
4	Material Science	BTM304	3	-	-	3	20	20	100	3	60%	-	100
5	Thermodynamics	BTM305	3	-	2	4	20	20	100	3	60%	50	150
6	Manufacturing Science -I	BTM306	3	-	2	4	20	20	100	3	60%	50	150
Laboratory Courses													
7	Strength of Materials Laboratory	BTM352	-	2	-	1	-	-	-	-	-	50	50
8	Material Science Laboratory	BTM354	-	2	-	1	-	-	-	-	-	50	50
9	Machine –Shop Practice - I	BTM399	-	2	-	1	-	-	-	-	-	50	50
Value Added Courses (Note 1)													
10	Engg. Computations with Python prog.	BTM325	-	2	-	1	20	20	100	3	60%	-	100
Online Courses (Note 2)													
11	Online Course 1	BTM381	-	-	-	0	-	-	-	-	-	-	-
Mandatory Courses: Refer to Mandatory course list in Semester I													
	TOTAL		**16**	**6+***	**9**	**23.5 +***							**925 +***

Note: (1) Department will offer the Value Added and Elective courses in a semester subject to availability of resources and enrollment of minimum 25 students opting for the course. (* additional credits, contact hours and points will depend upon number of value added and Elective courses offered in a particular semester).
(2) Department will offer online course subject to availability of a course on https://swayam.gov.in/ , availability of resources and enrollment of minimum 25 students opting for the course.

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2017-18

Courses Offered for Second Year B.Tech. in Mechanical Engineering (Semester IV)

Sr. No.	Course Name	Code	Course Plan per Week (Hrs)			Credits	In semester Evaluation (Points)		End Semester Evaluation (Points)		End semester weightage (%)	Term work	Total Points
			L	P	T		T-I	T-II	Points	Time (Hrs)			
Theory Courses													
1	Applied Mathematics -IV	BTM401	3	-	1	3.5	20	20	100	3	60%	25	125
2	Theory of Machines - I	BTM402	3	-	2	4	20	20	100	3	60%	50	150
3	Fluid Mechanics	BTM403	3	-	-	3	20	20	100	3	60%	-	100
4	Mech. Engineering Measurement	BTM404	3	-	-	3	20	20	100	3	60%	-	100
5	Manufacturing Science – II	BTM405	3	-	2	4	20	20	100	3	60%	50	150
6	Presentation and Communication Technique	BTM406	1	-	2	2	10	10	50	2	60%	50	100
Laboratory Courses													
7	Fluid Mechanics Laboratory	BTM453	-	2	-	1	-	-	-	-	-	50	50
8	Measurement Laboratory	BTM454	-	2	-	1	-	-	-	-	-	50	50
9	Machine –Shop Practice – II	BTM499	-	2	-	1	-	-	-	-	-	50	50
Value Added Courses (Note 1)													
10	Introduction to Composite Material Technology	BTM425	1	-	2	2	20	20	100	3	60%	-	100
11	Internet of Things (IOT)	BTM426	1	-	2	2	20	20	100	3	60%	-	100
12	CNC Programming	BTM427	-	2	-	1	20	20	100	3	60%	-	100
13	Automation of Engineering Drawings	BTM428	-	2	-	1	20	20	100	3	60%	-	100
14	Introduction to Nanotechnology	BTM429	1	-	2	2	20	20	100	3	60%	-	100
15	Smart Product Development	BTM430	-	2	-	1	20	20	100	3	60%	-	100
Online Courses (Note 2)													
16	Online Course 1	BTM481	-	-	-	0	-	-	-	-	-	-	-
Mandatory Courses: Refer to Mandatory course list in Semester I													
	TOTAL		**16+ ***	**6+ ***	**7+ ***	**22.5 +***							**875+ ***

Note: (1) Department will offer the Value Added and Elective courses in a semester subject to availability of resources and enrollment of minimum 25 students opting for the course. (* additional credits, contact hours and points will depend upon number of value added and Elective courses offered in a particular semester).
(2) Department will offer online course subject to availability of a course on https://swayam.gov.in/ , availability of resources and enrollment of minimum 25 students opting for the course.

BTM301 Applied Mathematics -III
Course Pre-requisite: - BT201

Course Objectives:

1. Introduce Laplace & Inverse Laplace transforms and its application to solve differential equations.
2. Introduction to Complex integration (Cauchy's theorem)
3. Introduce Rank of Matrix, Caley-hamilton theorem.
4. Introduce vector integration, Green's Stoke's& Gauss theorems.

Course Outcomes:

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

1. Solve problems based on Laplace and inverse Laplace transform.
2. Solve integration of complex valued functions.
3. Solve problems on vector integration.

Course Contents:

Module	Details	Hrs.
01	**Laplace Transforms** Function of bounded variation (statement only) Laplace's transforms of 1, t^n, e^{at}, sin(at), cos (at), sinh (at), cosh (at) Linearity property, expressions (without proof) for L [e^{at} f (t)], L[f(at)], L[$t^n f(t)$], L[$f(t)/t$], L $\left[\int_0^t f(u)du\right]$, L$\left[\frac{d^n}{dt^n}f(t)\right]$ Periodic functions, Heaviside unit step function, Dirac- delta Function and their Laplace transforms (statement only)	06
02	**Inverse Laplace Transforms** Linearity property evaluation of inverse Laplace Transforms using theorems and by partial fraction method Convolution Theorem (without proof) and Heaviside unit step function. Application to solve initial and boundary valve problems involving ordinary differential equations with one dependent variable	06
03	**Vector Integration** Vector integrals – Line, area and surface integrals Green theorem in plane Stoke's theorem Gauss's Divergence theorem Application to mechanical systems	08
04	**Complex Integration** Regions and Paths in the Z-plane Line integral of a function of complex variable Cauchy's integral theorem Cauchy's integral formula and deduction (without proof)	08

	Taylor's and Laurent's development (without proof) Singularities, poles, residue at isolated singularity and its evaluation Cauchy's Residue Theorem and application to evaluate real integrals.	
05	**Matrices** Types of Matrices (Hermitian,skew Hermitian,symmetric, skew symmetric) Orthogonal and Unitary matrices) Elementary transformations, rank of a matrix. Reduction to a normal form. System of homogeneous and non-homogeneous equations, their Consistencyand solution	06
06	**Eigen values, Vectors** Brief revision of vectors over real field, Inner product, Norm, Linear dependence and independence, Orthogonality of matrix Characteristic polynomial, Eigen values and vectors of square matrix Characteristic polynomial,	06
07	**Cayley Hamilton theorem and derogatory matrix** Cayley Hamilton Theorem (without proof) Functions of square matrix. Diagonalizable matrix. Powers of matrix using diagonal matrix. Derogatory matrix.	08

Reference Books:

1. Chapman, Stephen J. MATLAB programming for engineers. Nelson Education, 2015.
2. Spiegel, Murray R. *Schaum's outline of theory and problems of Laplace transforms*. McGraw-Hill, 1965.
3. Spiegel, Murray R. "Schaum's outline of theory and problems of vector analysis and an introduction to tensor analysis." (1959).
4. Brown, James Ward, Ruel Vance Churchill, and Martin Lapidus. *Complex variables and applications*. Vol. 7. New York: McGraw-Hill, 1996.
5. Grewal, B. S. *Higher engineering mathematics*. Khanna Publisher, New Delhi, 1996.

Text Books

1. Kumbhojkar, G.V., "*Applied Mathematics-III*", C.Jamanadas, 2011.

BTM302 Strength of Materials

Course Pre-requisites: - BT104, BT204

Course Objectives:

1. To determine the internal forces developed in structural members.
2. To determine the stresses and strains produced in the structural members and machine components and their deformations under various types of loads.
3. To understand analytical methods for determining the strength, stiffness and stability of various load carrying structural members and machine components
4. To study the failure theories

Course Outcomes:

Upon successful completion of the course, students should be able

1. To apply principles of engineering mechanics, science and mathematics to derive equations governing the internal resistance forces in machine components subjected to different types of loading.
2. To identify, formulate and solve for stresses and strains produced in basic components of mechanical engineering systems.
3. To analyze and interpret data obtained from the experiments related to strength of materials.
4. To examine effect of complex loading in mechanical components using energy methods, principal stress computations and theories of failure.

Course Contents:

Module No.	Details	Hrs.
01	**STRESS AND STRAIN:** Definitions of stress and strain, tensile and compressive stresses, shear stress, elastic limit, Hooke's law, Poisson's ratio, modulus of elasticity, modulus of rigidity, bulk modulus, yield stress, ultimate stress, factor of safety, state of simple shear, relation between elastic constants, volumetric strain, volumetric strain for tri-axial loading,	6
02	**SIMPLE DEFORMATIONS:** Deformation of tapering members, deformation due to self weight, bars of varying sections, composite sections, **THERMAL STRESSES:** Temperature stresses in composite structural components **ENERGY METHODS:** strain energy, Resilience, proof Resilience, strain energy stored in the member due to gradually applied load, suddenly applied load, impact load, strain energy stored due to shear.	6
03	**SHEAR FORCE AND BENDING MOMENT in beams**: Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal Hinges for different types of loading, relationship between rate of loading, shear force and bending moment.	6
04	**STRESSES IN BEAMS:-** Theory of pure bending, assumptions, flexural formula for straight beams, moment of resistance, bending stress distribution, section moduli for different sections, beams of uniform strength. **SHEAR STRESSES IN BEAMS :** Distribution of shear stress across plane sections used commonly for structural purposes, shear connectors **TORSION**: Torsion of circular shafts – solid and hollow, stresses in shaft when	9

	transmitting power, shafts in series and parallel, strain energy due to torsion.	
05	**PRINCIPLE STRESSES:** General equations for transformation of stress, principal planes and principal stresses, maximum shear stress, determination using Mohr's circle, maximum principal & maximum shear stress theory of failure, combined bending and torsion, equivalent bending moment and equivalent torque.	5
06	**DEFLECTION OF BEAMS**: Deflection of cantilevers, simply supported and over hanging beams using double integration and Macaulay's methods for different types of loadings.	5
07	**THIN CYLINDRICAL AND SPHERICAL SHELLS:** Stress and strain in thin cylinders and spheres due to internal pressure, cylindrical shell with hemispherical ends. **THICK SHELLS:** Introduction, Lame's theory, Lame's equation, Longitudinal stress, maximum shear stress, Volumetric strain.	5

Term Work:

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

Text Books:

1. Junnarkar, S. B., and H. J. Shah. *Mechanics of structures (Vol. I)*, *Charotar Pub. House, Anand* (1995).

Reference Books:

1. Gere, James M., and S. P. Timoshenko. "Mechanics of materials Brooks." Cole, Pacific Grove, CA (2001): 815-39.
2. Beer, Ferdinand P., R. Johnston, J. Dewolf, and D.Mazurek. "Mechanics of Materials, McGraw-Hill." (2006).

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

BTM303 Machine Drawing
Course Pre-requisites: BT103, BT203

Course Objectives:

1. It is expected to possess 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. Besides it is also expected to possess 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 hence as a part of curriculum.

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

1. To interpret the assembly and details of given machine components including fits and tolerances in production drawing.
2. To sketch free hand proportionate illustrative representation of common machine components.
3. To create and compose engineering drawings for standard machine components or assemblies.
4. To create 3d models of the machine parts, assemble and plot manufacturing drawings using any CAD software.

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.	03

	Free Hand sketches of Keys: sunk, parallel, woodruff, saddle, feather etc.	
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:** **Belt Pulleys**- V-belt, rope belt, fast and loose pulleys, **Pipe Joints:** flanged joint, spigot and socket joint, stuffing box, expansion joint, union joint.	02
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.	01

Term Work:

SECTION A:

1 Sheet on Intersection of curves minimum two problems

1 Sheet on auxiliary views one problem

1 Sheet on free hand sketches of each topic from module 2 and calculating limits, fits and tolerances.

1 Sheet on of details and assembly drawings of any two topics 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.

SECTION B:

3 sheets on Part modelling, assembly and plot manufacturing drawings of any three topics from module 4, 5 and 6 using CAD Software.

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., 20

BTM304 Material Science
Pre-requisites: - **BTM105, BTM106**

Course Objectives:

The objective of this course is to:

Make students familiar with of mechanical, physical and chemical properties of common engineering materials- metals, ceramics, polymers and composites with rationale behind these properties and to develop good understanding of these.

Course Outcomes:

Students shall be able to

1. To explain basic concepts of materials science and metallurgy in terms of material properties at micro as well as macro scale and to discuss economic, environmental and social issues of material usage.
2. To categorize different material imperfections and fractures and apply this knowledge to explain failures.
3. To demonstrate the concept of iron-carbon equilibrium diagram & phase diagrams and understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions.
4. To describe heat treatment requirements and to examine properties of nonferrous, ceramic and composite materials.

Course Contents:

Module No.	Description	Duration (Hrs.)
1	**Introduction:** Historical perspective and Materials Science, Important Mechanical properties of Materials, Classification of materials, Advanced materials and Smart materials and their examples.	4
2	**Phase diagrams:** Equilibrium phase diagrams, Particle strengthening by precipitation and precipitation reactions, Kinetics of nucleation and growth, The iron-carbon system, phase rule, phase transformations and TTT diagrams, Microstructure and property changes in iron-carbon system. **Iron-carbon equilibrium diagram:** Invariant Reactions, Study of Different Types of Steel and their mechanical properties, Types of Different types of cast iron and their mechanical properties, lever rule.	6
3	**Atomic Arrangements:** Lattice, Unit cells, Crystal structures, lattice parameters and atomic radius, packing factor, FCC and BCC cell, density of FCC and BCC cell. Imperfections in the atomic and ionic arrangements like point and line defects, dislocations, ASTM grain size.	6
4	**Heat Treatment:** Different types of heat treatment like annealing, normalizing, tempering, austempering, stress relieving etc. **Failure:** Fracture, ductile and brittle fracture, Fracture mechanics, Impact fracture, ductile brittle transition, Fatigue, crack initiation and propagation, Creep, generalized creep behavior, stress-strain curves of materials.	7

5	**Nonferrous Alloys:** Aluminum, Magnesium, Copper, Nickel and chromium alloys, effects and properties of alloying elements.	5
6	**Ceramic, Composites & Nano materials:** Ceramic materials, application of ceramics, properties of ceramics, synthesis and processing of ceramic powders, inorganic glasses. **Polymers:** classification of polymers, thermoplastics and mechanical properties, Elastomers, Thermosetting polymers **Composites:** types, characteristics and applications **Introduction to Nano materials:** Nano structured materials. Nano clusters & Nano crystals.	7
7	**Economic, environmental and social issues of material usage:** Economic considerations, Environmental and societal considerations, Recycling issues, Materials used in constructions.	6

Text Books:

1. Callister, William D., and David G. Rethwisch. Materials science and engineering: an introduction. Vol. 7. New York: Wiley, 2007.
2. Kodgire, V. D., and S. V. Kodgire. "Material science and metallurgy." Everest Publication, 2009.
3. Balasubramaniam, R. Callister'S Materials Science and Engineering: Indian Adaptation (W/Cd). John Wiley & Sons, 2009.

Reference Books:

1. Lawrence, H., and Van Vlack. "Elements of materials science and engineering." (1989).
2. Raghavan, V. "Materials Science and Engineering: A First Course, PHI Learning Pvt." (2004).
3. Guy, Albert G. *Physical metallurgy for engineers*. Addison-Wesley Pub. Co., 1962.

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

BTM305 Thermodynamics

Course Pre-requisites: Good knowledge of Higher Secondary Level Mathematics and Physics

Course Objectives:

The objectives of this course are:

1. To explain the fundamental concepts and principles of Classical Thermodynamics.
2. To explain and illustrate Laws of Thermodynamics and its application to practical thermal systems.
3. To explain and analyze various fundamental thermodynamic cycles - Vapor Power Cycles, Gas Power Cycles and Refrigeration Cycles.
4. To develop understanding and insight for thermodynamic analysis of various processes, cycles and systems

Course Outcomes:

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

1. To explain, exemplify and interpret the fundamental concepts, Principles and Laws of Classical Thermodynamics and apply them for solution of thermodynamic problems of practical thermal system.
2. To explain fundamental principles, discuss detailed features of arrangements and operations, interpret and compare performance parameters of various practical thermodynamic cycles used in Thermal Power Plants, I.C. Engines and Automobiles and Refrigeration.
3. To apply the acquired knowledge to analyze, assess and evaluate the practical thermodynamic systems.
4. To build foundation as a pre-requisite for further core thermal engineering courses in B.Tech.(Mechanical) program.

Course Contents:

Module No.	Details	Hrs.
1.	**Fundamental Concepts:** Macroscopic Vs.Microscopic apparaoach, Thermodynamic system, surrounding and universe, Control Volume,Thermodynamic State, Properties, Process and Cycle, Thermodynamic Equilibrium, Quasi-Static process, State and Path functions, Work Transfer, Displacement work and other types of work transfers, Free expansion, Net Work Transfer, Heat Transfer.	04
2.	**First Law of Thermodynamics:** Statement and expressions for First Law of Thermodynamics for a Closed System undergoing a Cycle and Change of State, Concepts of Energy, Internal Energy, Enthalpy, Specific heats, Latent heats, PMM-I. Steady Flow process, Steady Flow Energy Equation (SFEE), First Law of Thermodynamics (SFEE) applied to various thermal devices such as boilers,	06

	nozzles and diffusers, turbines and engines, compressors and pumps, thrtling device, condensers and heat exhangers.	
3.	**Zeroth and Second Law of Thermodynamics:** **Zeroth Law of Thermodynamics:** Statement, Temperature and its measurement, IPTS. **Second Law of Thermodynamics:** Limitations of First Law of Thermodynamics, Cyclic Heat Engine, Energy Reservoirs, Kelvin-Planck and Claussius' statements and their equivalence, Refrigerator and Heat Pump, Reversibility and Irreversibility, Causes and conditions of Irreversibility, Carnot Cycle, Reversed Heat Engine, Carnot Theorem and its corollary, Absolute Thermodynamic Temperature Scale.	06
4.	**Entropy and Energy:** **Entropy:** Claussius' Theorem, The Inequality of Claussius,Entropy-a Property, Entropy change in an irreversible process, Principle of Entropy,Entropy and Direction, Entropy and Disorder. **Energy:** Available Energy of a Cycle, Law of Degradation of Energy, Reversible Work in a Nonflow and Steady Flow Process, Useful Work, Dead State, Availability in a Nonflow and Steady Flow Process, Irreversibility.	06
5.	**Vapor Power Cycles**: Properties of Pure Substances,Property Diagrams- p-v, T-s and h-s Diagrams, Dryness Fraction, Use of Steam Tables and Mollier Diagram, Rankine Cycle, Actual Vapour Cycle, Comparison of Rankine and Carnot Cycle, Reheat Cycle, Ideal Regenerative Cycle, Regebnerative Cycle, Reheat-Regenarative Cycle, Efficiencies in Staem Power Plant.	07
6.	**Gas Power Cycles:** Carnot Cycle, Overview of reciprocating I.C.Engine, Air Standard Cycles- Otto Cycle, Diesel Cycle, Dual Cycle and their comparison, Brayton Cycle, Comparision of Brayton Cycle with Otto Cycle and Rankine Cycle, Brayton Cycle with Intercooling, Reheating and Regeneration.	06
7.	**Refrigeration Cycles:** Refrigeration by Non Cyclic Process, Reversed Heat Engine Cycle, Vapour Compression Refrigeration (VCR) Cycle, Performance and Capacity of a VCR Plant, Components in a VCR Plant, Multistage Vapour Compression Systems, Refrigerants, Absortion Refrigeration Cycle, Heat Pump system, Gas Cycle Refrigeration.	07

Term Work:

One assignment on each module comprising analytical solutions of numerical problems based on course contents. Use of EXCEL / MATLAB to solve simple representative problems is desirable.

Text Books :

1. Nag, P.K., *Engineering Thermodynamics*, 5th edn, Tata McGraw Hill, New Delhi, 2013.
2. Cengel, Yunus A., and Boles, Michael A., *Therhmodynamics An Engineering Approach*, 8th edn, McGraw Hill,New York, 2014.
3. Holman, J.P., Thermodynamics, McGraw Hill, New York, 1987.

Reference Books :

1. Saad, Michel A., *Thermodynamics for Engineers- Principles and Practice*, 1997.
2. Eastop, T. D., and A. McConkey, *Applied Thermodynamics for Engineering Technologists*, 1996
3.Sonntag, Richard Edwin, Claus Borgnakke, Gordon John Van Wylen, and Steve Van Wyk. *Fundamentals of Thermodynamics*. Vol. 6. New York: Wiley, 1998.

BTM306 Manufacturing Science -I
Course Pre-requisites: - BT105, BT106, BT205, BT206

Course Objectives:

The objective of this course is to:

- To impart understanding and appreciation of breadth and depth of the field of manufacturing
- To impart basic concept, process parameters & capabilities of manufacturing processes like, Casting, plastic moulding and metal surface treatment.
- To impart knowledge of parts and working of various machines like, Lathe, Milling, Drilling, Surface Grinding & Shaper, and the tools used in these machines.
- To learn and apply the concepts of machining for particular component, by deciding sequence of operations and concerned machine tool requirement for same
- To make the students aware of the basic welding processes and their specific method of application
- To learn and apply the concepts of non-conventional manufacturing processes for products of different design and material

Course Outcomes:

Upon successful completion of the course,

1. Student will broaden the knowledge and perspective of the manufacturing world in which many of the students will contribute their talents and leadership
2. Student will be able to decide/select the manufacturing processes which they have learned to manufacture any new product
3. Students will be conversant with the unconventional machining processes, basic welding, molding and metal surface treatment processes and will be able to identify the process needed and its limitation
4. Student will be able to explain construction & working principles of machines like Lathe, Milling, drilling etc. & their application.

Course contents:

Sr. No.	Description	Duration (hrs.)
1	**Pattern making and Foundry**: Materials used for pattern making, Types of pattern, allowance Pattern, core box, core prints and cores. Plastic molding: Compression molding, Injection molding, Blow molding, Transfer molding, shell molding, carbon dioxide molding Casting: Gravity die or permanent mold casting, pressure die casting, cold chamber die casting, centrifugal casting, , investment mold casting, Plaster mold casting, continuous casting. Metal surface treatment: Electroplating, galvanizing, anodizing, metal spraying.	05

2	**Lathes**: type of lathes, their construction and working, operation of lathes, attachments and accessories used on lathe, type of tools, cutting speed, feed, depth of cut and machining time. Capstan and turret lathes, tooling for simple jobs. NC, CNC and DNC machines, machining centers and types.	07
3	**Milling Machines**: types of machines, horizontal, universal, vertical, Cutters and their applications, Operation on milling machines, Use of dividing head and circular table. Direct, simple, compound, differential and angular indexing Table feed in milling. Work holding devices.	06
4	**Drilling Machines**: Types of machines, Types of drillings, operations such as drilling, boring, reaming, spot facing, counter boring, counter sinking and tapping. Drill speeds and feeds.	06
5	**Planner machines, shaping machines and slotting machine**: Various types, construction and working of machine, operations and tools, field of application, quick return mechanism and feed mechanisms of these machines.	04
6	**Grinding**: Grinding machines such as pedestal, cylindrical surface, centre less and tool and cutter grinder. Operations on the above mentioned machines. Grinding wheel, selection and specifications. Dressing and trimming of grinding wheels. Finishing operations such as lapping and honing. Green Manufacturing	06
7	**Welding**: Riveting, soldering and brazing, fusion welding, gas and arc welding, submerged arc welding-inert gas welding, electro slag welding, thermit welding, welding equipments, Pressure welding – Solid phase welding, resistance and friction welding- other miscellaneous welding processes, weld joint types, weldability. **Non Conventional Machining Processes**: Abrasive jet machining, Electric discharge machining, Electron beam machining, Plasma arc machining, Ultrasonic machining etc.	08

Recommended Books:

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.W. A. J. Chapman, "*Workshop Technology- Part I, II and III*", Edward Arnold
6. S K & A K Hajra Choudhary, "*Workshop Technology, Vol. I, II*", Media promotors and publishers pvt. Limited, 2007

7. Dr. P.C. Sharma, "*Production Technology*", S Chand and Co.
8. L E Doyle, "*Manufacturing Processes & materials for Engineers*", Prentice Hall
9. M. Lal and O P Khanna, "*Textbook of Foundry Technology*", S Chand and Co.

Term work:

1. One assignment on each module of the syllabus.
2. Industrial visit report (format should be provided by teacher)
3. Seminar presentation on the topic related to any one of the topics [Desirable: inclusion of video of the manufacturing process of any product]

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

BTM325 Engineering Computations with Python Programming

Course Prerequisites: - BTM207

Course Objectives:

The objective of this course is to:

- Learn capabilities of Python programming for numerical computations
- Prepare student to do engineering calculations using Python programming.
- Use Python for data analysis related to engineering applications.

Course Outcomes:

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

1. Develop algorithms to do engineering computations
2. Apply features of python language to produce efficient and modular computer code
3. Write modular code for portability
4. Implement opensource numerical libraries to build engineering applications

Course contents:

Sr.No.	Description	Duration (hrs)
1	Practical 1: Introduction to Python, variable Types, Operators and Branching	4
2	Practical 2: Development of program, Bindings, Strings, Input/Output, IDEs, Control Flow, Iteration	4
3	Practical 3: Functions, Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Recursion on non-numerics, File operations	4
4	Practical 4: Tuples and Lists: List Operations, Mutation, Aliasing, Cloning Dictionaries: Functions as Objects, Global Variables	4
5	Practical 5: Classes and Inheritance: Object Oriented Programming, Class Instances, Methods Debugging techniques	4
6	Practical 6: Use of opensource library NumPy	4
7	Practical 7: Writing an engineering application for data analysis	4

Recommended Books:

1. Opensource documentation at *https://docs.python.org/3/library/index.html*
2. Nagar Sandeep. *Introduction to Python: For Scientists and Engineers*, Independently published (2016).

BTM352 Strength of Materials Laboratory
Course Pre-requisites: - BT104, BT204
Course Objectives:

1. To determine the internal forces developed in structural members.
2. To determine the stresses and strains produced in the structural members and machine components and their deformations under various types of loads.
3. To understand analytical methods for determining the strength, stiffness and stability of various load carrying structural members and machine components
4. To study the failure theories

Course Outcomes:

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

1. Explain underlying principle of the experiment and outline experimental procedure and describe the parts of the experimental setup
2. Accurately record experimental observations and examine correctness of experimental readings
3. Analyze and interpret data obtained through the experiment
4. Prove compliance of experimental data with theory and justify in case results do not comply with theory and/or standard values

List of Experiments to be conducted is as follows.

1. Tension test on mild steel bar (stress- strain behavior, modulus determination)
2. Tension Test on tor-steel
3. Test on cast iron (transverse, tension)
4. Shear test on mild steel, cast iron, brass
5. Torsion test on mild steel bar/cast iron bar
6. Brinell hardness test
7. Rockwell hardness test
8. Izod impact test/Charpy test
9. Flexural test on beam (central point load) *
10. Flexural test on beam (two-point load) *

* For experiment no. 9 and 10, plot load deflection curve and find value of Young's modulus.

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

BTM354 Material Science Laboratory
Pre-requisites: - BT304

Course Objective:

1. To familiarize with use of optical laboratory microscope
2. To acquaint with microstructures of Materials.
3. To familiarize with microstructures of steel under different heat treated conditions.

Course Outcomes:

Students shall be able to

1. Demonstrate the understanding of the procedure to prepare samples for studying microstructure using microscope (metallography).
2. Interpret different phases present in different steels and cast irons.
3. Interpret different failures and dislocations in different material samples.
4. Identify effects of Annealing, Normalizing and Hardening on microstructure of medium carbon steel.

List of Experiments:

The laboratory work shall consist of a journal based on the below mentioned laboratory experiments/study

1. Study of Metallurgical Microscope.
2. Preparation of Specimen for microscopic examination.
3. Study of microstructure of plain carbon steels of various compositions.
4. Study of microstructure of various types of C.I.
5. Study of microstructure of various types of alloy steels.
6. Study of microstructure of non – ferrous metals and their alloys.
7. Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)
8. Surface hardening and study of microstructure
9. Study of I.S. codes of steels and selection procedure.

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

BTM399 Machine Shop Practice-I

Course Pre-requisites: -

Course Objectives:

The objective of this course is to provide students the hands on experience about basic manufacturing processes which are nerve centre of any manufacturing industry.

Course Outcome:

Upon successful completion of the course, students should be able

1. To explain the various parts and working of lathe and shaper machines
2. To explain the different tools used in various manufacturing operations such as machining on lathe, shaper, forging and welding.
3. To apply the knowledge of various operations such as Plain turning, taper turning, precision turning on lathe machine Thread cutting on lathe machine Machining plain, horizontal and inclined surfaces on shaper machine, Preparation of composite welding joint, Operations in forging for manufacturing

Course Contents

Job No.	**Details**	**Hrs.**
01	One job on lathe machine involving plain turning, precision turning, taper turning and screw cutting operation.	07
02	One job on shaper involving machining of horizontal and inclined surfaces.	06
03	One job on forging of cutting tools used on lathes such as boring tool.	05
04	One job on forging of parting tool	05
05	One job on welding exercise to make a composite joint such as T-Joint.	05

BTM401 Applied Mathematics -IV

Course Pre-requisites: -

Course Objectives:

1. Introduce Statistical methods, probability distribution and testing of hypothesis.
2. Introduce Fourier series orthogonal orthonormal functions
3. Introduce PDE and how to use PDE to solve wave equation and heat equation.

Course Outcomes:

Upon successful completion of course students will be able to

1. Solve problem in basic statistics, probability, probability distribution, testing of hypothesis.
2. Solve the problem based on fourier series expansion.
3. Solve PDE problems based on heat and wave equation.

Course Contents:

Module No.	Details	Hrs.
01	**Statistics:** Correlation. Co-variance, Karl Pearson Coefficient and Spearman's Rank Co-relation Coefficient (non-repeated and repeated ranks, without proof) Regression Coefficient and lines of regression.	06
02	**Random Variables** Introduction to probability and conditional probability, Baye's theorem Discrete and continuous random variables, probability mass function and density function. Probability distribution for random variables. Expected value, Variance.	06
03	**Probability Distributions** Binomial, Poisson and Normal Distributions.	04
04	**Sampling Theory** Sampling distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples. Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples. Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples, Chi-square distribution and its properties, Test of the Goodness of fit.	05
05	**Fourier Series** Orthogonal and orthonormal functions, Dirichlets conditions Fourier Series of periodic functions with period 2π and 2L, Even and odd functions Half range sine and cosine series, Parseval's identities (only statement) and examples based on Parseval's identities, Complex form of Fourier series, Fourier	07

	integrals.	
06	**Partial Differential Equations** Classification of PDE and their characteristic. Method of separation of variables to solve PDE, Partial differential equation governing transverse vibrations of an elastic string, its formulation and solution using Fourier series.	04
07	**Partial Differential Equation (Heat Equations)** Heat equation, steady- state configuration for heat flow. Two & Three-dimensional Laplace equation.	04

Reference Books:

1. Shahnaz Bathul. *A Textbook of Probability and Statistics*, Cengage Learning (2009)
2. Gupta, S. C. "Fundamental of Statistics, S." *Chand & Co., Delhi* (2007).
3. Spiegel, Murray R. *Theory and Problems*. Schaum Publishing, 1961.
4. Grewal, B. S. *Higher engineering mathematics*. Khanna Publisher, New Delhi, 1996.
5. Jain, Rajinder Kumar, and Satteluri RK Iyengar. *Advanced Engineering Mathematics*. Alpha Science Int'l Ltd., 2004.

Text Books

1. Kumbhojkar, G.V., "*Applied Mathematics-III*", C.Jamanadas, 2011.

BTM402 Theory of Machines – I
Course Pre-requisites: BTM104, BTM204
Course Objectives

1. To provide basic concept of kinematics analysis of machines and machine members.
2. To give basic knowledge on kinematic and dynamic design of machinery.
3. To understand the relationship between geometry and motion of the part of the machine.
4. To create a basic foundation for static and dynamic force analysis and ultimately for mechanical transmission system.

Course Outcome:

Upon successful completion of the course, student will demonstrate knowledge in

1. Basic concept of kinematics analysis, drawing velocity and acceleration diagrams for different mechanisms.
2. Inversions of kinematic chains, special purpose mechanisms.
3. Selecting belt, chain and gear depending on application.
4. Static and dynamic force analysis for designing mechanical components.

Course Contents:

Module No.	Details	Hrs.
01	**1. Basic Kinematics:** **Structure, Machine, Link and its types** **Kinematics pair -**Lower pair and higher pair, Form closed pair and force closed pairs, Based on relative motion permitted such as revolute, prismatic, cam, helical, globular. **Kinematics chain and Mechanisms:** Grublers criterion for movability of chains and mechanisms, Limitations of Grubler's Criteria. **Inversion of chain:** Study of various mechanisms derived from inversions of following chains (with regard to motion of links of mechanisms, motion modification, quality of motion transmission (uniform, non-uniform, SHM, Non-SHM), limiting positions, deadpositions, quick return property, applications). -- Four bar chain (Grashoffian, and non-Grashoffian), Single slider crank chain, and Double slider crank chain.	06
02	**Special Mechanisms:** **Straight line generating Mechanisms:** Exact Straight line generating Mechanisms – Peaucellier and Harts, Approximate straight line generating Mechanisms – Watts, Roberts, Evans and Chebyshev, Offset slider crank mechanisms, Pantograph, Hook joint single and Double Steering gear mechanisms – Ackerman, Devis	06
03	**Velocity and Acceleration Analysis of mechanisms (mechanisms up to 6 links).** Velocity analysis by instantaneous center of rotation method (Graphical approach) Velocity and acceleration analysis by relative method (Graphical approach) Velocity and acceleration analysis analytical approach--four bar mechanism only.	06

04	**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.	03
05	**Cam and Follower-** classification, motion analysis and plotting of displacement-time, velocity –time, jerk-time for uniform velocity, UARM, SHM & Cycloidal motion (combined motions during one stroke excluded), generation of cam profile for roller and flat face follower,	06
06	**Flexible Connectors:** Belt – Types of belts, law of belting, velocity ratio, slip, length of belt. Chains – types of chains, chordal action, variation in velocity ratio, chain length.	06
07	**GEARS:** Law of gearing, Conjugate profile and its graphic construction, Involute and cycloid gear tooth profile, Construction of involute profile, Path of contact, arc of contact, contact ratio for involutes and cycloid tooth, Interference in involutes gears. Critical Numbers of teeth for interference free motion. Methods to control interference in involutes gears.	09

Term Work:

1.THEORY ORIENTED:

Assignment based on topics covered.

2.PROBLEM ORIENTED:

A Graphic work (on half imperial drawing sheets)

(a) Location of instant center 3P
(b) Velocity analysis by ICR 3P
(c) Velocity analysis by relative method 3P
(d) Velocity – Acceleration analysis by relative method 3P
(e) Construction of involute profiles 1P
(f) Construction of x-t, v-t, a-t, j-t curves of follower motions and cam profile 2P

B Analytical / Numerical work

1. Velocity – Acceleration analysis by analytical method 3P
2. Numerical Problems on belts / chains 2P
3. Numerical Problems on gear 4P
4. Numerical Problems on cams 3P
5. Any two problem using computer programming. (C++/MATLAB) 2P

P = Problem

C. Demonstration with physical models of mechanisms

D. Simulation of motions of mechanism using CAD package (e.g. CATIA)

Recommended Books:

1. S.S. Rattan, *"Theory of Machines"*, McGraw Hill Education (India), ed.4, 2014.
2. J.J. Uicker, G.R. Pennock, J.E. Shigley, *"Theory of Machines and Mechanisms",* Oxford University Press, ed.3, 2014.
3. A. Ghosh, A.K. Mallik, *"Theory of Mechanisms and Machines"*, East West Press, ed.3, 1999.
4. P.L. Ballaney, *"Theory of Machines and Mechanisms"*, Khanna Publishers, 2003.

BTM403 Fluid Mechanics

Pre-requisites : - BTM305

Course Objectives:

The objective of the course is to make student familiar with the mechanics of fluid flow which includes developing knowledge of static and dynamic nature fluid and fluid flow systems, flow related measurements, techniques of fluid flow analysis, internal and external fluid flow, among students.

Course Outcomes:

On successful completion of the course students will

1. have knowledge of fundamentals of static and dynamic behavior of incompressible and compressible fluid.
2. have understanding of performing calculation of different flow quantities and parameters.
3. be able to apply basic principles to solve single phase flow problem.
4. be able to analyze an existing flow system and recommend solution for it.

Course Contents:

Module	Description	Hrs.
1	**Fundamental Concepts:** Continuum, fluid properties - density, pressure, viscosity, surface tension, compressibility. Classification of fluid – Newtonian and Non-Newtonian, Viscous and Inviscid, Compressible and Incompressible.	04
2	**Fluid Statics:** Definition of body forces and surface forces, static pressure, Pascal's law, Derivation of basic hydrostatic equation, Application to manometer, Forces on submerged surfaces, Fluid in rigid body motion, Buoyancy, stability and Archimedes' Principle.	06
3	**Fluid Kinematics:** Velocity and approach of description- Lagrangian and Eulerian, Acceleration, Classification of flow field – one, two and three-dimensional, steady and unsteady, uniform and non-uniform, rotational and irrotational, Laminar and turbulent. Fluid element's translation, rotation and deformation, Flow patterns: streamlines, path lines and streak lines.	06
4	**Fluid Dynamics:** Basic flow conservation equations and method of analysis- Integral and Differential approach. Reynolds Transport Equation and its application. Navier–Stokes equations (without proof) for rectangular and cylindrical co-ordinates. Cases of exact solutions of NS equations: viscous laminar flow of a fluid through a pipe, Couette flow, Euler's equations in two, three dimensions; Bernoulli's equation and its applications	06
5	**Turbulence and Boundary Layer:** Reynolds number and its significance in flow characterization.	08

	Concept of turbulence, its measurement, effect on NS equation and flow pattern. Modeling of turbulence. Boundary layer and its measurement, its development flat plate with zero pressure gradient Boundary layer equations its solution –Blasius solution (without derivation), Von-Karman momentum integral approach. Description of turbulent velocity profile in boundary layer- viscous, buffer and turbulent.	
6	**Internal and External Flows:** Internal - Laminar flow through pipes and ducts. Deriving velocity profile using NS equation and developing expression to compute other quantities- flow rate, pressure drop, shear stress, friction factor etc. Head losses- major and minor losses, Moody's diagram, Flow through branched pipes. External – Flow over immersed bodies: Plate, Sphere, Cylinder and other objects. Concept of drag and lift, flow separation and methods to control, Streamlined and bluff bodies.	06
7	**Compressible Flow:** Characteristics of compressible flow, Concept of speed of sound, pressure, stagnation and sonic properties, Effect of area variation on flow properties in isentropic flow, Isentropic flow through converging nozzle – critical pressure ratio and chocked flow, Effect of friction and heat transfer on flow properties, High speed flow	06

Recommended Books:

1. Fox and McDonald, "*Introduction to Fluid Mechanics*", John Wiley & Sons, 8ed.
2. Frank M. White, "*Fluid Mechanics*", McGraw Hill, 7ed.
3. V L Streeter and E B Wylie, "*Fluid Mechanics*", McGraw Hill, 8ed.
4. B R Munson and W WHuebsch, "*Fundamentals of Fluid Mechanics*", Wiley, 7ed.
5. E J Shaughnessy, "*Introduction to Fluid Mechanics*", Oxford University Press, 1ed.
6. Yunus Cengel and John Cimbala, "*Fluid Mechanics*", Tata McGraw Hill. 1ed.
7. M C Potter, "*Mechanics of Fluids*", Cengage Learning; 4 ed

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

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BTM404 Mechanical Engineering Measurements
Course Pre-requisites: - BT105, BT205

Course Objectives:

The objective of the course is to impart fundamental knowledge of mechanical measurement techniques and data analysis with its application to the measurement of several mechanical engineering quantities.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To describe overall methodology of measurement and fundamental concepts of experimental data analysis
2. To define different types or errors and to discuss uncertainty analysis
3. To examine common techniques used for measurement of mechanical quantities
4. To select measurement system for engineering applications

Course contents:

Module No.	Description	Duration (hrs.)
1	**Introduction:** Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, Modifying and Interfering. **Static characteristics:** Static calibration, Linearity, Static Sensitivity, Accuracy, Precision, Threshold, Resolution, Reproducibility, Hysterisis, Drift, Range and Span etc. **Dynamic characteristics**: Order of instruments, dynamic behavior under standard inputs and key terminology	05
2	**Errors in measurement and data analysis:** Types of errors, factor influencing measurement, methods of elimination, Probable errors, Uncertainity and Uncertanity analysis **Statistical analysis of data:** arithmetic mean, deviation, average deviation, standard deviation, variance.	05
3	**Displacement measurement:** Transducers for displacement measurement – Potentiometers, LVDT, Capacitance type, Digital transducers (Optical Encoder), Nozzle Flapper transducer. **Strain measurement:** Theory of strain gauges, gauge factor, Temperature compensation, Bridge circuit, Orientation of strain gauges for force and torque measurement, Strain gauge based load cells and torque sensors.	06
4	**Angular velocity measurement:** Tachometers, Tachogenerators, Digital tachometers, Stroboscopic methods. **Acceleration measurement:** Theory of accelerometers and vibrometers, Practical accelerometers, strain gauge based and piezoelectric accelerometers.	06
5	**Pressure measurement:** Pressure standards, Elastic pressure transducers viz. Bourdon Tubes, Diaphragms, Bellows and Piezoelectric pressure sensors, **High**	07

	pressure measurement: Bridgman gauges. Calibration of pressure sensors. **Vacuum measurement:** Vacuum gauges viz. Mcleod gauge, Pirani gauge, Ionization gauge, Thermal conductivity gauge, Knudsen gauge etc.	
6	**Temperature measurement:** Thermodynamic Temperature Scale and IPTS, Electrical methods of temperature measurement viz. Resistance Thermometers, Thermistors, Thermocouples, Pyrometers.	07
7	**Flow measurement:** Venturimeter, Orifice meter, flow nozzles, Pitot tube, Rotameter, Hot wire Anemometrs, Turbine flow meters, Laser Doppler Anemometer etc. Miscellaneous measurement: Measurement of liquid level, humidity etc.	06

Recommended Books:

1. E.O.Dobelin, "Measurement Systems (Applications and Design)", McGraw Hill.
2. A.K. Sawhney & Puneet Sawhney, "Mechanical Measurements and Instrumentation & Control", Dhanpat Rai & Co., Twelfth Edition.
3. Thomas Beckwith, N. Lewis Buck, Roy Marangoni, "Mechanical Engineering Measurement", Narosa Publishing House, Bombay.
4. B.C. Nakra and K.K. Chaudhry, "Instrumentation Measurement and Analysis", Tata McGraw Hill. Third Edition.
5. A.K. Thayal, "Instrumentation and Mechanical Measurements". Galgotia Publications Pvt. Ltd.
6. E.O. Dobelin, "Engineering Experimentation", McGraw Hills International Edition
7. J.P. Holman, "Experimental Methods for Engineers", McGraw Hills International Edition.
8. S.P. Venkateshan, "Mechanical Measurements", Ane Books, India.
9. C.S. Rangan, G.R. Sharma, V.S.V. Mani, "Instrumentation Devices and System", Tata Mcgraw Hill, New Delhi.

Sr. No.	Examination	Module
13.	T-I	1,2
14.	T-II	3,4
15.	End Semester	1 to 7

BTM405 Manufacturing Science II
Pre-requisites: - **BTM306**

Course Objectives:

The objective of this course is to:

- As a result of having learned this module 1 Jigs and Fixtures the students will be able to analyze design of product and interpret locator, support, clamping element
- As a result of having learned this module 2 Metal Cutting and Tool Engineering, 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 3 Measurement of cutting Forces, 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 Design of Cutting Tools, the 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 5 Sheet Metal Working Operations, 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 6Rolling of metals and Forming of Metals
- 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 7 forming of sheet metal and drawing of metals

the students will be able to introduce and develop the knowledge related to forming of sheet metal and drawing of metals.

Course Outcomes:

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

1. To select and design tooling devices like jigs and fixtures for manufacturing of particular product
2. To explain metal cutting principles and important analytical aspects of machining process.
3. To select and design Cutting tools for various machining processes and specify the effects of machining environment on machining mechanism.
4. To explain principle of operation for rolling, forming of sheet metal and forging of metals

Course contents:

Sr. No.	Description	Duration (hrs.)
1	Design of Jigs and Fixtures, Introduction, need, Definitions, Principles of location, types of locators, Principles of Clamping, Types of clamping, Jig Bushes and types of Jig Bushes, Indexing devices, Fool proofing means, Types of Jigs and fixtures, Box Jig, Latch Jig, Milling fixtures, Turning Fixtures, Design principles for Jigs and fixtures, Design of Jigs and Fixtures	06

2	Metal Cutting and Tool Engineering, 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
3	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	04
4	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
5	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
6	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. Forging : 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	07
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, equipments 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. Drawing: Introduction and Classification, Wire Drawing, Rod Drawing, Tube Drawing, Deep Drawing, Analysis of Wire Drawing Process and Load Calculations.	07

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. Dr.P.C.Sharma , Production Engineering, S.CHAND,2008
7. W A J Chapman ,Workshop Technology Part 1,2,&3 , Edward Arnold, 01-Jan-1972
8. B. L. Juneja&Sekhon, Fundamentals of Metal Cutting and Machine Tools, New Age Intl.
9. V.D. Kodgire, "Material Science and Metallurgy", Everest Publishing House - 25 th. Edition –
10. 2009.
11. Lawrence E.Doyle, Manufacturing processes and materials for engineers. Author, Prentice-Hall, 1961
12. HMT Banglore, Tata McGraw-Hill Education, 2001
13. Hajra Choudhary, S.K. and Hajra Choudhary A.K. ,Elements of Workshop Technology, Vol. II, Media Promoters, Mumbai. Shaw, M.C. (2005)
14. Jain R.K. & Gupta S.C."Production Technology " : Khanna Publisher, New Delhi, ; 8th Edition

Term work:

1. One assignment on each module of the syllabus.
2. Industrial visit report (format should be provided by teacher)
3. Seminar presentation on the topic related to any one of the topics [Desirable: inclusion of video of the manufacturing process of any product]

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

BTM425 Introduction to Composite Material Technology
Pre-requisites: - BTM304

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	02
2	**Composite materials** Reinforcement fibers, whiskers, polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC),	02
3	**Composite Science** Material and microstructure parameters of layered and phased composites, micro and macro approaches to study and prediction of structure property relations.	02
4	**Introduction to micromechanics** Anisotropy of composites, anisotropic elastic constants, failure criteria under multiaxial loading, interlaminar failure mechanism	02
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.	02
6	**Composite post processing operation** Machining, cutting, polishing, welding of thermoplastic PMC, bonding, riveting and painting	02
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.	02

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

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.

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

BTM426 Internet of Things (IOT)

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

Course Objectives:

Upon successful completion of the course, students will be

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

Course Outcomes:

After successful completion of the course student should be able to

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

Course Content:

Module No	Details	Hrs.
Module 01	**Introduction** Fundamentals of Internet of Things (IOT), Components in IOT, Architecture of IOT, Security, Privacy, Advantages, Applications: Smart Vehicles, Medical, Smart city, Smart Supply Chain etc.	02
Module 02	**Enabling Technologies of IOT** Technology Roadmap, RFID, Augmented Reality, Blue Tooth, Zigbee, WiFi, RFLinks, MEMS etc	02
Module 03	**Programming the Microcontroller for IOT** Cloud computing and IOT –Arduino/Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors - Communication-Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using WiFi / Ethernet	02
Module 04	**Resource Management** Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results	02
Module 05	**IOT PROTOCOLS** Network Overview, Various Types of Networks, Network Protocols, Selecting the Right Network for the Right Use case, Network Challenges for IOT: Connecting sensors, Integrating with Application Platform	02
Module 06	**IOT Platforms** Introduction, Necessity of IOT Platform, Industrial Grade Platform, Key IOT Platform Features, IOT Platform Architecture, Getting access to IOT platforms, Introduction to Model based development on IOT platforms	02

Module 07	**Challenges & Opportunities of IOT** New business markets in IOT, IOT Design Challenges, IOT Design Opportunities, Technological challenges faced by IOT devices	02

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Internet of Things (IOT) Course Evaluation Scheme:

It is an audit course which involves both Theory and Tutorial sessions. Students shall select an Mechanical or any interdisciplinary application & apply concepts of IOT, learned during theory & tutorial. Following evaluation scheme will be adopted for the evaluation of the course.

Test 1: 20% (Theory paper)
Test 2: 20% (Theory paper)
In-semester evaluation: 60%

On successful completion of the course by the candidate Audit "PASS" grade shall be awarded in the final grade-sheet whereas **no grade will be awarded** on failure of completion of the course by the candidate registered for the course.

BTM427 CNC Programming
Pre-requisites: - BTM306

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.

List of Experiments/Practicals (Any seven to be completed in a semester):

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.

BTM428 Automation of Engineering Drawings
Prerequisites: - BT103, BT203, BTM303

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	04
02	Data Structures for handling graphical entities	04
03	Part Drawing 1 creation with Programming language	04
04	Part Drawing 2 creation with Programming language	04
05	Part Drawing 3 creation with Programming language	04
06	Generate variations of drawings created using Programming language	04
07	Controlling plotting parameters using Programming language	04

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

BTM429 Introduction To Nanotechnology
Prerequisites: - BT105, BT205

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.	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**	2

	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,	
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.	**2**
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**

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
3.	T-I	1,2 and part of 3
4.	T-II	Remaining part of 3,4 and part of module 5
5.	End Sem	1 to 7

BTM430 Smart Product Development
Prerequisites: - BTM302, BTM303, BTM304, BTM305, BTM306

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	02
02	Understanding different techniques available for generating innovative solutions to product design problem	02
03	Smart product development: Stage 1 – develop multiple design solutions	04
04	Smart product development: Stage 2 – Analysis of solutions and selection of one solution based on pre-defined criteria	04
05	Smart product development: Stage 3 – preparation of calculation report and engineering drawings	04
06	Smart product development: Stage 4 – Fabrication of prototype	08
07	Smart product development: Stage 1 – Testing of prototype	04

Term Work:

- 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.

BTM453 Fluid Mechanics Laboratory
Pre-requisites: - **BTM403**

Course Objectives:

The objective of this course is to enhance the knowledge and understanding of course BTM403 through live examples and by performing experiments which involves principles of fluid mechanics

Course Outcome:

On successful completion of the course, students will

1. have improved understanding of the principals of fluid mechanics.
2. learn to carryout experiment in fluid related problems and apply basic principles to solve real life problem based of fluid mechanics.
3. be able to record experimental data, its interpretation and representation.
4. be able to design simple experimental setup in fluid mechanics

Exp. No.	Details of Laboratory Experiment	Hrs.
1	To determine specific gravity of a given liquid	02
2	To verify Archimedes principle and to determine specific gravity of a concrete block	02
3	To determine the coefficient of discharge of a given orifice plate	02
4	To determine kinematic viscosity using Hagen-Poiseuille setup and prove that head loss is proportional to volume flow rate	02
5	To determine the coefficient of discharge of a given Venturimeter	02
6	To determine Darcy Friction factor for pipes of different diameters	02
7	To carryout experiment on a given experimental setup to verify Bernoulli's theorem	02
8	Case based numerical calculations involving fundamentals of fluid mechanics	10

Recommended Books:

1. *Fluid Mechanics Laboratory Manual*, Department of Mechanical Engineering, SPCE.

BTM454 Mechanical Engineering Measurements Lab.
Pre-requisites: - **BT205**

Course Objectives:

1. To impart hands on different mechanical engineering measurement system
2. To understand methodology to characterize the measurement systems and error analysis
3. To design and synthesize the measurement system

Course Outcomes:

On successful completion of the course learner should be able to

1. Calibrate the mechanical engineering measurement system.
2. Characterize measurement system and find the error and perform uncertainty analysis
3. Design measurement system
4. Synthesize measurement system/sensor

List of Experiments: Any seven experiments from the following list of experiments:

1. Calibration of pressure gauge using dead weight pressure gauge tester.
2. Calibration of load cell.
3. Calibration of strain gauges.
4. Calibration of LVDT.
5. Calibration of tachometer.
6. Calibration of accelerometer/vibrometer.
7. Calibration of flow meters.
8. Calibration of temperature sensors.
9. Time constant of thermometer.
10. Study of anemometer.
11. Study of Optical Encoders

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. Mini project on development of measurement system or characterization of sensor in group of 4 students.
4. Examination (MCQ)
5. Oral Examination

BTM499 Machine Shop Practice-II

Course Objective:

The objective of this course is to provide students the hands on experience about basic manufacturing processes which are nerve centre of any manufacturing industry.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To explain the Various parts and operation of lathe, shaper, milling, drilling, grinding machines
2. To apply the knowledge of various operations such as Plain turning, taper turning, precision turning on lathe machine Thread cutting on lathe machine Machining plain, horizontal and inclined surfaces on shaper machine Preparation of composite welding joint Operations in forging for manufacturing
3. To apply the knowledge of various operations such as precision turning on lathe machine, Boring and taper boring on lathe machine, External and internal thread cutting on lathe machine.
4. To explain the defects and their elimination in various manufacturing processes

Term Work:-

Job No.	Details	Hrs
01	One composite job of assembly of minimum three components produced using lathe, shaper, milling, drilling and grinding machines and involving the operations of precision turning, taper turning, taper boring, internal and external threading, shaping plain flat surfaces, slot milling ,drilling and grinding etc.	28

THIRD YEAR B.TECH. IN MECHANICAL ENGINEERING

SEMESTER V AND VI

YEAR 2017-18

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2017-18

Courses Offered for Third Year B.Tech. in Mechanical Engineering (Semester V)

Sr. No.	Course Name	Code	Course Plan per Week (Hrs)			Credits	In semester Evaluation (Points)		End Semester Evaluation (Points)		End semester weightage (%)	Term work	Total Points
			L	P	T		T-I	T-II	Points	Time (Hrs)			
Theory Courses													
1	Heat and Mass Transfer	BTM501	3	-	-	3	20	20	100	3	60%	-	100
2	Theory of Machine-II	BTM502	3	-	-	3	20	20	100	3	60%	-	100
3	Mechatronics	BTM503	3	-	-	3	20	20	100	3	60%	-	100
4	Thermal Systems	BTM504	3	-	-	3	20	20	100	3	60%	-	100
5	Hydraulic Machinery	BTM505	3	-	-	3	20	20	100	3	60%	-	100
6	Numerical Methods	BTM506	2	-	2	3	20	20	100	3	60%	50	150
Laboratory Courses													
7	Heat and Mass Transfer Lab.	BTM551	-	2	-	1	-	-	-	-	-	50	50
8	Theory of Machine-II Lab.	BTM552	-	2	-	1	-	-	-	-	-	50	50
9	Mechatronics Laboratory	BTM553	-	2	-	1	-	-	-	-	-	50	50
10	Thermal Systems Laboratory	BTM554	-	2	-	1	-	-	-	-	-	50	50
11	Hydraulic Machinery Lab.	BTM555	-	2	-	1	-	-	-	-	-	50	50
Value Added Courses (Note 1)													
12	Compliant Mechanisms	BTM525	1	-	2	2	20	20	100	3	60%	-	100
13	Digital Manufacturing	BTM526	1	2	-	2	20	20	100	3	60%	-	100
14	Knowledge Based Engineering	BTM528	-	2	-	1	20	20	100	3	60%	-	100
15	Reverse Engg. and Product Development	BTM529	1	2	-	2	20	20	100	3	60%	-	100
16	Introduction to Aerodynamics	BTM530	1	-	2	2	20	20	100	3	60%	-	100
Online Courses (Note 2)													
17	Online Course 1	BTM581	-	-	-	0	-	-	-	-	-	-	-
Mandatory Courses: Refer to Mandatory course list in Semester I													
	TOTAL		**17+***	**10+***	**2+***	**23 +***							**900 +***

Note: (1) Department will offer the Value Added and Elective courses in a semester subject to availability of resources and enrollment of minimum 25 students opting for the course. (* additional credits, contact hours and points will depend upon number of value added and Elective courses offered in a particular semester).(2) Department will offer online course subject to availability of a course on https://swayam.gov.in/ , availability of resources and enrollment of minimum 25 students opting for the course.

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2017-18

Courses Offered for Third Year B.Tech. in Mechanical Engineering (Semester VI)

Sr. No.	Course Name	Code	Course Plan per Week (Hrs)			Credits	In semester Evaluation (Points)		End Semester Evaluation (Points)		End semester weightage (%)	Term work	Total Points
			L	P	T		T-I	T-II	Points	Time (Hrs)			
Theory Courses													
1	Refrigeration and Air Conditioning	BTM601	3	-	-	3	20	20	100	3	60%	-	100
2	Machine Design-I	BTM602	3	-	2	4	20	20	100	3	60%	50	150
3	Health Safety and Environment (HSE)	BTM603	3	-	2	4	20	20	100	3	60%	50	150
4	Internal Combustion Engine	BTM604	3	-	-	3	20	20	100	3	60%	-	100
5	Manufacturing Planning and Control	BTM605	3	-	2	4	20	20	100	3	60%	50	150
Laboratory Courses													
6	Refrigeration and Air Conditioning Lab.	BTM651	-	2	-	1	-	-	-	-	-	50	50
7	Internal Combustion Engine Laboratory	BTM654	-	2	-	1	-	-	-	-	-	50	50
Value Added Courses (Note 1)													
8	Introduction to MEMS	BTM625	1	-	2	2	20	20	100	3	60%	-	100
9	Advanced Solid Mechanics	BTM626	1	-	2	2	20	20	100	3	60%	-	100
10	Product Lifecycle Management	BTM627	1	-	2	2	20	20	100	3	60%	-	100
11	Advanced Heat Transfer	BTM628	1	-	2	2	20	20	100	3	60%	-	100
12	Lean and Green Manufacturing	BTM629	1	-	2	2	20	20	100	3	60%	-	100
13	Intro. to Computer Integrated Manufacturing	BTM631	2	-	-	2	20	20	100	3	60%	-	100
Online Courses (Note 2)													
14	Online Course 1	BTM681	-	-	-	0	-	-	-	-	-	-	-
Mandatory Courses: Refer to Mandatory course list in Semester I													
	TOTAL		**14+***	**4+***	**6+***	**20 + ***							**750+***

Note: (1) Department will offer the Value Added and Elective courses in a semester subject to availability of resources and enrollment of minimum 25 students opting for the course. (* additional credits, contact hours and points will depend upon number of value added and Elective courses offered in a particular semester). (2) Department will offer online course subject to availability of a course on https://swayam.gov.in/ , availability of resources and enrollment of minimum 25 students opting for the course.

BTM501 Heat and Mass Transfer

Course Pre-requisites: BTM305

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 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 Content:

Module No	Details	Hrs.
Module 01	**Basic Concepts:** Understanding generalized energy equation in the mathematical form, Identifying the mode of heat transfer in a thermal system. Modes of heat transfer, its mechanism and mathematical models.	03
Module 02	**Conduction:** General conduction equation in cartesian, cylindrical and spherical coordinates 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. Critical thickness of insulation and its importance. Extended surfaces.	07
Module 03	**Transient Conduction:** Lumped capacity method, Distributed parameter treatment, Use of transient temperature chart, Semi infinite solids.	03
Module 04	**Fundamental of Convection:** Natural and Forced convection, hydrodynamic and thermal boundary layers. Similarity between velocity profile and temperature profile. 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, Grashoff s Number, Prandtl's Number, Reynolds Number and Stanton's Number. Principle of dimensional analysis. Application of dimensional analysis to Convection for finding heat transfer coefficient.	10

	Empirical relations and their use for forced internal and external convection under standard boundary condition for circular and non-circular duct. Empirical relations for free convection for standard cases.	
Module 05	**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, Kirchoff s law, Stefan-Boltzman law, Wien's.-.displacement law and Lambert's Cosine law. Intensity of Radiation Radiosity. Radiation heat exchange between two black bodies. Electrical network analogy for radiation heat exchange between two and three grey bodies. Shape factor for simple geometries. Properties of shape factor.	07
Module 06	**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.	07
Module 07	**Mass Transfer:** Mechanism of mass transfer. Importance of mass transfer in engineering. Fick's law of diffusion. Steady State diffusion of gases and liquids through plane, cylindrical and spherical walls. Equimolal diffusion. Isothermal evaporation of water into air. Convective mass transfer and mass transfer coefficient. 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)

BTM502 Theory of Machine -II
Course Pre-requisites: BTM402

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 to

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 define damped and undamped SDOF vibration system
4. To derive governing equations of motion for damped and undamped vibration systems.

Course Content:

Module No.	Details	Hrs.
01	**Clutches:** Positive clutches, friction clutches, Friction Clutches-Analysis of frictional torque, power transmission. Power loss in Friction in single plate, multiple plate clutch, and cone clutch, Centrifugal Clutches-construction,working **Brakes:**Type of Brakes, Analysis of Block brakes –external and internal, Band brake-simple and differential, Bandand block brake simple and differential, Braking of vehicles front wheels, rearwheels, all wheels on level and, transmission, epicyclic, torsion dynamometers, Froude hydraulic dynamometer. **Dynamometers**–Absorption and transmission dynamometers,Study and analysis of absorption type dynamometer –Proney brake, Rope brake, dynamometers, Study and analysis of transmission type dynamometers.	12
02	**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 governors-stability, sensibility, isochronisms, Hunting, governor effort and governor power, coefficient of insensitiveness.	7
03	**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.	5

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.	5
05	**Basic Concepts of Vibration:** Vibration and oscillation, causes and effects of vibrations, Vibration parameters -spring, mass, damper, Damper models, Motion- periodic, nonperiodic, harmonic, non–harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis.	3
06	**Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional system, Methods for formulation of differential equations by Newton, Energy, Lagrangian (Rayleigh'smethod) ,Effect of spring's mass and shaft inertia on natural frequency, Effect of flexible bearings on natural frequency **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.	7
07	**Balancing:** Static and dynamic balanceing of multirotor system, Balancing of reciprocating masses In-line engines, V-engines (excluding radial engines)	3

TermWork / Laboratory Work:
Journal work shall consist of experiments (at least 06) and assignments (one on each Module).

TextBooks:

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.

ReferenceBooks:

1. Norton, Robert L. *Design of machinery: an introduction to the synthesis and analysis of mechanisms and machines*. McGraw-Hill Professional, 2004.
2. Ghosh A., Malik A., *Theory of Mechanisms and Machines*, West Press Pvt. Ltd., New Delhi (2014)
3. Green, Walter George. *Theory of machines*. Blackie, 1962.
4. Srinivas J., *Mechanics & Dynamics of Machinery*, Scitech, 2001.
5. Waldron, Kenneth J., Gary L. Kinzel, and Sunil K. Agrawal.*Kinematics, dynamics, and design of machinery*. John Wiley & Sons, 2016.
6. Hahn, Brian, and Daniel Valentine. *Essential MATLAB for engineers and scientists*. Newnes, 2007.

BTM503 Mechatronics

Course Pre-requisites: Engineering sciences, BTM402

Course Objectives:

- In the recent trend of automation in industry environment has changed very fastly from mechanical to electromechanical. Hence aim is to implement such a mechatronics systems 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, Mechtronics Systems in Factory, Home and Business Applications. Basic Components of Mechatronic Systems, Mechatronics Design process, Objectives.	02
Module 02	Overview of micro processors and micro-controllers 8051microcontrollers: Functional block diagram and architecture, 14 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-	08

	state errors, static error constants, steady state analysis of different type of systems 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

TermWork:

Atleast 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 question 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.

BTM504 Thermal Systems
Course pre-requisites: BTM305

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

- Understand fundamentals involved in compressor technology and power generation.
- Carry out basic calculation involving compressor, turbine, condenser and steam generator.
- Understand performance characteristics of compressors and turbines.

Course Outcome:
Upon successful completion of the course, students should be able to
1. apply the knowledge of thermodynamics and fluid mechanics to study the performance of different types of compressors.
2. get knowledge of different types of steam generators and condensers.
3. do simple calculations on the performance of steam turbines and gas turbines.
4. choose specified compressor, turbine, condenser and steam generator as per desired application.

Course Content:

Module No.	Details	Hrs.
01	**Introduction to thermal systems:** Basic principles of steam power cycle – carnot cycle, rankine cycle; Equipments and accessories of thermal power plant.	3
02	**Reciprocating Compressors**: 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.	6
03	**Rotodynamic Compressor:** Energy conversion in rotodynamic machines, Rotary, centrifugal and axial compressor; Surging, chocking and stalling, Multi-staging, performance parameters and characteristics.	5
04	**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.	8
05	**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.	4
06	**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.	8
07	**Gas Turbine**: Application of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output,	8

	open cycle with intercooling, reheat, and regeneration. Effect of operating variable on thermal efficiency and work ratio.	

TermWork / Laboratory Work:

Journal work shall consist of experiments (at least 06) and assignments (one on each module).

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.

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."

BTM505 Hydraulic Machinery

Course pre-requisites: BTM403, BTM453

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 of pumping machines- reciprocating and centrifugal,
- 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., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done.	04
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	06
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,	07
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 σ. Use of σ Vs specific speed graphs. Determination of safe height of installation for the turbine. Characteristics of turbines, governing of turbines.	05

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 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.	07
7	**Pumping System:** Concept of system and system characteristics, priming of pumps. 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	07

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
22.	T-I	1,2
23.	T-II	3,4
24.	End Sem	1 to 7

BTM506 Numerical Methods

Course Pre-requisites: Engineering Mathematics

Course Objectives:

1. To understand the fundaments of numerical computation.
2. To learn the common numerical techniques for basic tools of mathematical.
3. To apply numerical techniques to solve simple 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	**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	03
2	**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
3	**Numerical Solution of Systems of Non-linear Equations:** Roots of equations: Bisection, False position, Secant, Newton- Raphson methods. Non-linear system of equation - Newton- Raphson methods	04
4	**Numerical Integration and Differentiation:** Newton-Cotes Integration Formulas - Trapezoidal rule, Simpson's rule, Finite Difference Methods - Forward difference, Backward difference and Central Difference	04
5	**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	06
6	**Curve Fitting;** Regression - Least- square regression Interpolation - Newton's divided difference polynomials, Lagrange's polynomials, Spline interpolation;	04

7	**Use of Code / Software for Numerical Techniques:** Using Excel / MATLAB / Pseudo -Code to solve engineering problems.	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

BTM525 Compliant Mechanisms
Prerequisites: BTM402

Course Objectives:

1. To develop the student's understanding on compliant mechanisms
2. To develop the student understands of the working of compliant mechanisms
3. To develop student to understand analysis of compliant mechnism.

Course Outcomes:

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

1. Explain working of complaint mechanisms
2. Distinguish the difference between conventional and compliant mechanisms
3. analyse compliant mechanisms for displacement
4. design basic compliant XY scanning mechanisms

Course Content:

Sr.No.	Description	Hrs.
1	**Introduction** - Definition of compliant mechanisms - Advantages and disadvantages of compliant mechanisms Nomenclature and Diagrams	2
2	**Fexibility and Deflection** - Linear vs. nonlinear deflections - Stiffness, strength, and flexibility - Materials choice - Linear elastic deflections - Large-deflection analysis	2
3	**Analysis of Flexure Mechanisms in the Intermediate Displacement Range** Modeling Geometric Nonlinearities in Beam Flexures Beam Constraint Model Case Study: Parallelogram Flexure Mechanism	1
4	**Modeling of Large Deflection Members** Equations of Bending for Large Deflections Solving the Nonlinear Equations of Bending Examples-- Fixed-Pinned Beam, Fixed-Guided Beam (Bistable Mechanism)	2
5	**Pseudo-Rigid-Body Model** - Introduction - Pseudo-rigid-body models for flexible segments - Pseudo-Rigid-Body Models for Planar Beams Modeling of Mechanisms	2
6	**Complaint Mechanism Synthesis** - Rigid-body replacement - Synthesis through Freedom and Constraint Topologies - Synthesis through Topology Optimization	2
7	**Case Studies:** 1. Compliant mechanism in microsterolithography 2. Spiral Shaped flexural bearing for compressor of cryocooler	2

	3. Flexural based mechanisms in machine tools	

Recommended References:

1. Handbook of Compliant Mechanisms by Larry L. Howell and Brian M. Olsen, John Wiley & Sons.
2. Compliant Mechanisms by Nicolae Lobontiu, CRC press
3. Compliant Mechanisms by Larry L. Howell, John Wiley & Sons, Inc. ISBN 0-471-38478-X
4. Thesis "Synthesis and analysis of parallel Kinematic XY flexure mechanisms" by Shorya Awtar, Doctoral Reseach at MIT.
5. Flexures: Elements of Elastic Mechanisms, S. T. Smith, CRC press

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

BTM526 Digital Manufacturing

Course Pre-requisutes: 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 shopfloor 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 Mnufacturing in Automotive & Auto Component Industries	02
Module 02	**DIGITAL FACTORY AND VIRTUAL MANUFACTURING:** Introduction, Scope, Methods and Tools Used in Virtual Manufacturing, Benefits. Virtual factory simulation.	02
Module 03	**HARDWARE & SOFTWARE** Hardware & software technologies used in Digital Manufacturing, Conversion of CAD Model to VR Model	02
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	02
Module 05	**VIRTUAL COMMISSIONING** Virtual Commissioning, Validation	02
Module 06	**R&D** Research & Development status of Digital Manufacturing	02
Module 07	**Research & Development Status of Digital Amnufacturing** Bionic Manufacturing, Holonic Manufacturing, Biological Manufacturing	02

TERM WORK:

Practicals based on any Digital Manufacturing software

Text Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", Springer, 2005

BTM528 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	02
Module 02	Elements of Knowledge Based System, Knowledge Representation, Knowledge representation methods.	02
Module 03	Knowledge Representation Issues: Representations And Mappings, Approaches To Knowledge Representation. knowledge Based Engineering (KBE), KBE Methodology	02
Module 04	Knowledge Base integration, Knowledge Based Engineering in CAD, Product Development, Computer Aided Process Planning (CAPP), KBE & Product Life Cycle Management (PLM)	02
Module 05	CASE STUDIES & Applications of knowledge Based Engineering (KBE) in Design, Manufacturing & other fields	02
Module 06	Business Challenges, Programming tools & skills	02
Module 07	Future of knowledge Based Engineering (KBE)	02

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

BTM529 Reverse Engineering & Product Development

Course Pre-requisites: knowledge of any CAD software

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 enggg.	02
Module 03	Product Development Sequence & Reverse Engineering (RE) Methodology.	02
Module 04	Contact & Non-Contact data aquisition 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

BTM530 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.	1
2.	**Inviscid Flow:** Flow with no friction, Continuity equation, Momentum equation, Energy equation, Equation for isentropic flow.	2
3	**Applications:** Speed of sound, Low speed subsonic wind tunnels, Measurement of airspeed in incompressible, compressible and supersonic flow.	2
4	**Viscous Flow:** Flow with friction, Boundary layer concept, laminar and turbulent boundary layer, Transition from laminar to turbulent flow, Flow separation.	2
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.	3
6	**Wings:** Finite wing, Induced drag, Change in lift slope, Swept wings, Flaps,	2
7	**Aerodynamics of bodies:** Aerodynamics of Cylinders and spheres, Circulation and Kutta-Joukowsky theorem.	2

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.

BTM551 Heat and Mass Transfer Laboratory

Course Pre-requisites: 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 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

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-Finn
7. To determine the Critical Heat flux.

BTM552 Theory of Machine-II Laboratory
Course Pre-requisites: BTM502

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 define damped and undamped SDOF vibration system
4. To derive governing equations of 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.

BTM553 Mechatronics Laboratory
Course Pre-requisites: 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 systems 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 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 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

BTM554 Thermal Systems Laboratory
Course Pre-requisites: BTM504

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 and working of turbines.

Course Outcome:
Upon successful completion of the course, students should be able to
1. apply the knowledge of thermodynamics and fluid mechanics to study the performance of different types of compressors.
2. know working of nozzles and steam turbines
3. know working of steam generators
4. know working of turbines.

Course Contents
List of Experiments to be conducted is as follows.

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

BTM555 Hydraulic Machinery Laboratory
Course pre-requisites: BTM403, BTM453

Course Objectives:

1. To demonstrate working of hydraulic turbines
2. To demonstrate working of hydraulic pumps
3. To study performance and operating characteristics of turbines
4. To study performance characteristics of pumps

Course Outcomes:

On successful completion of the course learner should be able to

1. Identify the different types of hydraulic turbines and pumps
2. obtain performance characteristics of turbines
3. obtain operating characteristics of turbines
4. obtain pump and system characteristics

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

12. Study of hydro-electric power plant.
13. Estimation of Impact of jet
14. Constant head test on Impulse turbine.
15. Constant head test on medium head medium specific speed reaction turbine
16. Constant head test on low head high specific speed reaction turbine
17. Constant speed test on Impulse turbine.
18. Constant speed test on medium head medium specific speed reaction turbine
19. Constant speed test on low head high specific speed reaction turbine
20. Load test on centrifugal pump
21. Constant speed test on centrifugal pump
22. Performance of centrifugal pumps in series and parallel
23. Load test on positive displacement pump.

Term Work:

The term work will comprise of following

4. Journal of laboratory experiments.
5. At least one assignment on each module of the theory course.
6. Examination (MCQ)
7. Oral Examination

BTM601 Refrigeration and air
Course pre-requisites: BTM305, BTM504

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

- Understand fundamentals involved in basic refrigeration.
- Understand construction and principle of working of air conditioners and refrigerators.
- Learn about current issues of ODP, TEWI and effects of air-conditioning on global warming.
- Learn about heat load estimation and design air conditioning systems.

Course Outcomes:

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

1. Understand basic refrigeration cycles like Vapour compression cycle and Vapour absorption cycle and know working of equipment working on these cycles.
2. Understand working and use of different aircraft refrigeration systems.
3. Select refrigerants which are environment friendly and know about 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	08
02	Aircraft Air refrigeration systems • Need for aircraft air-refrigeration • Simple air-cooling system • Bootstrap air cooling system • Reduced ambient air-cooling system • Regenerative air cooling system Comparison of above systems, DART, layout of system components in aircraft	06
03	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 • Cooling Towers, Types, Approach, Range, Efficiency, Components and maintenance	06

04	Psychrometry • Psychrometric properties, chart and processes. • Bypass factor, ADP, Adiabatic mixing of two air streams • RSHF , RADP, CADP, GSHF, ESHF • Cooling Load estimation, Design of summer and winter air-conditioning systems.	08
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. Introduction to AHU-design/selection	06
06	Human Comfort- • Effective temperature, Comfort chart, Comfort zone, • Methods of improving Indoor Air Quality(IAQ) • Sick Building Syndrome	02
07	Vapor Absorption Refrigeration. • Ammonia Water • Water/Lithium Bromide system-Single Effect, Double Effect Electrolux refrigeration system	04

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).

BTM602 Machine Design –I

Course pre-requisites: BTM302, BTM303, BTM304, BTM306, BTM402, BTM405, BTM502

Course Objectives:

The primary objective of this course is

- 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 springs 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 formulate and analyze stresses and strains in machine elements courseed to static and fluctuating load conditions
2. To design and evaluate adequacy of standard/custom-built machine elements such as shafts, belts, chains, bolted/weled 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, Material properties and their uses in design, Manufacturing considerations in design: tolerances, types of fits, selection of fits, Design considerations of casting and forging. Basic principles of Machine Design, Modes of failures, Factor of safety, Design stresses, Principle Stresses, Theories of failures-Standards, I.S. codes, Preferred Series and numbers.	04
02	Design against static Loads: Cotter joint, knuckle joint, Bolted and welded joints under eccentric loading. Power Screw– Screw Presses along with the Frame.	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.	8
05	Design of springs- Helical compression, tension springs under static and variable loads, Laminated Springs.	06
06	Design of Belts –Flat and V belt with Pulley construction, Selection of Standard Roller chains.	08
07	Riveted Joints – eccentrically loaded riveted joints Welded Joints – Design of single transverse, double transverse parallel fillet, eccentricallyLoaded welded joint Bolted Joints – Design of bolted joints under eccentric loading.	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) Atleast four A-2 size drawing sheets shall be submitted.
3) Class Assignments

Text Books:

1) Bhandari, V. B. *Design of machine elements*. Tata McGraw-Hill Education, 2010.

2) Sharma, C. S., and Kamlesh Purohit. *Design of Machine Elements*. Prentice-Hall of India, 2003.

3) Robert, L. Nortron. "Machine Design An Integrated Approach." (2006).

4) Pandya, M. C., M. C. Pandya, and C. S. Shah. *Machine Design*. Charotar Book House. 1974.

5) Shigley, Joseph E., Charles R. Mischke, and Richard G. Budynas.*Mechanical engineering design*. McGraw-Hill,, 2004.

6) **Recommended Data Books**- PSG, K.Mahadevan

Reference Books:

1) Reshetov, DmitriĭNikolaevich, and Nicholas Weinstein. *Machine design*. 1978.
2) BLACK, PH, and OEJ ADAMS. *Machine Design* (1981).
3) Hamrock, Bernard J., Bo O. Jacobson, and Steven R. Schmid.*Fundamentals of machine elements*. Singapore: WCB/McGraw-Hill, 1999.
4) Faires, Virgil Moring. *Design of machine elements*. 1965.
5) Spotts, Merhyle Franklin, Terry E. Shoup, and Lee EmreyHornberger. *Design of machine elements*. Vol. 2. Pearson Education India, 2004.

BTM603 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 Outcome:
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. apply evaluation tool such as GRIHA to help design, build, operate, and maintain a resource efficient environment management system

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, Safety- Health	**04**
02	**OSH Laws And Regulations**: The OSH Act, Standards, and Liability, Workers' Compensation, Accident Investigation and Reporting, Product Safety and Liability,	**06**
03	**Hazard Assessment, Prevention, and Control:** Stress and Safety, Safety and Health Training, Mechanical Hazards and Machine Safeguarding, Fire Hazards and Life Safety, Ethics and Safety, Hazard Analysis/Prevention and Safety Management, Environmental Safety and ISO 14000 (Environmental Management)	**08**
04	**Introduction to Environmental Engineering:** Biotic and Abiotic Environment, Adverse effects of environment, Types of environmental pollution - Water pollution, Air pollution, Solid waste management, Control Strategies of different environmental problems.	**06**
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	**06**
06	**International Concerns:** Conventions and Treaties-RAMSAR Convention, CITES, Convention on Biological Diversity, Convention to Combat Desertification, Convention on Climate Change.	**06**
07	**Introduction to National Rating System** GRIHA (Green Rating For Integrated Habitat Assessment)**:** An evaluation tool to help design, build, operate, and maintain a resource-efficient built environment. Case studies of GRIHA registered buildings	**06**

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*,WileyIndiaPrivateLtd.New Delhi (2009)
3. Basak, Anindita. *Environmental studies*. Pearson Education India, (2009).

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. *GRIHA Manual Volume 1* - Ministry of New and Renewable Energy, Government of India, New Delhi (2009).
4. ISO 14001:2004(E) - *Environmental management systems Requirements with guidance for use*, (2004).

BTM604 Internal Combustion Engine
Course pre-requisites: BTM305

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

- Understand fundamentals involved in internal engine combustion technology.
- Understand construction and working principle of different types of engines and able to calculate work done and various efficiencies.
- 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 Engine
4. Evaluate the requirements of a modern Engine for better economy and emissions

Course Content:

Module No.	Details	Hrs.
01	Constructional Features of Reciprocating I.C. Engines: Four stroke and two stroke engines. **Types of engines** - Stationary, Automotive, and Marine engines. Comparative study of Two stroke and Four stroke engines ifferent methods of Scavenging and scavenging blowers. Cycle Analysis of I.C. Engines: Variable specific heat and its effect on Air Standard Cycles, Fuel Air Cycles. Dissociation and other losses. Actual cycles.	**04**
02	Carburetion - Theory of Carburetion, Simple carburetor, various systems of actual Carburetor, Types of Carburetors. Ignition System - Battery and Magnetic Ignition Systems. Electronic Ignition System. Combustion: Combustion phenomenon in S.I. Engines, Ignition delay, Velocity of flame propagation, pressure - crank angle diagram, detonation, factors affecting combustion and detonation, types of combustion chambers. Petrol Injection - MPFI etc.	**08**
03	**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, Governor characteristics. **Combustion:** Combustion phenomenon in C.I. Engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers.	**10**

04	Supercharging /Turbo charging: Objectives of Supercharging / Turbo charging. Effect of Supercharging / Turbo charging on power output and efficiency of the engine. Methods of Supercharging / Turbo charging. Types of Superchargers / Turbochargers SA Limit of Supercharging / Turbo charging. 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. Method of determining indicated power of the engine.	**08**
05	Exhaust Gas Analysis and Air Pollution: Necessity of exhaust gas analysis. Constituents of exhaust gas, Orsat apparatus for carrying out exhaust gas analysis. Different methods of determining Air/Fuel ratio. Fuels of I.C. Engines: Requirement of fuels. Classification of hydrocarbon fuels. Physical and Chemical properties of fuels. Rating of Fuels - Octane No., Cetane No. & Performance No. Determination of Octane and Cetane Nos.	**04**
06	Engine Lubrication: Types of lubricants used in I.C. Engines. Properties of Lubricants. SAE Ratings of Lubricants. Types of Lubrication Systems. Engine Cooling: Systems of Cooling - Air, Water-cooling. General arrangements.	**04**
07	Non-Conventional fuels for I.C. Engines. CNG, LPG, Hydrogen, Bio- fuels, alcohol etc. Air Pollution due to engine exhaust. Pollution control devices and EURO standards. Introduction to Stratified Charge and Wankel engines. Recent developments in I. C. Engines	**04**

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." (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).

BTM605 Manufacturing Planning & Control
Course pre-requisites: BTM306, BTM405

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.

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.

BTM625 Introduction to Micro Electro Mechanical Systems

Course pre-requisites: Engineering sciences

Course Objectives

1. To introduce basic concepts of MEMS and its applications.
2. To introduce sensors and actuators in Micro-domain.
3. To study modelling and simulation techniques for various applications.
4. Apply knowledge of micro fabrication techniques and applications to the design and manufacturing of an MEMS device or a micro system

Course Outcomes: Learner will be able to…

1. Select appropriate sensors and actuators for a given MEMS application.
2. Select a micro-fabrication technique for a specific MEMS fabrication process.
3. Model and simulate a given MEMS system
4. Design MEMS

Course content:

Sr.No.	Description	Hrs.
1	**Introduction to MEMS & Applications** • Introduction to Micro-Electro-Mechanical Systems, • Applications and Materials, • Advantages & Disadvantages of Micro-sensors, and micro-actuators.	2
2	**Sensors and Actuators in Micro-domain** • Concept of Sensors & Actuators, • Sensing & Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys • Comb Drive Actuation & Sensing. Micro-mechanisms, Air-Bag Sensors.	2
3	**Fabrication Methods** Microfabrication Methods (VLSI Techniques) • Positive and Negative Photoresists, • Bulk Micromachining, • Surface Micromachining, • Etching (Isotropic and Anisotropic), • Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques.	2
4	**3D High Aspect Ratio Fabrication Techniques** • LIGA, • AMANDA, • Microstereolithography, • IH-Process, • X-Ray Techniques, • Ion-beam Lithography etc	2
5	**Modelling and Simulation Techniques** • Scaling Laws, Governing Equations • Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal Laws, Fluid Flow Analysis.	1
6	**Characterization Techniques** Topography Methods (Optical, Electrical and Mechanical Methods) • Microscopy, STM (Scanning Tunneling Microscopes), • SEM (Scanning Electron Microscopes),SPM (Scanning	2

	ProbeMicroscopes), AFM (Atomic Force Microscopes) Mechanical Structure Analysis	
7	**Introduction to Advances of MEMS and Nanotechnology** • CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, • Nano-mechanical Systems (NEMS), • Domestic and Industrial Applications of nanotechnology • Social and Ethical Implications of nanotechnology in Society	**2**

Recommended Books:

1. Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim "Microsensors MEMS and Smart devices", John Wiley and sons, Ltd.
2. NadimMulaf and Kirt Williams, "An Introduction to Microelectromechanical systems Engineering", Artech House.
3. NicolaeLobontiu and Ephrahim Garcia, "Mechanics of Microelectromechanical systems", Kluwer Academic Publication.
4. Stanley Wolf and Richard Tauber, "Silicon Processing for the VLSI era Volume -1 Technology", Lattice press.
5. Vijay K. Varadan, K.J.Vinoy and S. Gopalkrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies", John Wiley and sons Ltd.
6. Bhushan, "Springer Handbook of Nanotechnology", Springer Inc.

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

BTM626 Advanced Solid Mechanics
Prerequisites: BTM302

Course Objectives:
The objective of this course is to:

- Understand stress and strain in 3-D geometry.
- Get overview of theories of failure.
- Make students able to solve stress analysis problems using computational techniques

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

1. Explain and describe stresses and strains in 3-D
2. Apply theories of failure to address design of mechanical components.
3. Analyze and obtain stresses in non-circular shafts and apply theory of beam on elastic foundation.
4. Evaluate stresses in curved beams and predict buckling failure of columns

Course contents:

Sr.No.	Description	Duration (hrs)
1	Stresses and strains in 3-D – Cauchy Formula, Principal, hydrostatic and deviatoric stresses, stress transformations, strain energy density	2
2	Mohr circle in 3D, Theories of failure, introduction to fracture mechanics	2
3	Torsion of non-circular shaft, torsion of thin box and open sections	2
4	Bending of curved beams, application of theory for design of hooks and chain links	2
5	Columns and failure in buckling mode	2
6	Theory of plates, approximate formulae for bending of rectangular and circular plates	2
7	Thin shells of revolution subjected to pressure loads, application of beam on elastic foundation theory to obtain discontinuity stresses in pressure components	2

Recommended Books:
1. Crandall S. H. *An Introduction to Mechanics of Solids*, Tata McGraw Hill (2017).
2. Srinath L. S. *Advanced Mechanics of Solids*, McGraw Hill (2017).

Term work:
Assignment based on above topics and seminars.

BTM627 Product Lifecycle Management

Course Pre-requisites: knowledge of any CAD software

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.	02
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,	02
Module 03	**TECHNOLOGIES ENABLING PLM** Jupiter Technology, Computer Aided Design (CAD), Computer Aided Engineering(CAE), ALIAS, DFA, DFMA, Virtual Reality etc.	02
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.	02
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	02
Module 06	**Implementation Issues of PLM** Implementation Process, Problems in implementation, Legacy system integration, Management Approach, implementation status in industries, Case study on implementation	02
Module 07	**PLM Integration** PLM+CRM Integration, PLM+MES integration, PLM+ERP integration, Multi CAD integration	02

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 Interna tional Edns, 1999.

References

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

Term Work:

Assignments based on the above topics
Case study based on Industry

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

BTM628 Advanced Heat Transfer
Course pre-requisites: BTM501

Course Objectives:
Upon successful completion of the course, students should be able to
1. Understand modes of heat transfer in Forced and Natural convection,
2. Analyze steady and transient conduction problems,
3. Learn the fundamentals of Laminar and Turbulent boundary condition,
4. Learn and use of boiling and condensation principles in design of equipments,
5. Understand the methods of analyzing heat exchangers,

Course Outcomes:
Upon successful completion of the course, students should be able to
1. Understand different modes of heat transfer and estimate heat transfer by using conduction and convection laws.
2. Apply the knowledge of mathematics, science, and heat transfer to develop the basic understanding of designing of heat exchanger equipments.
3. Use of New technology of heat transfer in design of heat pipe and other thermal equipments.
4. Analyze and evaluate heat transfer in context with conduction, convection, and heat exchangers.

Course Content:

Module No	Details	Hrs.
01	Steady and unsteady heat transfer.	02
02	Flow inside Ducts. Laminar and turbulent boundary condition	02
03	Natural convection and forced convection: Practical applications.	02
04	Advance Heat exchanger like Helical coil heat exchanger Spiral coil heat exchangerplate heat exchangerMicro channel heat exchanger. • Construction • working	02
05	Heat pipe: Construction and working principle.	02
06	Boiling and condensation: Types and applications.	02
07	Pressure drop calculation and heat transfer calculations in heat exchangers.	02

Term work:
At least two 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)

BTM629 Lean and Green Manufacturing
Course pre-requisites: BTM306, BTM405

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-

- Students will learn the basic concepts of Lean manufacturing
- Students will be able to explore the wastes in oganisations as per the Lean principles
- Students will be able to develop the New Process using the VSM
- Students will learn basics of green manufacturing and identify the best practices used in the manufacturing environment

Detailed Syllabus:

Sr. No.	Description	Hrs.
01	**ModuleI: 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;	01
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	01
03	**ModuleIII: 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;	04
04	**ModuleIV: 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.	02
05	**Module V: Lean Sustenance** Human Development for sustainable Lean implementation; Involvement of Employees, Cultural Change; Reviews; Recognition; Improving Targets and Benchmarking the best practices; Road map.	02
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	01

	(Quality Optimization), Lean and Green Construction, Lean Healthcare, Lean in Education system etc. A case study on application of Lean in any sector.	
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	01

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

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

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.

BTM631 Introduction to Computer Integrated Manufacturing
Course pre-requisites: BTM306, BTM405

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	6
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.	6
3.	CELLULAR MANUFACTURING Group Technology(GT), Part Families – Parts Classification and coding – 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	8

	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.	6
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.	8
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.	5
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.	6

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
7.	T-I	1,2
8.	T-II	3,4
9.	End Sem	1 to 7

BTM651 Refrigeration and Air Conditioning laboratory
Course pre-requisites: BTM601

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 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 of air-conditioners.

Course Contents

List of Experiments to be conducted is as follows.

Term Work: Laboratory

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.

BTM654 Internal Combustion Engine Laboratory
Course pre-requisites: BTM604

Course Objectives:
The studentsafter studying these topics should be able to

- Understand fundamentals involved in internal engine combustion technology.
- Understand construction and working principle of different types of engines and able to calculate work done and various efficiencies.
- 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 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.

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.
8) Experimental determination of Air fuel ratio.
9) Exhaust Gas/Smoke analysis of S.I. / C.I. engines
10) Effect of Supercharging on Performance Characteristics of an engine.

FINAL YEAR B.TECH. IN MECHANICAL ENGINEERING

SEMESTER VII AND VIII

YEAR 2017-18

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2017-18

Courses Offered for Final Year B.Tech. in Mechanical Engineering (Semester VII)

Sr. No.	Course Name	Code	Course Plan per Week (Hrs)			Credits	In semester Evaluation (Points)		End Semester Evaluation (Points)		End semester weightage (%)	Term work	Total Points
			L	P	T		T-I	T-II	Points	Time (Hrs)			
Theory Courses													
1	Machine Design -II	BTM701	3	-	2	4	20	20	100	3	60%	50	150
2	Renewable Energy Sources and Utilization	BTM702	3	-	2	4	20	20	100	3	60%	50	150
3	Finite Element Method	BTM703	3	-	2	4	20	20	100	3	60%	50	150
4	Ind. Engineering and Project Management	BTM704	3	-	2	4	20	20	100	3	60%	50	150
Elective Courses - I (Note 1,3)													
5	Business process re-engineering and TQM	BTM707	3	-	2	4	20	20	100	3	60%	50	150
	Computational Fluid Dynamics	BTM708											
	Process Eqpt. Design and Piping Engineering	BTM710											
Project Course													
6	Project Stage I	BTM798	-	-	2+6#	4	@	@	-	-	-	50	50
Value Added Courses (Note 1)													
7	Introduction to Cryogenics	BTM725	2	-	-	2	20	20	100	3	60%	-	100
8	Introduction to Research Methodology	BTM771	1	-	2	2	20	20	100	3	60%	25	125
UG/PG Elective Courses													
9	Stress Analysis	MTMD101	3	-	2	4	20	20	100	4	60%	25	125
Online Courses (Note 2)													
10	Online Course 1	BTM781	-	-	-	0	-	-	-	-	-	-	-
Mandatory Courses: Refer to Mandatory course list in Semester I													
	TOTAL		**15+***	**0**	**12+***	**24+ ***							**800 +***

Note: (1) Department will offer the Value Added and Elective courses in a semester subject to availability of resources and enrollment of minimum 25 students opting for the course. (* additional credits, contact hours and points will depend upon number of value added and Elective courses offered in a particular semester).
(2) Department will offer online course subject to availability of a course on https://swayam.gov.in/ , availability of resources and enrollment of minimum 25 students opting for the course.
(3) Student must choose only one of the elective courses frome those offered by the department in the semester. # For Project course: contact hours = 2 and self-learning hours = 6; @ For project course, in semester evaluation shall include one in-semester presentation.

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2017-18

Courses Offered for Final Year B.Tech. in Mechanical Engineering (Semester VIII)

Sr. No.	Course Name	Code	Course Plan per Week (Hrs)			Credits	In semester Evaluation (Points)		End Semester Evaluation (Points)		End semester weightage (%)	Term work	Total Points
			L	P	T		T-I	T-II	Points	Time (Hrs)			
Theory Courses													
1	Design of Mechanical Systems	BTM801	3	--	2	4	20	20	100	3	60%	50	150
2	CAD/CAM/CIM	BTM802	3	--	2	4	20	20	100	3	60%	50	150
3	Industrial Management, Entrepreneurship and ERP	BTM803	3	--	2	4	20	20	100	3	60%	50	150
Elective Courses - II (Note 1,3)													
4	Industrial Robotics	BTM807	3	-	2	4	20	20	100	3	60%	50	150
	Supply Chain Management	BTM808											
	Automobile Engineering	BTM809											
	Welding Process and Welding Technology	BTM810											
	Power Plant Engineering	BTM811											
Project Course													
5	Project Stage II	BTM898	-	-	2+11#	6.5	@	@	-	-	-	100	100
Value Added Courses (Note 1)													
6	Advanced I.C. Engine	BTM825	1	-	2	2	20	20	100	3	60%	-	100
UG/PG Elective Courses													
7	Air-Conditioning System Design	MTTH211	3	-	2	4	20	20	100	4	60%	25	125
Online Courses (Note 2)													
8	Online Course 1	BTM881	-	-	-	0	-	-	-	-	-	-	-
Mandatory Courses: Refer to Mandatory course list in Semester I													
	TOTAL		**12+***	**--**	**10+***	**22.5+***							**700 +***

Note: (1) Department will offer the Value Added and Elective courses in a semester subject to availability of resources and enrollment of minimum 25 students opting for the course. (* additional credits, contact hours and points will depend upon number of value added and Elective courses offered in a particular semester).
(2) Department will offer online course subject to availability of a course on https://swayam.gov.in/ , availability of resources and enrollment of minimum 25 students opting for the course.
(3) Student must choose only one of the elective courses frome those offered by the department in the semester.
For Project course: contact hours = 2 and self-learning hours = 10; @ For project course, in semester evaluation shall include one in-semester presentation.

BTM701 Machine Design – II
Course pre-requisites: 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 cam and follower mechanisms.	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: Snatch Block assembly of EOT crane and centrifugal pump.	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) Design and detailed assembly drawing on **FULL** imperial 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.

Note:
Use of standard design data books like PSG Data Book, Design Data by Mahadevan is permitted at the examination and shall be supplied by the institute.

Text books:

1. Trikha, S. N. *Machine Design Exercises*. Khanna Publishers, 1966.
2. Bhandari, V. B. *Introduction to machine design*. Tata McGraw-Hill Education, 2013.
3. Norton, Robert L. "Machine design: an integrated approach, 1996."
4. Shigley, Joseph E., Charles R. Mischke, and Richard G.

References:

1. Maitra, Gitin M. *Handbook of gear design*. Tata McGraw-Hill Education, 1994.
2. Rudenko, Nikola Ďeodos′evich, and Nikolaĭ Feodos′evich Rudenko. *Materials handling equipment*. Peace Pubs., 1964.
3. Alexandrov, M. P. *Materials handling equipment*. Mir Pub., 1981.
4. Reshetov, Dmitriĭ Nikolaevich, and Nicholas Weinstein. *Machine design*. 1978.
5. Faires, Virgil Moring. *Design of machine elements*. No. TJ230 F3 1965. 1965.
6. Spotts, Merhyle Franklin. *Design of machine elements*. Pearson Education, 1998.
7. Sahu G.K., *Pumps*, New Age International, 2000.

BTM702 Renewable Energy Sources and Utilization
Prerequisites: 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-Formation and causes of tides, site selection, turbines selection.	08
6	**GEOTHERMAL ENERGY:** History and future, origin and types of geothermal energy regions, dry rock and hot Aquifer analysis, vapor	03

	dominated and liquid nominated geothermal systems, operational and environmental problems.	
7	**BIOMASS ENERGY:** Various forms of biomass as a potential energy 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
25.	T-I	1,2
26.	T-II	3,4
27.	End Sem	1 to 7

BTM703 Finite Element Analysis
Prerequisites: BTM301, BTM401, 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 FEAnalysis, 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) Concepts & Applications of Finite Element Analysis by R.D.Cook.
2) Bathe, K.J., Finite Element Procedures in Engineering Analysis, *Prentice Hall of India.*
3) Finite Elements Analysis , C.S.Krishnamoorthy, *Tata McGrawHill* .
4) The Finite Element Method in Engineering , 4th Edition, S.S.Rao, *Academic Press, Elsevier*
5) *Introduction to Finite Elements Methods by Desai and Abel, CBS Publication.*

BTM704 Industrial Engineering and Project Management
Course pre-requisites: 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.

BTM707 Business Process Reengineering and Total Quality Management

Prerequisites: 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	6

	Benefits	

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.

BTM708 Computational Fluid Dynamics
Pre-requisites: BTM305, BTM403, 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	06

	of Pressure for Viscous Flow, SIMPLE, SIMPLER and PISO Algorithm	
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
28.	T-I	1,2
29.	T-II	3,4
30.	End Sem	1 to 7

BTM710 Process Equipment Design and Piping Engineering
Pre-requisites: BTM302, 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

5. Explain and interpret essential design documents such as PFD, P&ID, vessel specification
6. Calculate size of major process equipment and piping components using design rules as well as IT tools.
7. Design of pressure vessels, heat exchangers and piping as engineering systems.
8. 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 codes associated to piping

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, equipment layout drawing, Design codes and standards, Process equipment and piping components	4
2	**Materials of Construction and Fabrication** Material classification and selection of material for various processes, Preparation of Material Specification Sheets. Review of fabrication, inspection and testing methods	6
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	6
5	**Design of supports** for tall vertical vessels; skirt support subjected to wind and seismic loads, design of saddle supports for horizontal vessels. **Elementary heat exchanger design**. Tubesheet thickness calculations, baffle plate design	6

6	**Design of Pipes and Pipe Fittings** Pipe specification, Line designation list, Calculations for piping and pipeline sizing, Pressure drop in pipelines, piping and pipeline pressure integrity regarding thickness, including straight pipe, curved pipe, and intersections. Design of branch pipe and miter bends.	6
7	**Pipe Supports and Flexibility** Study and selection of various types of pipe supports. Design considerations, supporting span of overhead pipelines. Calculations for occasional loadings such as wind and earthquake. Piping flexibility, Stress Intensification Factors and Flexibility Factors for pipe fittings, piping reactions for sustained, thermal and occasional loading.	6

Recommended Books:

3. Brownell, Lloyd E., and Edwin H. Young. *Process equipment design: vessel design*. John Wiley & Sons, 1959.
4. Harvey, John F., and H. Saunders. "Theory and design of pressure vessels.", Van Nostrand Reinhold Company, 1987.
5. Mahajan, Kanti K. "Design of process equipment: selected topics.", Pressure Vessel Handbook Pub, 1992.
6. MW Kellogg Co. *Design of Piping Systems*. Wiley, 1961.
7. Silowash, Brian. *Piping systems manual*, McGraw Hill Professional, 2009.

Term work:

Assignment based on above topics.

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

BTM725 Introduction to Cryogenics
Pre-requisites: BTM305, BTM501

Course Objectives:

The objective of this course is to:

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

Course Outcomes:

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

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

Course Contents:

Module No.	Details	Hrs.
1.	**Introduction to Cryogenic Engineering:** Introduction, Historical background, Developments, Scope of application, Present areas involving Cryogenic Engineering, Principles of Thermodynamics, Heat Transfer, Momentum Transfer, Cool down.	02
2.	**Low Temperature Properties of Engineering Materials:** **Properties of Solids:-**Mechanical Properties, Thermal Properties, Electrical and Magnetic Properties of solids including metals and non-metals (insulators), Design considerations, Material selection criterion for Cryogenic Applications. **Cryogenic Fluids: -** P-V-T Behaviour of a Pure substance, T-s and T-h diagrams of a Pure substance, Properties of cryogenic fluids:- Fluids other than Hydrogen and Helium, Hydrogen , Helium.	04

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

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

Recommended Books :

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

BTM771 Introduction to Research Methodology
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:

1. Students will be able to understand the basics of Research Methodology
2. Students will be able to understand the Tools and techniques in Research Methodology
3. Students will be able to use the knowledge of data collection methods
4. Students will be able to 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

BTM798 Project Stage I
Course pre-requisites: 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 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)**

BTM801 Design Of Mechanical System
Prerequisites: BTM602, 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
1. To 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. To compare and evaluate available design alternatives and to select the most suitable one to fulfil technical requirements of the system
3. To discuss and review the design features and requirements of different mechanical systems
4. To 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	Introduction to centrifugal pump and positive displacement pump such as gear pump, vane pump, etc.	4
5	Design of main components of centrifugal pump - Motor selection, Suction and delivery pipe, Impeller, Impeller shaft, Volute casing. (system design approach)	8
6	Design of main component of gear pump – Motor selection, Gear design, Shaft design and bearing selection, Casing and bolt design, Suction and delivery pipe.	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.

NOTE:

Use of standard design data books like PSG Data Book, Design Data by Mahadevan is permitted at the examination and shall be supplied by the college.

Text Books:

1. Shigley, Joseph E., Charles R. Mischke, and Richard G. Budynas.*Mechanical engineering design*. McGraw-Hill,, 2004.
2. Bhandari, V. B. *Design of machine elements*. Tata McGraw-Hill Education, 2010.
3. Data, Design. "PSG College of Technology." (1994).

References

1. Johnson, Ray C. "Mechanical design synthesis with optimization applications." (1971).
2. Dieter, George Ellwood, and Linda C. Schmidt. *Engineering design*. Vol. 3. New York: McGraw-Hill, 2013.
3. Basu, Saroj Kumar, and D. K. Pal. *Design machine tools*. New Delhi etc: Oxford a. IBH publ. co, 1989.
4. Mehta, N. K. *Machine tool design*. Tata McGraw-Hill Education, 2012.
5. PATIL, SP. *Mechanical System Design,* JAICO students Ed., 2014.
6. Rudenko, Nikola Ғeodos′evich, and Nikolaĭ Feodos′evich Rudenko. *Materials handling equipment*. Peace Pubs., 1964.
7. Sahu G.K., *Pumps*, New Age International, 2000.

BTM802 Computer Aided Design/Computer Aided Manufacturing /Computer Integrated Manufacturing
Prerequisites: BTM303, BTM306, BTM405

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

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 Content:

Sr. No.	Details	Hrs.
Module 01	**INTRODUCTION & ELEMENTS OF INTERACTIVE COMPUTER GRAPHICS** The Design process, the role of modeling & communication, modeling using CAD, Product life cycle & CAD/ CAM, 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.	**07**

Module 02	**TECHNIQUES FOR GEOMETRIC MODELING:** Graphic standards, The parametric representation of geometry, Bezier curves, Cubic Spline curve, B-Spline curve, 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.	**06**
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. 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	**08**
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	**08**
Module 05	**TRANSFORMATION, MAINPULATION & DATA STORAGE** 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.	**03**
Module 07	**EMERGING AREAS in CAD/CAM & ITS INTEGRATION SCENARIOS WITH OTHER INFORMATION TECHNOLOGIES** Virtual Prototyping, Design for Manufacturing, Design for Assembly and Dis- Assembly, Reverse Engineering and Data Capture techniques, Artificial Intelligence in Design & Manufacturing, Representation of Knowledge, and Knowledge base Engineering (KBE). Green Manufacturing, Virtual Reality(VR), Product Life Cycle Management (PLM), CAD-VR Integration, CAD-PLM Integration	**04**

NOTE:

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

TERM WORK:

Term work shall consist of class assignments, 3D modeling on any advanced CAD Package, C++ Programming for transformations & Algorithms, 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. David L. Goetsch, Fundamental of CIM technology ,Delmar publication
9. David Bedworth, Computer Integrated Design and Manufacturing, *McGraw Hill.*
10. "CNC Machines" by B.S. Pabla and M. Adithan, *New Age International Publishers.*
11. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
12. "CNC Technology and Programming", Krar, S., and Gill, A., *McGraw Hill publishers*
13. "Flexible Manufacturing Systems" by H.K. Shivanand, M.M. Benal, V.Koti, *New Age International Publishers*
14. "Automation, Production Systems and Computer Integrated Manufacturing ", Groover M.P., *Prentice-Hall of India Pvt. Ltd*
15. "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*

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, Organizing-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,	06

	Process and Techniques, Leadership, Motivation and Morale – Significance and Theories, Dynamics of Change Management, Stress Management, Work Groups Management, Management of Organizational Conflicts and Negotiations , Inter Personal Behavior, 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, Entrepreneur 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 Labor 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.

BTM807 Industrial Robotics

Prerequisites: BTM402, BTM502, 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,	6

	Robotic Cell Design & Control.	
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).

BTM808 Supply Chain Management
Prerequisites: 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**: 2.1 Planning and Sourcing Demand forecasting ,Pricing and Promotional Impacts on demand, CPFR Concepts, CODP Concepts, Consensus Forecasting, Demand and Pricing Optimization 2.2 Making and Delivering 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 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	05

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.

BTM809 Automobile Engineering

Prerequisites: 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 content:

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 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. **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.	**06**
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)

5. Study of ignition and charging system.
6. Study of starting system, lighting system and battery.
7. Study of suspension system.
8. Study of basic dimension and vehicle layout.
9. Study of computer control engine.
10. Study of wheels and tiers.
11. Study of vehicle maintenance.
12. Study of different drives.
13. Study of steering system.

Term work :

Term work shall consists 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.

BTM810 Welding Process and Welding Technology

Prerequisites: BTM304, BTM306, 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,	09
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.	08

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)

BTM811 Power Plant Engineering
Prerequisites: BTM305, BTM504

Course Objectives:

The objectives of this course are:

1. To outline and explain different types of practical power generation systems with economics involved.
2. To explain fundamental principles, detailed features of arrangements and operation of various power generation systems in use.
3. To explain impact of power generation technologies on environment and illustrate methods adapted for improving efficiency and reducing the environmental impact.
4. To develop understanding for the power generation scenario in the country.

Course Outcomes:

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

1. To explain and exemplify different types of practical power generation systems and understand cost economics involved with them.
2. To explain, discuss and compare principles, detailed features of arrangements and operation of various power generation systems in use with related technologies.
3. To explain and evaluate impact of power generation technologies on environment and adapt techniques for improving efficiency and reducing the environmental impact.
4. To develop understanding for the power generation scenario and apply the acquired knowledge to analyze and evaluate the problems related to power plants.

Course Contents:

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.	06
2.	**Hydro Power Plants:** Rainfall, Runoff and its measurement, Hydrograph, Flow Duration Curve, Mass Curve and Reservoir Storage Capacity. Classification of the 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 Fast Breeder Reactors, Reactor Control.	06
5.	**Diesel and Gas Turbine Power Plants:** General Layout, Applications of Diesel Power Plant, Advantages and Disadvantages, Components, Performance of Gas Turbine Power Plant, Gas Turbine Material, Current Scenario and Future Scope for GT Power Plants.	06
6.	**Combined Cycle Power Generation:** Thermodynamics of Coupled Cycle and Combined Cycle Plant and GT-ST plant operation, Advantage, Base Load Plants. Peak Load Plants. Co-ordination of different types of Power Plants.	06
7.	**Environmental Impact of Power Plants:** Social and economical issues of the power plants, Greenhouse effect, Acid precipitation- Acid Rain and Acid Snow, Dry deposition and acid fog, Thermal pollution, Air Pollution, Radiation, from Nuclear Power Plant efforts. Coal storage, In-plant handling of coal, Ash handling systems. Dust collectors. Flue gas, desulfurization methods. Power Generation: Global and Indian Scenario.	06

Text Books:

4. Nag, P. K., *Power Plant Engineering*. Tata McGraw-Hill Education, 2002.
5. Morse, Frederick T., *Power plant engineering*, Van Nostrand, 1963.
6. Domkundwar, A. S., *Power Plant Engineering*, Dhanpat Raj & Sons, India, 2000.
7. Sharma, P. C. *Power Plant Engineering*. SK Kataria and Sons, 2009.
8. Rajput, R. K., *Power Plant Engineering*, Laxmi Publication (P) Ltd, 1995.

Reference Books:

4. Potter, Philip J. *Power plant theory and design*. Ronald Press Company, 1959.
5. Weisman, Joel, and Eckart Roy. *Modern Power Plant Engineering*, 1985.
6. Bennet, John Donald and Thomson James Robert, *The Elements Of Nuclear Power*, 1989.
7. Elliott, Thomas C., *Standard Handbook of Power Plant Engineering*, 1989.

BTM825 Advanced I.C. Engines
Prerequisites: BTM604

Course Objectives:

The students after studying these topics should be able to

- Understand fundamental designs of I. C. engine components.
- Learn and analysis the emission problems of I. C. engines
- Understand the performance of I. C. engines.
- Understand and analyse the fuel characteristics 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	Design of I C engine components. Design of combustion chamber	**02**
02	Effect of fuel characteristic on engine performance. Introduction of biodiesel in the engines. Performance and emission analysis of I. C. Engines.	**02**
03	Detailed study on Bharat stage III and IV – change in diesel engine and diesel fuel. Factors affecting combustion phenomenon. Engine Modification for alternative fuels**.**	**02**
04	Homogeneous charge compression ignition engine. Variable compression engines.	**02**
05	Advance supercharger and Turbocharger	**02**
06	MPFI system and direct injections	**02**
07	Hybrid electric technology	**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).

BTM898 Project Stage II
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) + 11 (self-study)**