Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

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Proposed Course Contents for

B. Tech. in Production Engineering

w.e.f. June 2019

From 3rd Semester - 6th Semester

Vision

The vision of the department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need based research and extension.

Graduate Attributes

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities

and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO1	Graduates should excel in engineering positions in industry and other organizations that emphasize design and implementation of engineering systems and devices.
PEO2	Graduates should excel in best post-graduate engineering institutes, reaching advanced degrees in engineering and related discipline.
PEO3	Within several years from graduation, alumni should have established a successful career in an engineering-related multidisciplinary field, leading or participating effectively in interdisciplinary engineering projects, as well as continuously adapting to changing technologies.
PEO4	Graduates are expected to continue personal development through professional study and self-learning.
PEO5	Graduates are expected to be good citizens and cultured human beings, with full appreciation of the importance of professional, ethical and societal responsibilities.

Program Outcomes

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

PO1	Apply knowledge of mathematics, science and engineering to analyze, design and evaluate mechanical components and systems using state-of-the-art IT tools.
PO2	Analyze problems of production engineering including manufacturing and industrial systems to formulate design requirements.
PO3	Design, implement and evaluate production systems and processes considering public health, safety, cultural, societal and environmental issues.
PO4	Design and conduct experiments using domain knowledge and analyze data to arrive at valid conclusions.
PO5	Apply current techniques, skills, knowledge and computer based methods and tools to develop production systems.
PO6	Analyze the local and global impact of modern technologies on individual organizations, society and culture.
PO7	Apply knowledge of contemporary issues to investigate and solve problems with a concern for sustainability and eco-friendly environment.
PO8	Exhibit responsibility in professional, ethical, legal, security and social issues.
PO9	Function effectively in teams, in diverse and multidisciplinary areas to accomplish common goals.
PO10	Communicate effectively in diverse groups and exhibit leadership qualities.
PO11	Apply management principles to manage projects in multidisciplinary environment.
PO12	Pursue life-long learning as a means to enhance knowledge and skills.

Abbreviations

PEO:	Program Educational Objectives
PO:	Program Outcomes
CO:	Course Outcomes
L:	No. of Lecture hours (per week)
T:	No. of Tutorial hours (per week)
P:	No. of Practical hours (per week)
C:	Total number of credits
BSH:	Basic Science and Humanity
BSC:	Basic Sciences Course
PCC:	Professional Core Course
OEC:	Open Elective Course
PEC:	Professional Elective Course
BHC:	Basic Humanity Course
ESC:	Engineering Science Course
HSMC:	Humanity Science and Management Course
NCC:	National Cadet Corps
NSS:	National Service Scheme
CA:	Continuous Assessment
MSE:	Mid Semester Exam
ESE:	End Semester Exam

B. Tech. Production Engineering

Course Structure for Semester III [Second Year] w.e.f. 2018-2019

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTBSC301	BSC 7	Engineering Mathematics-III	3	1	--	20	20	60	100	4
BTMEC302	ESC 11	Materials Science and Metallurgy	3	1	--	20	20	60	100	4
BTMEC303	PCC 1	Fluid Mechanics	3	1	--	20	20	60	100	4
BTMEC304	PCC 2	Machine Drawing and CAD	2	--	--	20	20	60	100	2
BTPRC305	PCC 3	Theory of Machines	2	1	--	20	20	60	100	3
BTHM3401	HSMC 3	Basic Human Rights	2	--	--	50	--	--	50	Audit (AU/NP)
BTPRL307	ESC 12	Materials Science and Metallurgy Lab	--	--	2	60	--	40	100	1
BTPRL308	PCC 4	Fluid Mechanics Lab	--	--	2	60	--	40	100	1
BTPRL309	PCC 5	Machine Drawing and CAD Lab	--	--	4	60	--	40	100	2
BTPRL310	PCC 6	Theory of Machines Lab	--	--	2	60	--	40	100	1
BTPRF311	Project 1	Field Training /Internship/Industrial Training I	--	--	--	--	--	50	50	1
		Total	15	4	10	390	100	510	1000	23

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Course Structure for Semester IV [Second Year] w.e.f. 2018-2019

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTPRC401	PCC 7	Casting &Moulding Technology	2	1	--	20	20	60	100	3
BTPRC402	PCC 8	Engineering Thermodynamics & Heat Transfer	3	1	--	20	20	60	100	4
BTMEC403	PCC 9	Strength of Materials	3	1	--	20	20	60	100	4
BTMEC404	BSC 8	Numerical Methods in Mechanical Engineering	2	1	--	20	20	60	100	3
BTID405	PCC 10	Product Design Engineering - I	1	--	2	60	--	40	100	2
BTBSE406A	OEC 1	Physics of Engineering Materials	3	--	--	20	20	60	100	3
BTBSE3405A		Advanced Engineering Chemistry								
BTHM3402		Interpersonal Communication Skill& Self Development								
BTPRL407	PCC 11	Production Processes Lab - I	--	--	2	60	--	40	100	1
BTPRL408	PCC 12	Engineering Thermodynamics & Heat Transfer Lab	--	--	2	60	--	40	100	1
BTPRL409	PCC 13	Strength of Materials Lab	--	--	2	60	--	40	100	1
BTPRL410	BSC 9	Numerical Methods Lab	--	--	2	60	--	40	100	1
		Total	14	4	10	400	100	500	1000	23
Minimum 4 weeks training which can be completed partially in third and fourth semester or in at one time.										

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Course Structure for Semester V [Third Year] w.e.f. 2019-2020

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTPRC501	PCC 14	Design of Machine Elements	3	1	--	20	20	60	100	4
BTPRC502	PCC 15	Joining Technology	2	1	--	20	20	60	100	3
BTPRC503	PCC 16	Metal Forming Processes	2	1	--	20	20	60	100	3
BTPRC504	PCC 17	Machine Tools and Metal Cutting	3	1	--	20	20	60	100	4
BTMEC505	PCC 18	Metrology and Quality Control	2	1	--	20	20	60	100	3
BTID506	PCC 19	Product Design Engineering - II	1	--	2	60	--	40	100	2
BTMEC506A	OEC 2	Automobile Engineering	3	--	--	--	--	--	--	Audit (AU/NP)
BTMEC506B		Nanotechnology								
BTMEC506C		Energy Conservation and Management								
BTPRL507	PCC 20	Machine Design Practice	--	--	2	30	--	20	50	1
BTPRL508	PCC 21	Production Processes Lab - II	--	--	2	30	--	20	50	1
BTPRL509	PCC 22	Mechanical Measurement & Metrology Lab	--	--	2	30	--	20	50	1
BTPRF510	Project 2	Field Training /Internship/Industrial Training II	--	--	--	--	--	50	50	1
		Total	16	5	8	250	100	450	800	23

B. Tech. Production Engineering

Course Structure for Semester VI [Third Year] w.e.f. 2019-2020

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTPRC601	PCC 23	CAD/CAM/CIM	3	1	--	20	20	60	100	4
BTPRC602	PCC 24	CNC Machines & Programming	2	1	--	20	20	60	100	3
BTPRC603	PCC 25	Industrial Engineering & Management	2	1	--	20	20	60	100	3
BTPRC604A	PEC 1	Flexible Manufacturing Systems	2	1	--	20	20	60	100	3
BTPRC604B		Production Planning and Control								
BTPRC604C		Assembly Planning & Management								
BTPRC604D		Supply Chain Management								
BTMEC605A	OEC 3	Quantitative Techniques in Project Management	3	--	--	20	20	60	100	3
BTMEC605B		Sustainable Development								
BTMEC605C		Renewable Energy Sources								
BTMEC606A	OEC 4	Biology for Engineers	3	--	--	--	--	--	--	Audit (AU/NP)
BTMEC606B		Solar Energy								
BTMEC606C		Human Resource Management								
BTPRL607	PCC 26	Metal Cutting Lab	--	--	2	30	--	20	50	1
BTPRL608	PCC 27	CAD/CAM/CIM Lab	--	--	2	30	--	20	50	1
BTPRL609	PCC 28	CNC Machines & Programming Lab	--	--	2	30	--	20	50	1
BTPRM610	Project 3	Technical Project for Community Services	--	--	4	30	--	20	50	2
		Total	15	4	10	220	100	380	700	21

Semester III

Engineering Mathematics-III

BTBSC301	BSC 7	Engineering Mathematics-III	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	
CO7	
CO8	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												
CO7												
CO8												

Course Contents:

Unit 1: Laplace Transform[07 Hours]

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n, scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

Unit 2: Inverse Laplace Transform[07 Hours]

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding

inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

Unit 3: Fourier Transform [07 Hours]

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms ; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

Unit 4: Partial Differential Equations and Their Applications [07 Hours]

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation $\left(\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}\right)$, and two dimensional heat flow equation (i.e. Laplace equation : $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$).

Unit 5: Functions of Complex Variables (Differential calculus)[07 Hours]

Limit and continuity of f(z); Derivative of f(z) ; Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form;Mapping: Translation, magnification and rotation, inversion and reflection , bilinear transformation; Conformal mapping.

Unit 6: Functions of Complex Variables (Integral calculus)[07 Hours]

Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs).

Text Books:

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
3. A Course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledge ware, Mumbai.
4. A Text Book of Applied Mathematics (Vol I & II) by P. N. Wartikar and J. N. Wartikar, Pune VidyarthiGrihaPrakashan, Pune.
5. Higher Engineering Mathematics by H. K. Das and Er. RajnishVerma, S. Chand & CO. Pvt. Ltd., New Delhi.

Reference Books:

1. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd., Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-HillPublishing Company Ltd., New Delhi.
4. Integral Transforms and Their Engineering Applications by Dr. B. B. Singh, Synergy. Knowledge ware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill, New York.

General Instructions:

1. The tutorial classes in Engineering Mathematics-III are to be conducted batch-wise. Each class should be divided into three batches for the purpose.
2. The Continuous Assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

Material Science and Metallurgy

BTMEC302	ESC 11	Materials Science and Metallurgy	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Study various crystal structures of materials
CO2	Understand mechanical properties of materials and calculations of same using appropriate equations
CO3	Evaluate phase diagrams of various materials
CO4	Suggest appropriate heat treatment process for a given application
CO5	Prepare samples of different materials for metallography
CO6	Recommend appropriate NDT technique for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1									
CO2	3	2	2	3	2							
CO3	2	1	2	1	1							
CO4	1	2	2	1	2	1	2	1	1	1		
CO5	1	1	1	3	2		1		1			
CO6	1	1	2	2	2	1	2		1	1		

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Structure of Materials[08 Hours]
Crystal structures, indexing of lattice planes, Indexing of lattice directions, Imperfections in crystals-point defects, line defects, surface and bulk defects, Mechanism of plastic deformation, deformation of single crystal by slip, plastic deformation of polycrystalline materials.

Unit 2: Mechanical Properties and their Testing[08 Hours]
Tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, bend test, torsion test, formability, hardness testing, different hardness tests-Vickers, Rockwell, Brinnel, Impact test, fatigue test, creep test.

Unit 3: Equilibrium Diagrams[09 Hours]
Definitions of terms, rules of solid-solubility, Gibb's phase rule, solidification of a pure metal, plotting of equilibrium diagrams, lever rule, Iron-iron carbide equilibrium diagram, critical temperatures, solidification and microstructure of slowly cooled steels, non-equilibrium cooling of steels, property variation with microstructures, classification and application of steels, specification of steels, transformation products of austenite, TTTdiagram, critical cooling rate, CCT diagram.

Unit 4: Heat Treatment[07 Hours]
Heat treatment of steels, cooling media, annealing processes, normalizing, hardening, tempering, quenching and hardenability, surface hardening processes-nitriding, carbo-nitriding, flame hardening, induction hardening.

Unit 5: Metallography[08 Hours]
Microscopy, specimen preparation, polishing abrasives and cloths, specimen mounting, electrolytic polishing, etching procedure and reagents, electrolytic etching, optical metallurgical microscope, macroscopy, sulphur printing, flow line observations, examination of fractures, spark test, electron microscope.

Unit 6: Strengthening Mechanisms and Non-destructive Testing[08 Hours]
Refinement of grain size, cold working/strain hardening, solid solution strengthening, dispersion strengthening, Precipitation hardening. Magnetic particle inspection, dye Penetrant inspection, ultrasonic inspection, radiography, eddy current testing, acoustic emission inspection.

Texts:

1. V. D.Kodgire, S.V.Kodgire, "Material Science and Metallurgy for Engineers", Everest Publishing House, Pune, 24th edition, 2008.
2. W. D.Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, 5th edition,2001.
3. V.Raghvan, "Material Science Engineering", Prentice Hall of India Ltd., 1992.
4. S. H.Avner, "Introduction to Physical Metallurgy", Tata McGraw Hill, 2ndedition, 1997.
5. R. A.Higgins, "Engineering Metallurgy: Part I", ELBS, 6th edition, 1996.

References:

1. V. B.John, "Introduction to Engineering Materials", ELBS, 6thedition, 2001.
2. G. F.Carter, D. E.Paul, "Materials Science and Engineering", ASM International, 3rd edition, 2000.
3. T. E.Reed-Hill, R.Abbaschian, "Physical Metallurgy Principles", Thomson, 3rdedition, 2003.

Fluid Mechanics

BTMEC303	PCC 1	Fluid Mechanics	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**

Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Define fluid, define and calculate various properties of fluid
CO2	Calculate hydrostatic forces on the plane and curved surfaces and explain stability of floating bodies
CO3	Explain various types of flow. Calculate acceleration of fluid particles
CO4	Apply Bernoulli's equation and Navier-Stokes equation to simple problems in fluid mechanics
CO5	Explain laminar and turbulent flows on flat plates and through pipes
CO6	Explain and use dimensional analysis to simple problems in fluid mechanics
CO7	Understand boundary layer, drag and lift

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							1
CO2	3	3	1	1	1							1
CO3	3	3	1	1	1							1
CO4	3	3										1
CO5	3	3										1
CO6	2	3										1
CO7	2	3										1

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Basics[08 Hours]

Definition of fluid, fluid properties such as viscosity, vapour pressure, compressibility, surface tension, capillarity, Mach number etc., pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, pressure measurement by simple and differential manometers using manometric expression.

Unit 2: Fluid Statics[08 Hours]

Hydrostatic forces on the plane and curved surfaces, centre of pressure, Buoyancy, centre of buoyancy, stability of floating bodies, metacentre and metacentric height its application in shipping.

Unit 3: Fluid Kinematics[08 Hours]

Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate freeform, acceleration of fluid particle, rotational and irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function, flownet.

Unit 4: Fluid Dynamics[08 Hours]
Momentum equation, development of Euler's equation, Introduction to Navier-Stokes equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venturimeter, orificemeter, rectangular and triangular notch, pitot tube, orifices, etc.

Unit 5: Types of Flow[08 Hours]
a) Laminar Flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, loss of head due to friction in viscous flow.
b) Turbulent Flow: Reynolds's experiment, frictional loss in pipe flow, shear stress in turbulent flow, major and minor losses, HGL and TEL, flow through series and parallel pipes.

Unit6: Dimensional Analysis[08 Hours]
a) Dimensional Analysis: Dimensional homogeneity, Raleigh's method, Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers.
b) Introductionto boundary layer theory and its analysis.
c) Forces on Submerged bodies: Drag, lift, Drag on cylinder, Development of lift in cylinder.

Texts:

1. P. N. Modi, S. M. Seth, "Fluid Mechanics and Hydraulic Machinery", Standard Book House, 10th edition,1991.
2. Robert W. Fox, Alan T. McDonald, "Introduction to Fluid Mechanics", John Wile and Sons, 5thedition.

References:

1. V. L. Streeter, K. W. Bedfordand E. B. Wylie, "Fluid Dynamics", Tata McGraw-Hill, 9thedition, 1998.
2. S. K. Som, G.Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2ndedition, 2003.

Machine Drawing and Computer Aided Drafting

BTMEC304	PCC 2	Machine Drawing and Computer Aided Drafting	2-0-0	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Interpret the object with the help of given sectional and orthographic views.
CO2	Construct the curve of intersection of two solids
CO3	Draw machine element using keys, cotter, knuckle, bolted and welded joint
CO4	Assemble details of any given part. i. e. valve, pump , machine tool part etc.

CO5	Represent tolerances and level of surface finish on production drawings
CO6	Understand various creating and editing commands in Auto Cad

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2								3	2		1
CO2	2	1							2	1		1
CO3	2								2	1		
CO4	2	2			1				2	1		1
CO5	1	1			1				2	1		1
CO6	1	1			1				2	2		1

Course Contents:

Unit 1: Sectional Views[04 Hours]
Full section, half section, partial section, off-set section, revolved sections, removed sections, auxiliary section, guidelines for hatching, examples on all above types of sections of machine elements.

Unit 2: Study of Machine Elements[04 Hours]
Study of simple machine elements and components such as screwed fasteners, shaft couplings, pipe joints, riveted and welded joints, bearings, gears, etc.

Unit 3: Interpenetration of Surfaces (Emphasis on Applied Cases)[04 Hours]
Line or curve of intersection of two penetrating cylinders, Cone and cylinder, prism and a cylinder, cone and prism, Forged ends, etc.

Unit 4: Drawing of Assembly and Details[04 Hours]
Part drawing of standard machine components such as valves, components of various machine tools, pumps, shaft couplings, joints, pipe fittings, engine parts, etc.

Unit 5: Production Drawing and Reading Blue Prints[04 Hours]
Types of production drawings, size, shape and description; limits, fits and tolerances, surface roughness and surface roughness symbols, reading the blue prints.

Unit 6: Computer Aided Drafting[04 Hours]
Introduction to Computer Aided Design and Drafting, Advantages of CADD, study of preliminary AutoCAD commands like drawing, dimensioning, viewing commands. Drawing 3D views in AutoCAD, Introduction to AutoLISP programming.

Texts:

1. N. D. Bhatt,"Engineering Drawing", Charotar Publishing House, Anand, India.
2. N. D. Bhatt, "Machine Drawing", Charotar Publishing House, Anand, India.
3. Ajeet Sing, "Working with AutoCAD 2000", Tata McGraw Hill, New Delhi.
4. George Omura, "ABC of AutoLISP", BPB Publications, New Delhi.

References:

1. Narayana, Kannaiah, Reddy, "Machine Drawing", New Age International Publishers.
2. AutoCAD and AutoLISPmanuals from Autodesk Corp. U.S.A.
3. ISCode: SP46-1988, Standard Drawing Practices for Engineering Institutes.

Theory of Machines

BTPRC305	PCC 3	Theory of Machines	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: Engineering Mechanics

Objectives: To understand commonly used mechanisms for industrial applications, develop competency in drawing velocity and acceleration diagrams for simple and complex mechanisms and to understand the concepts of motion transmission elements.

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

CO1	Define basic terminology of kinematics of mechanisms.
CO2	Classify planar mechanisms and calculate its degree of freedom.
CO3	Perform kinematic analysis of a given mechanism using ICR and RV methods.
CO4	Perform kinematic analysis of a given mechanism analytically using vector or complex algebra method.
CO5	Perform kinematic analysis of slider crank mechanism using Klein's construction and analytical approach.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				1								1
CO2				1								1
CO3	1	1		2								1
CO4	1	1		2								1
CO5	1	1		2								1

Course Contents:

Unit 1: Fundamentals of Kinematics and mechanisms[06 Hours]

Kinematic Link, Kinematic Pair, Kinematic chain, Structure, mechanism, machine, Types of Constrained Motions, Degrees of Freedom, Grubler's Criterion for Plane Mechanisms, Equivalent linkage Mechanism, Inversions of Four Bar Chain, Single Slider Crank Chain, Double Slider Crank Chain Difference between Spatial and Planner Mechanism. Pantograph, Straight Line Motion mechanisms.Hooke's Joint / Universal Joint.

Unit 2: Velocity and Acceleration Analysis in Mechanisms[06 Hours]
Relative Velocity (Velocity polygon) for Kinematic link.Acceleration Diagram for a Link.Corioli's component of Acceleration.Velocity and acceleration in a Slider Crank Mechanism by Klein's construction.Instantaneous Centre of Rotation (ICR).Angular Velocity Ratio Theorem, Methods of Locating ICR in a Mechanism.Velocity analysis of a Kinematic Link by ICR Method, Body and Space centrode.

Unit 3: Static and Dynamic Force Analysis[06 Hours]
Introduction, Static Equilibrium, Equilibrium of Two Force and Three-Force Members, Resultant effect forces acting on a rigid body, D'Alembert's Principle, Equivalent Dynamic System, Compound Pendulum, Bifilar and Trifilar suspension methods. Static and Dynamic Analysis of inertia forces of Slider-Crank Mechanism by analytical and graphical method.

Unit 4: Friction and Lubrication[06 Hours]
Introduction, Types of Friction, Limiting Friction, Laws of Friction, Coefficient of Friction, Limiting Angle of Friction, Screw Friction, Screw Jack, Torque required to lift and lower the load by a Screw Jack, Efficiency of a Screw Jack, Over Hauling and Self Locking Screws, Efficiency of Self Locking Screws, Rolling Friction, Film Friction, Principles of Thick and Thin Film Lubrication, principles of hydrostatic and hydrodynamic lubrication.

Unit 5: Belt and Chain Drives[06 Hours]
Introduction, Selection of a Belt Drive, Flat and V Belt Drives, Open and cross Belt Drive. Materials used for Belts, Velocity Ratio of Belt Drive, Limiting tension ratio, Slip of Belt, Creep of Belt, Length of Flat Belts, Angle of Contact, Power Transmitted by a Belt, Maximum Power Transmitted by a Belt, Centrifugal Tension and its effect on power transmission. Initial Tension in the Belt, Design of Belt Dimensions, Chain Drive, Advantages and disadvantages of Chain drives, Terms used in Chain Drive, Angular Velocity of the Sprocket.

Unit 6: Introduction to Gears and Governors[06 Hours]
Classification, Terminology, Gear Characteristics, Gear Calculations, Gear Tooth Systems, Gear Tooth Profiles, Gear Materials, Law of Gearing, , Gear trains and its types, Calculation of velocity ratio for different gear trains, Gear Trains with bevel gears: Differential Gear Box. Governors: Introduction, Types of governors, Terms used in Governor, Sensitiveness, Stability and Hunting of Governor, Isochronous Governor, Governor effort and Governor power.

Texts:

1. A. Ghosh, A. K. Malik, "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi.
2. S. S. Rattan, "Theory of Machines", Tata McGraw Hill, New Delhi.

References:

1. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors, Delhi.
2. J. E. Shigely, J. J. Uicker, "Theory of Machines and Mechanisms", Tata McGraw Hill Publications, New York, International Student Edition, 1995.

Basic Human Rights

BTHM3401	HSMC 3	Basic Human Rights	2-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Understand the history of human rights.
CO2	Learn to respect others caste, religion, region and culture.
CO3	Be aware of their rights as Indian citizen.
CO4	Understand the importance of groups and communities in the society.
CO5	Realize the philosophical and cultural basis and historical perspectives of human rights.
CO6	Make them aware of their responsibilities towards the nation.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2						
CO2												
CO3												
CO4									3			
CO5								2		2		
CO6												1

Course Contents:

Unit 1: The Basic Concepts[04 Hours]
Individual, group, civil society, state, equality, justice. Human Values, Human rights and Human Duties: Origin, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people

Unit 2: Fundamental Rights and Economic Program [04 Hours]
Society, religion, culture, and their inter-relationship. Impact of social structure on human behavior, Social Structure and Social Problems: Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labour.

Unit 3: Workers and Human Rights[04 Hours]
Migrant workers and human rights violations, human rights of mentally and physically challenged. State, Individual liberty, Freedom and democracy.

Unit 4: NGOs and Human Rights in India[04 Hours]
Land, Water, Forest issues.

Unit 5: Human Rights in Indian Constitution and Law[04 Hours]
i) The constitution of India: Preamble
ii) Fundamental rights.
iii) Directive principles of state policy.
iv)Fundamental duties.
v) Some other provisions.

Unit 6: UDHR and Indian Constitution[04 Hours]
Universal declaration of human rights and provisions of India; Constitution and law; National human rights commission and state human rights commission.

References:

1. Shastry, T. S. N., "India and Human Rights: Reflections", Concept Publishing Company India (P Ltd.), 2005.
2. C. J. Nirmal, "Human Rights in India: Historical, Social and Political Perspectives (Law in India)", Oxford India.

Material Science and Metallurgy Lab

BTPRL307	ESC 12	Material Science and Metallurgy Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

List of Practicals/Experiments/Assignments (any ten experiments from the list)
1. Brinell Hardness Test
2. Rockwell Hardness test
3. Erichson Cupping Test
4. Magnaflux Test
5. Dye Penetrant Test
6. Specimen Preparation for Microscopy

7. Sulphur Print Test
8. Spark Test
9. Study and drawing of microstructures of plain carbon steels of varying carbon percentage
10. Study and drawing of microstructures of heat treated steels
11. Jominy End Quench Test
12. Study and drawing of microstructures of cast irons
13. Study and drawing of microstructures of non-ferrous alloys
14. Hardening of steels of varying carbon percentage

Fluid Mechanics Lab

BTPRL308	PCC 4	Fluid Mechanics Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	Understand laminar and Turbulent flow and determine Critical Reynolds number using Reynolds Apparatus
CO2	Verify Bernoulli's theorem
CO3	Determine pressure drop in flow though pipes and pipe fittings
CO4	Verify momentum equation using impact of jet apparatus
CO5	Determine viscosity using viscometer
CO6	Do calibration of pressure gauges, rotameter
CO7	Use manometers for pressure measurement

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	1				1	2		1
CO2	1	1	1	3	1				1	2		1
CO3	1	1	1	3	1				1	2		1
CO4	1	1	1	3	1				1	2		1
CO5	1	1	1	3	1				1	2		1
CO6	1	1	1	3	1				1	2		1
CO7	1	1	1	3	1				1	2		1

List of Practicals/ Experiments/ Assignments (any eight experiments from the list)

1. Flow visualization technique: characteristics of laminar and turbulent flow patterns using Helleshaw Apparatus.
2. Verification of Bernoulli's theorem
3. Determination of Critical Reynolds number using Reynolds Apparatus
4. Determination of pressure drop in pipes of various cross-sections

5. Determination of pressure drops in pipes of various pipe fittings etc.
6. Viscosity measurement using viscometer(at least one type)
7. Verification of momentum equation using impact of jet apparatus
8. Determination of metacentric height of a floating body
9. Calibration of a selected flow measuring device and Bourdon pressure gauge
10. Gauge and differential pressure measurements using various types of manometers, Bourdon type pressure gauge.
11. Demonstration of measurement using these instruments Lab.
12. Experiment to study hydraulic jump.

Machine Drawing and Computer Aided Drafting Lab

BTPRL309	PCC 5	Machine Drawing and Computer-aided Drafting Lab	0-0-4	2 Credits

Practical Scheme:	**Examination Scheme:**
Practical: 4 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	Draw Conventional representation of standard machine components, welds, materials etc.
CO2	Draw sectional view of a given machine component.
CO3	Develop Assemble view from details of given component i.e. valve, pump, machine tool part, etc.
CO4	Combine details of given machine component and draw assembled view.
CO5	Use various Auto-Cad commands to draw orthographic projection
CO6	Draw sectional view from pictorial view of given machine component using Auto-Cad

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		1				1			
CO2	2	1	1		1				1			1
CO3	3	1	1		1				2	1		2
CO4	3	1	1		1				2	1		1
CO5	2	1	1		2				2	2		1
CO6	1	1	1		1				1	1		1

List of Practicals/ Experiments/ Assignments (minimum six assignments should be completed)

1. One full imperial drawing sheet consisting the drawing/sketches of representation of standard components, symbols of pipe joints, weld joints, rivet joint etc., surface finish symbols and grades, limit, fit and tolerance sketches.

2. Two full imperial drawing sheets, one consisting of assembly and the other consisting of details of any one standard component such as valves, components of various machine tools, pumps, joints, engine parts, etc.
3. Two assignment of AutoCAD: Orthographic Projections of any one simple machine component such as bracket, Bearing Housing or Cast component for Engineers such as connecting rod, Piston, etc.; with dimensioning and detailing of three views of components.
4. 3-D model at least one simple machine component.

Theory of Machines Lab

BTPRL310	PCC 6	Theory of Machines Lab	0-0-2	1 Credits

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	Perform graphically kinematic analysis of any planar mechanism using ICR and RV methods.
CO2	Perform graphically kinematic analysis of slider crank mechanism using Klein's construction.
CO3	Demonstrate use of graphical differentiation method for kinematic analysis of slider crank mechanism or any other planar mechanism with a slider.
CO4	Sketch polar diagram for a Hooke's joint.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		1							
CO2	1	1	1		1							
CO3	1	1			1							
CO4	1	1			1							

List of Practicals/Experiments/Assignments

List of Experiments (Any 3 experiments from the given list):

1. Determination of Moment of Inertia of rigid bodies by bifilar or trifilar suspension method.
2. Compound Pendulum.
3. Experimental Verification of displacement relation for different shaft angles for single Hook’s Joint.
4. Developing a computer program for velocity and acceleration of slider crank mechanism.

List of drawing Sheets:

1. Graphical solution of problems on velocity & acceleration in mechanisms by Relative velocity & relative acceleration method including problem with Corioli’s component of acceleration.

2. Graphical solution of problems on velocity in mechanisms by ICR method.
3. Klein’s constructions for slider crank mechanism.
4. Inertia force analysis with graphical methods.
5. Straight line motion mechanisms.

Semester IV

Casting and Moulding Technology

BTPRC401	PCC 7	Casting and Moulding Technology	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To make students aware of different casting and moulding processes, foundry practices to design casting for different components.

Pre-Requisites: None

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

CO1	Classify different casting processes, advantages and limitations.
CO2	Identify various patterns and sand moulding processes.
CO3	Outline special casting processes, their advantages and limitations.
CO4	Select pouring and feeding methods of casting.
CO5	Design gating and risering system of casting.
CO6	Identify casting defects and various casting inspection and testing methods.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1				1							
CO4	1		1		1							
CO5	1		1		1							
CO6	1				1					1		1

Course Contents:

Unit 1: Introduction to casting processes[06 Hours]

Classification, advantages, limitations, applications of casting, casting terms, sand mold making procedure

Unit 2: Technology of patternmaking, moulding and core making[06 Hours]

Pattern materials, pattern making tools, types of patterns, pattern allowances, methods of Constructing patterns, color coding, tools and equipment's, types of modeling sands, sand Additives, properties of molding sand and testing, molding processes: green sand, dry sand

Molding: advantages, limitations and applications core materials, core prints, core boxes, core making, and chaplets.

Unit 3: Special casting processes[06 Hours]

Shell molding, investment molding, full molding process, CO_2 molding, permanent mold Casting, die casting, centrifugal casting and continuous casting, advantages, limitations and applications

Unit 4: Melting, pouring and feeding[06 Hours]

Introduction of furnaces for ferrous and non-ferrous casting, use, construction, charging and other furnaces

Unit 5: Gating and risering of castings[06 Hours]

Gating system, gates, gating ratio, casting yield and gating system design

Risering of casting: Function, shape, types, location, feeding distance, and its design parameters.

Unit 6: Design considerations and inspection of casting[06 Hours]

Designing for economical molding and eliminating defects, defects in casting, inspection Methods: visual, dimensional, mechanical, metallurgical and NDT

Texts/References:

1. Heine R.W, Loper C.R and Rosenthal P.C , "Principles of metal casting", Tata McGraw Hill Publication Co.1998
2. P. L. Jain , "Principles of foundry technology", Tata McGraw Hill Education , New Delhi, 2003.
3. PN Rao, "Manufacturing Technology - Foundry, Forming and welding", Tata McGraw Hill, New Delhi, 2006.

Engineering Thermodynamics and Heat Transfer

BTPRC402	PCC 8	Engineering Thermodynamics and Heat Transfer	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

Objectives: To study fundamental laws of thermodynamics, thermodynamics devices and their applications, to get conversant with steam engineering, vapour cycles and steam turbines. To study air compressors and its applications and various modes of heat transfer.

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

CO1	Define various gas laws and relate them to refrigerator, heat pump and heat engine
CO2	Apply gas laws to vapor processes and classify steam turbine

CO3	Classify various types of fuels and analyze the products of combustion by various methods
CO4	Classify the systems of IC engines and estimate the performance of IC engine
CO5	Compare various modes of heat transfer and apply them for solving various problems
CO6	Classify heat exchangers and estimate the effectiveness of heat exchangers

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	1	1										
CO3	1											
CO4	1				1							
CO5	1	1										
CO6	1				1							

Course Contents:

Unit 1: Elementary Thermodynamics[08 Hours]

Basics of Thermodynamics, Ideal gas Laws, First Law of Thermodynamics, Steady Flow Energy Equation, Carnot Cycle, reverse Carnot Cycle, Second Law of Thermodynamics, Concept of refrigeration, Heat Pump and Heat Engine.

Unit 2: Vapor Power Cycles[08 Hours]

Vapour power cycles Steam Generation and its properties, Measurement of dryness fraction, Carnot Cycle, Application of Gas laws to vapour processes. Ideal Rankine Cycle, Calculation of Thermal Efficiency, Specific Steam Consumption, Work ratio.

Steam Turbines: Types, construction, working, compounding, velocity diagram, & diagram efficiency (No numerical).

Unit 3: Fuels and Fundamentals of Combustion[08 Hours]

Solid, Liquid and gaseous fuels, Combustion equations, analysis of product of combustion, gravimetric and volumetric analysis, theoretical air, excess air and exhaust gas produced.

Unit 4: I. C. Engines[08 Hours]

Air standard Otto, Diesel cycles(Elementary Numerical treatment), classifications of ICE and systems of I.C. engines such as fuel supply system for SI & CI engines, ignition system, cooling system, lubrication system, Performance of IC Engine –Indicated power, Brake power, Thermal efficiency, Specific fuel consumption(Elementary Numerical).

Unit 5: Heat Transfer[08 Hours]

Introduction and Basic Concepts of Conduction: Application areas of heat transfer in manufacturing and machine tools, Modes and Laws of heat transfer, thermal conductivity, thermal diffusivity, Heat conduction in plane wall, composite slab, composite cylinder, composite sphere, electrical analogy, concept of thermal resistance, overall heat transfer

coefficient, conduction, critical radius of insulation for cylinders and spheres, economic thickness of insulation. (Elementary numerical)

Fundamentals of convection: Concept Laminar and turbulent flow, Reynold Number, Prandlt number, Grashoff number, Nusselt Number. Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity & thermal boundary layers.

Fundamentals of Radiation: Fundamental concepts of radiation, different laws of radiation, Concept of: shape factor, radiation between two black and diffuse gray surfaces and radiation shields. (No numerical)

Unit6: Heat Exchangers[08 Hours]

Introduction to heat exchangers, classification and applications; Heat exchanger analysis – LMTD for parallel and counter flow heat exchanger, concept of effectiveness, NTU method for parallel and counter flow heat exchanger (elementary level/ introduction, no numerical).

Texts:

1. R.K. Rajput, "Thermal Engineering", Laxmi Publications.
2. R. S. Khurmi and Gupta, "Thermal Engineering", S. Chand Publication.

References:

1. S.P. Sukhatme, "Heat Transfer", Orient Longman.
2. Y.A. Cengel, "Thermodynamics – an Engineering approach" Tata McGraw Hill.
3. Eastop, A. Mc'conkey, "Applied Thermodynamics", Pearson Publishers.
4. Holman J.P., "Heat Transfer", Tata McGraw Hill.

Strength of Materials

BTMEC403	PCC 9	Strength of Materials	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: Engineering Mechanics

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

CO1	State the basic definitions of fundamental terms such as axial load, eccentric load, stress, strain, E, μ, etc.
CO2	Recognise the stress state (tension, compression, bending, shear, etc.) and calculate the value of stress developed in the component in axial/eccentric static and impact load cases.
CO3	Distinguish between uniaxial and multiaxial stress situation and calculate principal stresses, max. shear stress, their planes and max. normal and shear stresses on a given plane.
CO4	Analyse given beam for calculations of SF and BM

CO5	Calculate slope and deflection at a point on cantilever /simply supported beam using double integration, Macaulay's , Area-moment and superposition methods
CO6	Differentiate between beam and column and calculate critical load for a column using Euler's and Rankine's formulae

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Simple Stresses and Strains[08 Hours]
Mechanical properties of materials, analysis of internal forces, simple stresses and strains, stress-strain curve, Hooke's law, modulus of elasticity, shearing, thermal stress, Hoop stress, Poisson's ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants.

Unit 2: Principal Stresses and Strains[08 Hours]
Uni-axial stress, simple shear, general state of stress for 2-D element, ellipse of stress, principal stresses and principal planes, principal strains, shear strains, strain rosettes, Mohr's circle for stresses and strains.
Strain energy and resilience: Load-deflection diagram, strain energy, proof resilience, stresses due to gradual, sudden and impact loadings, shear resilience, strain energy in terms of principal stresses.

Unit 3: Combined Stresses[08 Hours]
Combined axial and flexural loads, middle third rule, kernel of a section, load applied off the axes of symmetry.
Shear and Moment in Beams: Shear and moment, interpretation of vertical shear and bending moment, relations among load, shear and moment.

Unit 4: Stresses in Beams[08 Hours]
Moment of inertia of different sections, bending and shearing stresses in a beam, theory of simple bending, derivation of flexural formula, economic sections, horizontal and vertical shear stress, distribution shear stress for different geometrical sections-rectangular, solid circular, I-section, other sections design for flexure and shear.

Unit 5: Beam Deflections[08 Hours]
Differential equation of deflected beam, slope and deflection at a point, calculations of deflection for determinate beams by double integration, Macaulay's method, theorem of area-moment method (Mohr's theorems), moment diagram by parts, deflection of cantilever

beams, deflection in simple supported beams, mid-span deflection, conjugate beam method, deflection by method of superstition.

Unit 6: Torsion[08 Hours]
Introduction and assumptions, derivation of torsion formula, torsion of circular shafts, stresses and deformation indeterminate solid/homogeneous/composite shafts, torsional strain energy.
Columns and Struts: Concept of short and long Columns, Euler and Rankine's formulae, limitation of Euler's formula, equivalent length, eccentrically loaded short compression members.

Texts:
1. S. Ramamrutham, "Strength of Materials", DhanpatRai and Sons, New Delhi.
2. F. L. Singer, Pytle, "Strength of Materials", Harper Collins Publishers, 2002.
3. S. Timoshenko, "Strength of Materials: Part-I (Elementary Theory and Problems)", CBS Publishers, New Delhi.

References:
1. E. P.Popov, "Introduction to Mechanics of Solid", Prentice Hall, 2nd edition, 2005.
2. S. H. Crandall, N. C. Dahl, T. J. Lardner, "An introduction to the Mechanics of Solids", Tata McGraw Hill Publications, 1978.
3. S. B. Punmia, "Mechanics of Structure", Charotar Publishers, Anand.
4. B. C. Punmia, Ashok Jain, Arun Jain, "Strength of Materials", Laxmi Publications.

Numerical Methods in Mechanical Engineering

BTMEC404	BSC 8	Numerical Methods in Mechanical Engineering	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

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

CO1	Describe the concept of error
CO2	Illustrate the concept of various Numerical Techniques
CO3	Evaluate the given Engineering problem using the suitable Numerical Technique
CO4	Develop the computer programming based on the Numerical Techniques

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1	3							
CO2	3	3		1	3							
CO3	3	3		1	3							
CO4	3	3		1	3							

Course Contents:

Unit1: Error Analysis [06 Hours]
Significant figures, round-off, precision and accuracy, approximate and true error, truncation error and Taylor series, machine epsilon, data uncertainties, error propagation, importance of errors in computer programming.

Unit2: Roots of Equations [06 Hours]
Motivation, Bracketing methods: Bisection methods, Open methods: Newton Raphson method, Engineering applications.

Unit3: Numerical Solution of Algebraic Equations [06 Hours]
Motivation, Cramer's rule, Gauss- Elimination Method, pivoting, scaling, engineering applications.

Unit4: Numerical Integration and Differentiation [06 Hours]
Motivation, Newton's Cotes Integration Formulas: Trapezoidal Rule, Simpson's rule, engineering applications Numerical differentiation using Finite divide Difference method

Unit5: Curve Fitting and Interpolation [08 Hours]
Motivation, Least Square Regression: Linear Regression, Polynomial regression.
Interpolation: Newton's Divide Difference interpolation, engineering applications.
Solution to Ordinary Differentiation Equations: Motivation**,** Euler's and Modified Euler's Method, Heun's method, Runge–Kutta Method, engineering applications.

Unit6: Computer Programming [04 Hours]
Overview of programming language, Development of at least one computer program based on each unit.

Texts:

1. Steven C Chapra, Reymond P. Canale, "Numerical Methods for Engineers", TataMcGraw Hill Publications, 2010.
2. E.Balagurusamy, "Numerical Methods", TataMcGraw Hill Publications,1999.

References:

1. V. Rajaraman, "Fundamental of Computers", Prentice Hall of India,NewDelhi,2003.
2. S. S. Sastri,"IntroductoryMethodsofNumericalMethods",PrenticeHallofIndia,NewDelhi, 3rd edition,2003.
3. K. E. Atkinson, "An Introduction to Numerical Analysis",Wiley,1978.
4. M.J. Maron, "Numerical Analysis: A Practical Approach", Macmillan, New York, 1982

Product Design Engineering - I

BTID405	PCC 8	Product Design Engineering - I	1-0-2	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture-cum-demonstration: 1 hr/week Design Studio/Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

- **Pre-requisites:** Knowledge of Basic Sciences, Mathematics and Engineering Drawing
- **Design Studio/Practical:** 2 hrs to develop design sketching and practical skills
- **Continuous Assessment:** Progress through a product design and documentation of steps in the selected product design
- **End Semester Assessment:** Product design in studio with final product specification

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

1. Create simple mechanical designs
2. Create design documents for knowledge sharing
3. Manage own work to meet design requirements
4. Work effectively with colleagues

Course Contents:

Unit 1: Introduction to Engineering Product Design

Trigger for Product/Process/System, Problem solving approach for Product Design, Disassembling existing product(s) and understanding relationship of components with each other, Sketching of components, identifying materials and their processing for final product, fitting of components, understanding manufacturing as scale of the components, Reverse engineering concept, case studies of products in markets, (or in each discipline), underlying principles, Case studies of product failures, Revival of failed products, Public/Society's perception of products, and its input into product design.

Unit 2: Ideation

Generation of ideas, Funneling of ideas, Short-listing of ideas for product(s) as an individual or group of individuals, Sketching of products, Market research for need, competitions, Scale and cost, Initial specifications of products.

Unit 3: Conceptualisation

Designing of components, Drawing of parts and synthesis of a product from its component parts, Rendering the designs for 3-D visualization, Parametric modelling of product, 3-D visualization of mechanical products, Detail engineering drawings of components.

Unit 4: Detailing

Managing assembling, product specifications – data sheet, Simple mechanical designs, Workshop safety and health issues, Create documents for the knowledge sharing.

- **Hands-on Activity Charts for Use of Digital Tools:**

		No. of hrs
Activity 1	Learn the basic vector sketching tools	2
Activity 2	General understanding of shading for adding depth to objects. Understanding of editing vectors	2

Activity 3	Begin developing a thought process for using digital sketching	3
Activity 4	Create a basic shape objects sphere, box cylinders	3
Activity 5	Create automotive wheel concepts	3
Activity 6	Understanding navigation and data panel interface	2
Activity 7	Solid and surface modelling, rendering 3-D models	4
Activity 8	Product market and product specification sheet	3
Activity 9	Documentation for the product	2

Reference:

1. Model Curriculum for "Product Design Engineer – Mechanical", NASSCOM (Ref. ID: SSC/Q4201, Version 1.0, NSQF Level: 7)
2. Eppinger, S., & Ulrich, K.(2015). Product design and development. McGraw-Hill Higher Education.
3. Green, W., & Jordan, P. W. (Eds.).(1999).Human factors in product design: current practice and future trends. CRC Press.
4. Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design. McGRAW-HILL book company.
5. Roozenburg, N. F., &Eekels, J. (1995). Product design: fundamentals and methods (Vol. 2). John Wiley & Sons Inc.
6. Lidwell, W., Holden, K., & Butler, J.(2010). Universal principles of designs, revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design. Rockport Pub.

Physics of Engineering Materials

BTBSE406A	OEC 1	Physics of Engineering Materials	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the different types of structures of solid, defects in solids and analysis of

	crystal structure by X-ray diffraction technique.
CO2	Understand the origin and types of magnetism, significance of hysteresis loo in different magnetic materials and their uses in modern technology
CO3	Understand the band structure of solids and conductivity, categorization of solids on the basis of band structure, significance of Fermi-Dirac probability functions
CO4	Understand the principles of superconductivity, their uses in modern technology
CO5	Understand the position of Fermi level in intrinsic and extrinsic semiconductors, Semiconductor conductivity
CO6	Understand the electric field in dielectric
CO7	Understand basics of Nano materials, synthesis methods and characterization techniques

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		3	3		1					3
CO2	3	3			1		2		2		1	2
CO3	2	2			1		1					3
CO4	3	3			1		3		1		1	2
CO5	3	2		2	1		1					1
CO6	3	2			2		2		3		1	2
CO7	2	3	1		3	1	3	1				1

Course Contents:

Unit 1: Crystallography[06 Hours]
Crystal directions and planes, Diatomic Crystal (CsCl, NaCl, Diamond, $BaTiO_3$) Crystal imperfection, Point defects, Line defects, Surface and Volume defects, Structure properties relationship, structure determination by X-ray diffraction.

Unit 2: Magnetic Materials [06 Hours]
Origin of magnetization using atomic theory, classification of magnetic materials and properties, Langevin's theory of Dia, Para and ferromagnetism, Soft and Hard magnetic materials and their uses, Domain theory of ferromagnetism, Hysteresis loss, Antiferromagnetic and Ferrimagnetic materials, Ferrites and Garnets, magnetic bubbles, magnetic recording.

Unit 3: Conducting and Superconducting Materials[06 Hours]
Band theory of solids, Classical free electron theory of metals, Quantum free electron theory, Density of energy states and carrier concentration, Fermi energy, Temperature and Fermi energy distribution, Superconductivity, Factor affecting Superconductivity, Meissner effect, Type-I and Type-II superconductors, BCS theory, Josephson effect, High temperature superconductors, Application of superconductors (Cryotron, magnetic levitation)

Unit 4: Semiconducting Materials [06 Hours]
Band structure of semiconductor, Charge carrier concentration, Fermi level and temperature, Electrical conductivity, Hall effect in semiconductors, P-N junction diode, Preparation of single crystals, LED, Photovoltaic Cell

Unit 5: Dielectric Materials [06 Hours]
Dielectric constant and polarizability, types of polarization, temperature and frequency dependences of Dielectric parameter, internal fields in solids, Clausius-Mosotti equation, dielectric loss, dielectric breakdown, ferroelectric, pyroelectric and piezoelectric materials, applications of dielectric materials

Unit 6: Nano Materials [06 Hours]
Nano materials: Introduction and properties, synthesis of nano materials, Carbon Nano Tubes, Characterization techniques of nano materials- SEM, TEM, EDAX, FMR, XRD. Applications of Nano materials.

Texts:

1. Kittle, "Introduction to Solid state Physics", John Wiley and Sons, 8th edition, 2004.
2. M. Srivastava, C. Srinivasan, "Science of Engineering Materials and Carbon Nanotubes", New Age International Publication, 3rd edition, 2010.
3. A. J. Dekker, "Solid State Physics", Pan Macmillan and Co. Ltd., London, 01stJuly, 1969.

References:

1. V. Raghavan, "Material Science and Engineering", Prentice Hall Publication, 5th edition, 2007.
2. A. J. Dekker, "Electrical Engineering Materials", Prentice Hall Publication, 1st edition, 1959.

Advanced Engineering Chemistry

BTBSE3405A	OEC 1	Advanced Engineering Chemistry	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Classify and explain various types of Corrosion and should apply methods to minimize the rate of corrosion.
CO2	Understand and apply the concepts of Photochemical and Thermal reactions.
CO3	Understand the basic concepts of Polymers, Polymerization and Moulding techniques; Determine molecular weight of High-Polymers.
CO4	Understand and apply the basic techniques in Chemistry and capable to explain the concepts of Solvent Extraction.
CO5	Understand and apply various types of Spectroscopic, Chromatographic techniques and also able to explain the concepts of Thermo-Gravimetric Analysis (TGA).

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2		1		2				1	1
CO2	2	2	1				2		1		1	1
CO3	2	2	2		3	1	1		1		1	1
CO4	3	2	1		3				2		1	1
CO5	3	2	1		3				2		1	1

Course Contents:

Unit 1: Corrosion and Its Control [08 Hours]
Introduction, Fundamental reason, Electrochemical Corrosion, Direct Chemical Corrosion, Factors affecting the rate of corrosion, types of corrosion-Galvanic, Pitting Corrosion, Stress corrosion, methods to minimize the corrosion- Proper design, Cathodic and Anodic protection.

Unit 2: Photochemical and Thermal Reactions [06 Hours]
Introduction, Laws of Photochemistry, Measurement of absorbed intensity, Quantum yield or efficiency, Jablonski Diagram, Photosynthesis reaction of Hydrogen Bromide, Brief Discussion on Thermal Reactions – Cope Rearrangement.

Unit 3: Polymers [06 Hours]
Introduction, Nomenclature of Polymers, Type of Polymerization, Molecular Weight Determination by Osmotic Pressure and Viscosity Method, Plastic and its Classification, Constituents of Plastic, Moulding of Plastic by Injection Method.

Unit 4: Reaction Mechanism and Reaction Intermediates [06 Hours]
Introduction of Reaction Mechanism, Brief introduction of Reactivity of Substrate (Inductive Effect, Mesomeric Effect, Electromeric Effect, Hyperconjugative Effect), Bond Fission: Homolytic and Heterolytic Bond Fission, Reaction Intermediates: Carbocation (Structure, Stability and Applications).
Rearrangement Reactions
Intramolecular Rearrangement: Isomerisation, Beckmann Rearrangement, Benzidine Rearrangement.
Intermolecular Rearrangement: Orton Rearrangement, Diazoamino Rearrangenment.

Unit 5: Spectroscopy [08 Hours]
Brief introduction to spectroscopy, UV–Visible Spectroscopy: Laws of absorption, instrumentation and application. IR spectroscopy: introduction, theory, instrumentation and application. Brief discussion on NMR Spectroscopy, AAS (Atomic Absorption Spectroscopy).

Unit 6: Instrumental Methods of Analysis [06 Hours]
Introduction to Chromatography, Types of Chromatography (Adsorption and partition chromatography), Thin Layer Chromatography, Gas Chromatography – introduction, theory, instrumentation. Brief discussion of Thermo gravimetric analysis (TGA).

Texts:
1. Bhal and Bhal, "Advance Organic Chemistry", S. Chand and Company, New Delhi, 1995.

2. P. C. Jain, Monica Jain, "Engineering Chemistry", Dhanpat Rai and Sons, Delhi, 1992.
3. Bhal, Tuli, "Text book of Physical Chemistry", S. Chand and Company, New Delhi, 1995.
4. Chatwal Anand, "Instrumental Methods of analysis", Himalaya Publication.
5. Text Book of Organic Chemistry by Rakesh K. Parashar, V.K. Ahluwalia.

References:

1. L. Finar, "Organic Chemistry", Vol. I and II, Longman Gr. Ltd and English Language Book Society, London.
2. G. M. Barrow, "Physical Chemistry", Tata McGraw Hill Publication, New Delhi.
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and applications", Cambridge Publishers, 2015.
4. O. G. Palanna, "Engineering Chemistry", Tata McGraw Hill Publication, New Delhi.
5. WILEY, Engineering Chemistry, Wiley India, New Delhi 2014.
6. Willard, "Instrumental Methods of analysis", Merrit, Tata McGraw Hill Publications.
7. Glasstone, "Physical Chemistry", D. Van Nostrand Company Inc., 2nd edition, 1946.
8. Peter Atkins, "Physical Chemistry", W. H. Freeman and Co., 9th edition, 2009.

Interpersonal Communication Skill & Self Development

BTHM3402	OEC 1	Interpersonal Communication Skill& Self Development	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Acquire interpersonal communication skills
CO2	Develop the ability to work independently.
CO3	Develop the qualities like self-discipline, self-criticism and self-management.
CO4	Have the qualities of time management and discipline.
CO5	Present themselves as an inspiration for others
CO6	Develop themselves as good team leaders

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2										2		
CO3												2
CO4									1			
CO5										2		
CO6											3	

Course Contents:

Unit 1:Development of Proficiency in English[06 Hours]
Speaking skills, Feedback & questioning technique, Objectivity in argument (Both one on one and in groups). 5 Wsand 1 H and 7 Cs for effective communication.
Imbibing etiquettes and manners. Study of different pictorial expressions of non-verbal communication and their analysis

Unit 2: Self-Management[06 Hours]
Self-Management, Self-Evaluation, Self-discipline, Self-criticism; Recognition of one's own limits and deficiencies, dependency, etc.; Self-Awareness, Self-Management, Identifying one's strengths and weaknesses, Planning & Goal setting, Managing self-emotions, ego, pride. Leadership and Team Dynamics

Unit 3: Time Management Techniques[06 Hours]
Practice by game playing and other learning strategies to achieve the set targets Time Management Concept; Attendance, Discipline and Punctuality; Acting in time, Quality /Productive time.

Unit 4: Motivation/Inspiration[06 Hours]
Ability to shape and direct working methods according to self-defined criteria, Ability to think for oneself, Apply oneself to a task independently with self-motivation.
Motivation techniques: Motivation techniques based on needs and field situations

Unit 5: Interpersonal Skills Development[06 Hours]
Positive Relationship, Positive Attitudes, Empathise: comprehending others' opinions, points of views, and face them with understanding, Mutuality, Trust, Emotional Bonding, Handling Situations (Interview), Importance of interpersonal skills.

Unit 6: Effective Computing Skills[06 Hours]
Designing an effective Presentation; Contents, appearance, themes in a presentation, Tone and Language in a presentation, Role and Importance of different tools for effective presentation.

References:

1. Mitra, Barun, "Personality Development and Soft Skills", Oxford University Press, 2016.
2. Ramesh, Gopalswamy, "The Ace of Soft Skills: Attitude, Communication and Etiquette for Success", Pearson Education, 2013.
3. Stephen R. Covey, "Seven Habits of Highly Effective People: Powerful Lessons in Personal Change", Free Press Publisher, 1989.
4. Rosenberg Marshall B., "Nonviolent Communication: A Language of Life" 3rd edition, Puddle dancer Press, 1st September, 2003.

Production Processes Lab I

BTPRL407	PCC 11	Production Processes Lab - I	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks

	External Exam: 40 Marks

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

CO1	Perform plain turning, step turning, knurling, eccentric turning, chamfering and facing operations on lathe.
CO2	Prepare setup and fabricate composite job using milling, shaping and drilling machine.
CO3	Making spur gears on a milling machine.
CO4	Prepare sand casting setup using split pattern for simple component.
CO5	Perform joining of two plate using TIG/MIG welding.
CO6	Demonstrate cutting of a sheet metal using flame cutting.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		3	1		1		1	2		1
CO2	1	1		3	1		1		1	2		1
CO3	1	1		3	1		1		1	2		1
CO4	2	1		3	1		1		1	2		1
CO5	2	1		3	1		1		1	2		1
CO6	1	1		3	1		1		1	1		1

List ofPracticals/Experiments/Assignments

Each student shall be required to submit any six jobs from the following:

1. Making a job with a process plan involving plain, step and taper turning as well thread cutting as operations on a Centre lathe.
2. Preparation of process planning sheet for a job including operations such as milling, drilling and shaping.
3. Making a spur gear using universal dividing head on milling machine.
4. Making a simple component by sand casting using a split pattern.
5. Cutting of a steel plate using oxyacetylene flame cutting /plasma cutting.
6. Making a butt joint on two stainless steel plates using TIG/MIG Welding.
7. An experiment on shearing operation.
8. An experiment on blanking operation.
9. An experiment on drawing operation

Engineering Thermodynamics and Heat Transfer Lab

BTPRL408	PCC 12	Engineering Thermodynamics and Heat Transfer Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: Engineering Thermodynamics and Heat Transfer

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

CO1	Determine the dryness fraction of steam and energy contained in a substance with the help of Bomb calorimeter.
CO2	Illustrate the function of Bosch fuel injection pump and boilers.
CO3	Estimate the performance of diesel/petrol engine.
CO4	Demonstrate reciprocating compressing.
CO5	Determine thermal conductivity of an insulating material.
CO6	Determine effectiveness of parallel and counter flow heat exchanger and emissivity of a specimen.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		1								
CO2	1											
CO3	1	1		1								
CO4	1	1										
CO5	1	1		1								
CO6	1	1		1								

List of Practicals/Experiments/Assignments

Any eight experiments from the list:

1. Determination of dryness fraction of steam.
2. Trial on bomb calorimeter.
3. Study of MPFI and Bosh fuel injection pump
4. Study of High Pressure Boilers.
5. Test on Diesel/Petrol engine to determine BP, bsfc, Brake thermal efficiency.
6. Trial on reciprocating air compressor.
7. Determination of thermal conductivity of insulating material.
8. Test on parallel & counter flow heat exchanger.
9. Determination of Emissivity of a Test Plate.

Strength of Materials Lab

BTPRL409	PCC 13	Strength of Materials Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	

CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

List of Practicals/Experiments/Assignments (any ten experiments from the list)

1. Tension test on ferrous and non-ferrous alloys (mid steel/cast iron/aluminum, etc.
2. Compression test on mild steel, aluminum, concrete, and wood
3. Shear test on mild steel and aluminum (single and double shear tests)
4. Torsion test on mild steel and cast iron solid bars and pipes
5. Flexure test on timber and cast iron beams
6. Deflection test on mild steel and wooden beam specimens
7. Graphical solution method for principal stress problems
8. Impact test on mild steel, brass, aluminum, and cast iron specimens
9. Experiments on thermal stresses
10. Strain measurement in stress analysis by photo-elasticity
11. Strain measurement involving strain gauges/ rosettes
12. Assignment involving computer programming for simple problems of stress, strain computations.

Numerical Methods Lab

BTPRL410	BSC 9	Numerical Methods Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												

CO2												
CO3												
CO4												

Student should develop the computer programme along with the results on following topics. (Any six)

1. Programme to demonstrate the effect of round off error and significant number
2. Programme to find real single root of an Equation by Bisection Method
3. Programme to find real single root of an Equation by Newton- Raphson Method
4. Programme to solve linear simultaneous algebraic equations
5. Programme to solve the integration using Multi Trapezoidal Rule
6. Programme to solve the integration using Simpson's 1/3 rule
7. Programme to solve simple practical problem using finite difference method
8. Programme to solve ODE

It is expected that student should take up the simple real life problem for writing the programme.

Student should maintain a file containing all the programmes with results in printed form and also submit a CD containing all the programmes in soft form.

Semester V

Design of Machine Elements

BTPRC501	PCC 14	Design of Machine Elements	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Objectives: To understand material properties, design process and various theories of failures in order to design various basic machine components and new components based on design principles.

Pre-Requisites: Strength of Materials

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

CO1	Formulate the problem by identifying customer need and convert into design specification
CO2	Understand component behavior subjected to loads and identify failure criteria
CO3	Analyze the stresses and strain induced in the component
CO4	Design of machine component using theories of failures
CO5	Design of component for finite life and infinite life when subjected to fluctuating load
CO6	Design of components like shaft, key, coupling, screw and spring

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1				1
CO2	3	2		1		1		1		1		1
CO3	1	1				1		1		1		1
CO4	3	3	2	1		2		1		1		1
CO5	1	1				1		1		1		1
CO6	2	2	2	1		1		1		1		1

Course Contents:

Unit 1:

Mechanical Engineering Design Process

Traditional design methods, general industrial design procedure, design considerations, phases in design, creativity in design, use of standardization, preferred series, introduction to ISO9000, use of design data book, aesthetic and ergonomic considerations in design.

Theories of Failure: Maximum normal stress theory, Maximum shear stress theory, Maximum distortion energy theory, comparison of various theories of failure,

Unit 2: Design of Machine Elements

I. Against Static Loading

Direct loading and combined loading, Joints subjected to static loading e.g. cotter and knuckle joint, turnbuckle, etc. introduction to fluctuating loads.

II: Against Fluctuating Loads

Stress concentration, stress concentration factors, fluctuating stresses, fatigue failure, endurance limit, notch sensitivity, approximate estimation of endurance limit, design for finite life and finite life under reversed stresses, cumulative damage in fatigue, Soderberg and Goodman diagrams, fatigue design under combined stresses.

Unit 3: Design of Shafts, Keys, Couplings and Bearings

Various design considerations in transmission shafts, splined shafts, spindle and axles strength, lateral and torsional rigidity, ASME code for designing transmission shaft.

Types of Keys: Classification and fitment in keyways, Design of various types of keys.

Couplings: Design consideration, design of rigid, muff and flange type couplings, design of flexible couplings.

Bearings: Types, Constructional details of roller contact and sliding contact bearins, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent load, load and life relationship, selection of bearing life, Load factor, selection of bearing from manufacturer's catalogue, Lubrication and bearing materials.

Unit 4: Design of Threaded Joints

Stresses in screw fasteners, bolted joints under tension, torque requirement for bolt tightening, preloading of bolt under static loading, eccentrically loaded bolted joints.

Power Screws: Forms of threads used for power screw and their applications, torque analysis for square and trapezoidal threads, efficiency of screw, collar friction, overall efficiency, self-locking in power screws, stresses in the power screw, design of screw and nut, differential and compound screw, re-circulating ball screw.

Welded Joints: Type of welded joints, stresses in butt and fillet welds, strength of welded joints subjected to bending moments.

Unit 5: Mechanical Springs

Stress deflection equation for helical spring, Wahl's factor, style of ends, design of helical compression, tension and torsional spring under static loads, construction and design consideration in leaf springs, nipping

Unit 6: Design of Gears and Drives

Gear drives, Classification of gears, Law of gearing, Terminology of spur gear, Standard system of gear tooth force analysis, gear tooth failures, material selection, Number of teeth, Face with, Beam strength equation, Effective load on gear tooth, Estimation of module based on beam strength.

Design for maximum power capacity, Lubrication of gears.

Helical Gears: Terminology, Virtual number of teeth, Tooth proportions, Force analysis, Beam strength equation, Effective load on gear tooth, Wear strength equation.

Bevel Gears: Types of bevel gears, Terminology of straight bevel, force analysis, Beam and Wear strength, Effective load on gear tooth.

Worm Gears: Terminology, Proportions, Force analysis, Friction in worm gears, Vector method, Selection of materials, Strength and wear rating, Thermal considerations

Flat and V belts, Geometric relationship, analysis of belt tensions, condition for maximum

power, Selection of flat and V belts from manufacturer's catalogue, Adjustment of belt tensions.
Flywheel: Introduction, types of flywheel, stresses in disc and armed flywheel.

Texts:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publications, New Delhi, 2008.
2. R. L. Nortan, "Machine Design: An Integrated Approach", Pearson Education Singapore, 2001.

References:

1. R. C. Juvinall, K. M. Marshek, "Fundamental of machine component design", John Wiley & Sons Inc., New York, 3rd edition, 2002.
2. B. J. Hamrock, B. Jacobson and Schmid Sr., "Fundamentals of Machine Elements", International Edition, New York, 2nd edition, 1999.
3. A. S. Hall, A. R. Holowenko, H. G. Langhlin, "Theory and Problems of Machine Design", Schaum's Outline Series, Tata McGraw Hill book Company, New York, 1982.
4. J. E. Shigley and C. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Publications, 7th edition, 2004.
5. M. F. Spotts, "Design of Machine Elements", Prentice Hall of India, New Delhi.

Joining Technology

BTPRC502	PCC 15	Joining Technology	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To apply the basics of metal joining processes to join different metals with appropriate technique for joining suitable materials.

Pre-Requisites: None

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

CO1	Classify various joining processes and identify welding symbols, joints and edge preparation.
CO2	Identify various arc welding methods, equipments and electrodes.
CO3	Outline gas welding and their equipments and classify resistance welding processes.
CO4	Define various solid state welding processes, thermal cutting and their working principles.
CO5	Outline welding defects and their causes, destructive and non-destructive testing of welds.
CO6	Choose suitable welding fixtures, estimate cost of welding.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1				1							
CO4	1				1							
CO5	1				1							1
CO6	1		1		1		1					

Course Contents:

Unit 1: Fundamentals and Classification of Welding Processes

Introduction, classification of Welding processes. Comparison with other joining processes, advantages, disadvantages, practical applications. Welding symbols, Basic & supplementary weld symbols, types of weld Joints, Selection of Weld Joint, and edge preparation.

Unit 2: Arc Welding Processes and Equipments

Definition, types of processes, Carbon Arc Welding, Flux Shielded Metal Arc Welding, Submerged Arc Welding, Tungsten Inert Gas Welding, Metal Inert Gas Welding, Electroslag Welding, Electro Gas Welding, Plasma Arc Welding , Arc Welding equipments, Electrodes Types, classification and coding of electrodes.

Unit 3: Welding, Soldering and Brazing

Principle of operation, types of flames, Gas welding Techniques, filler material and fluxes, Gas welding equipments, advantages and applications

Resistances welding: Definition, Fundamentals, variables advantages and application, Spot Welding, Heat Shrinkage, Heat Balance Methods, Equipment, Electrodes, Seam, Projection Butt (up sets and flash), Percussion Welding – Definition, Principle of Operation, equipment, Metal Welded, advantages and application.

Soldering and Brazing: Definition, Comparison of Soldering, Brazing and Welding, principle, joint design, filler alloy, fluxes, processes and application.

Unit 4: Solid State Welding Processes

Cold Welding, Diffusion Welding, Ultrasonic Welding, Explosive Welding, Friction Welding, Inertia and Forge Welding – Definition, principle of operation advantages, limitation and application.

Thermal Cutting of Metal: Oxy-Fuel, Oxygen-Lance, Metal Powder, Chemicals Flux Cutting, Arc Cutting- Metallic, Air Carbon, Tungsten Arc, Plasma Arc Cutting

Unit 5: Weld Defects and Inspection

Weldability: Definition, effect of alloying elements, Purpose and types of tests, Hot Cracking, Root Cracking and Cold Cracking Tests. Common Weld defects, Causes and remedies. Concept of distortion, Types of distortion, Control of welding distortion

Destructive testing of weld – Tensile, Bend, Impact, Nick Break, Hardness, Etch Tests, Non Destructive Testing of Welds – Visual, Leak, X- ray and Gamma ray Radiography, Magnetic Particle Inspection, Dye, Fluorescent Penetrant Tests, Ultrasonic Inspection & Eddy Current Testing

Unit 6: Welding Automation and Robotics

Introduction, Automation options, Simple Mechanization, Dedicated and Special Purpose Automation, Robotic welding, Modular Automation, Programmable control, Remote Control Slave and Automated Systems

Welding Fixtures: Introduction, welding fixtures, their characteristics, classification and selection considerations, Principles governing design of good welding fixtures, various types of welding fixtures.

Estimation of Welding Cost: Introduction, main components costs of welding processes, factors involved in welding costs, basic costing procedure for arc welding, basic costing procedure for gas welding, factors affecting welding costs.

Texts:

1. O.P. Khanna, "Welding Technology" Khanna Publisher
2. Richard Little, "Welding & Welding Technology" TMH
3. N. K. Srinivasan, "Welding Technology" Khanna Publisher
4. Dr. R.S.Parmar, "Welding Processes and Technology" Khanna Publisher

References:

1. Md. Ibrahim Khan, "Welding Science & Technology" New Age International
2. V. M. Radhakrishnan, "Welding Technology & Design" New Age International Publisher
3. James E Brambaugh, "Welding Guide and Handbook" Taraporwala Mumbai
4. A.L. Davies, "Welding" Cambridge University Press
5. P. T. Houltcroft, "Welding Process Technology" Cambridge University Press
6. L.M.Gourd, "Principles of Welding Technology" ELBS

Metal Forming Processes

BTPRC503	PCC 16	Metal Forming Processes	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To apply basic of metal forming processes to shape products to their desired forms without any defects.

Pre-Requisites: None

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

CO1	Define basic stress strain relationship and failure criteria.
CO2	Identify effect of temperature, strain rate and microstructure on formability.
CO3	Calculate the roll separating force, pressure and power required for rolling.
CO4	Determine forces and power required in forging and extrusion.
CO5	Estimate bending force, spring back, effect in bending and forces in wire drawing.
CO6	Classify various advanced forming processes.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1		1	1	1							
CO4	1		1	1	1							
CO5	1		1	1	1							
CO6	1				1							

Course Contents:

Unit 1: Stress and Strain

Review of the theory of stress and Strain – transformation laws –principal stress and strain –Mohr's circle, Stress strain relations, Material properties, Theory of plasticity, Behaviour of metals under uni-axial tension and compression — true stress-true strain relations — effect of work hardening, Empirical stress-strain relations for work hardening materials. Representation of Tresca and von-Mises criterion – yield surface for work hardening materials, Stress strain relations in the plastic range

Unit 2: Metal Forming Processes

Effect of temperature, strain rate, metallurgical microstructure, chemical composition and mechanical properties, Classification of material forming process, Hot forming/ Cold forming, Concept of Formability, formability limits and formability diagram.

Unit 3: Mechanics of Rolling Process

Rolling, process parameters, pressure distribution and roll separating force, rolling pressure, driving torque and power requirements. Defects in rolling. Automatic gauge control- Roll pass classification & design.

Unit 4: Forging and Extrusion

Forging: Determination of forces in strip forging and disc forging, defects in forged components.

Extrusion: Process, parameters, determination of work load from stress analysis and energy considerations, power loss, hydrostatic extrusion, pressure required to extrude, variables affecting the process.

Unit 5: Bending, Punching and Blanking

Bending: Bendability, determination of work load and spring back.

Punching & Blanking: Two-dimensional deformation model and fracture analysis, determination of working force.

Introduction rod and wire drawing machines - construction and working. Preparation of stock for wire drawing. Wire drawing dies, material and design. Patenting heat treatment. Variables in wire drawing, Maximum reduction in wire in one pass, forces required in drawing.

Unit 6: Advanced metal forming processes

High velocity forming- principles, comparison of high velocity and conventional Forming processes. Explosive forming, Magnetic pulse forming, Electro hydraulic Forming, Microforming, Microcoining, microextrusion, Microbending, Stretch forming, coining embossing, curling spinning, flow forming advantages, limitations and application of the process.

Texts:

1. P. N. Rao, "Manufacturing Technology, Foundry, Forming and Welding" Vol.1, 3rd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2004

References:

1. ASM Handbook, Vol. 15 Metal Forming, ASM International, Metals Park, Ohio, 1989.
2. Die Design Handbook, ASTME,1989.
3. A. S. Deshpande, "Sheet Metal Engineering Notes", IIT Bombay, 1999.

Machine Tools and Metal Cutting

BTPRC504	PCC17	Machine Tools and Metal Cutting	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To make student aware of tool geometry, tool signature, and mechanics of chip formation, types of chip, tool wear, and surface finish and need of cutting fluids, machininabilty of the materials. Study of various features and capabilities of various machine tools, machining time calculation will help in selection of appropriate machine tool for a particular application.

Pre-Requisites: None

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

CO1	Classify various machine tools and estimate machining time.
CO2	Calculate the cutting forces in orthogonal and oblique cutting.
CO3	Evaluate the machinability of materials.
CO4	Identify the abrasive processes.
CO5	Classify the different precision machining processes.

CO6	Design jigs and fixtures for given application.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1			1	1							
CO3	1			1	1							
CO4	1				1							
CO5	1				1							
CO6	1		1		1							1

Course Contents:

Unit 1: Classification of Metal Removal Processes and Machine Tools
Introduction to Manufacturing and Machining, Basic working principle, configuration, specification and classification of machine tools, Construction, working principle and applications of shaping, planing and slotting machines, Use of various attachments in Machine Tools, Estimation of machining time

Unit 2: Mechanics of Machining (Metal Cutting)
Geometry of single point cutting tools, Mechanism of chip formation, Orthogonal and oblique cutting, Use of chip breaker in machining, Machining forces and Merchant's Circle Diagram (MCD), Analytical and Experimental determination of cutting forces, Dynamometers for measuring cutting Forces, Cutting temperature: causes, effects, assessment and control, Control of cutting temperature and cutting fluid application

Unit 3: Machinability
Concept of Machinability and its improvement, Failure of cutting tools and tool life, Cutting Tool Materials of common use, Advanced Cutting Tool Materials

Unit 4: Abrasive Processes (Grinding and Super Finishing)
Basic principle, purpose and application of grinding, Selection of wheels and their conditioning, Classification of grinding machines and their uses, Super finishing processes, Honing, Lapping and Super finishing

Unit 5: Gear and thread manufacturing
Production of screw threads by Machining, Rolling and Grinding, Manufacturing of Gears, Broaching– Principles and Applications

Unit 6: Introduction to Jigs and Fixtures
Role and importance of jigs and fixture, Principle of location and clamping, Locating, Supporting and clamping elements, Application of typical jigs and fixtures.

Texts:

1. P. N. Rao, " Manufacturing Technology- Metal Cutting and Machine Tools", Vol.II, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2nd edition, 2002.
2. Amitabha Bhattacharyya, G. C. Sen, "Principle of MetalCutting", New Central Book

Agency,1969.
3. M. C. Shaw, "Theory of Metal Cutting", Oxford and I.B.H.Publishing, 1st edition,1994.
4. P. H. Joshi, "Jigs and Fixtures", Tata McGraw Hill Publishing Co., New Delhi.

References:

1. Milkell P. Groover, " Fundamentals of Modern Manufacturing: Materials, Processes, and systems", John Wiley and Sons, New Jersey, 4th edition, 2010.
2. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley Longman (Singapore) Pte. India Ltd., 4thedition, 2000.
3. Geoffrey Boothroyd, Winston Knight, "Fundamentals of Machining and Machine Tools", Taylors and Francis, 3rd edition, 2006.
4. Edward G. Hoffman, "Jigs and Fixtures Design", Cengage Learning, 5th edition, 2004.
5. Paul De Garmo, J.T. Black, Ronald A. Kohser, " Materials and Processes in Manufacturing", Wiley, 10th edition, 2007.
6. www.nptel.com, IIT Kharagpur, Manufacturing Processes I.

Metrology and Quality Control

BTMEC505	PCC 18	Metrology and Quality Control	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To understand need of metrology and study basic terminologies of metrology. To learn the basics of limit, fit, tolerances and gauge designing, the principles of measurement of various mechanical properties such as geometrical, dimensional, surface finish, pressure, temperature etc. To learn the use of various measuring instruments with different setups for accurate measurements and get acquainted with various standards of measurements & the calibration process of instruments.

Pre-Requisites: None

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

CO1	Identify techniques to minimize the errors in measurement
CO2	Identify methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.
CO3	Choose limits for plug and ring gauges.
CO4	Explain methods of measurement in modern machineries
CO5	Select quality control techniques and its applications
CO6	Plot quality control charts and suggest measures to improve the quality of product and reduce cost using Statistical tools.

Mapping of course outcomes with program outcomes

Course	Program Outcomes

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3								2
CO2		2	2		2							
CO3			2	3	2							
CO4						3						
CO5	1					2		3	3		3	2
CO6	1					2		3	3		2	2

Course Contents:

Unit 1: Measurement Standard and Comparators
Measurement Standard, Principles of Engineering Metrology, Line end, wavelength, Traceability of Standards. Types and Sources of error, Alignment, Temperature, Plastic deformation, Slip gauges and gauge block, Linear and Angular Measurement (Sine bar, Sine center, Autocollimator, Angle Décor and Dividing head), Calibration. Comparator: Mechanical, Pneumatic, Optical, Electronic (Inductive), Electrical (LVDT).

Unit 2: Interferometry and Limits, Fits, Tolerances
Principle, NPL Interferometer, Flatness measuring of slip gauges, Parallelism, Laser Interferometer, Surface Finish Measurement: Surface Texture, Measuring Surface Finish by Stylus probe, Tomlinson and Talysurf, Analysis of Surface Traces: Methods.
Design of Gauges: Types of Gauges, Limits, Fits, Tolerance; Terminology for limits and Fits. Indian Standard (IS 919-1963) Taylor's Principle.

Unit 3: Metrology of Screw Thread
Gear Metrology: Gear error, Gear measurement, Gear Tooth Vernier; Profile Projector, Tool marker's microscope. Advancements in Metrology: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology.

Unit 4: Introduction to Quality and Quality Tools
Quality Statements, Cost of Quality and Value of Quality, Quality of Design, Quality of Conformance, Quality of Performance, Seven Quality Tools: Check sheet, Flow chart, Pareto analysis, cause and effect diagram, scatter diagram, Brain storming, Quality circles.

Unit 5: Total Quality Management
Quality Function Deployment, 5S, Kaizan, Kanban, JIT, Poka yoke, TPM, FMECA, FTA, Zero defects.

Unit 6: Statistical Quality Control
Statistical Quality Control: statistical concept, Frequency diagram, Concept of Variance analysis, Control chart for variable & attribute, Process Capability.
Acceptance Sampling: Sampling Inspection, OC curve and its characteristics, sampling methods.
Introduction to ISO 9000: Definition and aims of standardizations, Techniques of standardization, Codification system, Varity control and Value Engineering.

Texts:
1. I. C. Gupta, "Engineering Metrology", Dhanpat and Rai Publications, New Delhi, India.

2. M. S. Mahajan, “Statistical Quality Control”, Dhanpat and Rai Publications.

References:

1. R. K. Jain, “Engineering Metrology”, Khanna Publications, 17th edition, 1975.
2. K. J. Hume, “Engineering Metrology”, McDonald Publications, 1st edition, 1950.
3. A. W. Judge, “Engineering Precision Measurements”, Chapman and Hall, London, 1957.
4. K. L. Narayana, “Engineering Metrology”, Scitech Publications, 2nd edition.
5. J. F. Galyer, C. R. Shotbolt, “Metrology for Engineers”, Little-hampton Book Services Ltd., 5th edition, 1969.
6. V. A. Kulkarni, A. K. Bewoor, “Metrology & Measurements”, Tata McGraw Hill Co. Ltd., 1st edition, 2009.
7. Amitava Mitra, “Fundamental of Quality Control and Improvement”, Wiley Publication.
8. V. A. Kulkarni, A. K. Bewoor, “Quality Control”, Wiley India Publication, 01st August, 2009.
9. Richard S. Figliola, D. E. Beasley, “Theory and Design for Mechanical Measurements”, Wiley India Publication.
10. E. L. Grant, “Statistical Quality Control”, Tata McGraw Hill Publications.
11. J. M. Juran, “Quality Planning and Analysis”, Tata McGraw Hill Publications.

Product Design Engineering - II

BTID506	PCC 19	Product Design Engineering - II	1-0-2	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture-cum-demonstration: 1 hr/week Design Studio/Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

Pre-requisites:

Product Design Engineering: Part-I, Basic Knowledge of electronics, electrical, computer and Information Technology

- Design Studio/Practical: 2 hrs to develop design sketching and practical skills
- Continuous Assessment: Progress through a product design and documentation of steps in the selected product design
- End Semester Assessment: Product Design in Studio with final product specifications

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

1.Create prototypes
2. Test the prototypes
3. Understand the product life cycle management

Unit 1: Testing and Evaluation

Prototyping, Design Automation, Product architecture, Prototype testing and evaluation, Working in multidisciplinary teams, Feedback to design processes, Process safety and materials, Health and hazard of process operations.

Unit 2: Embedded Engineering- User Interface

Firmware and Hardware Design, UI programming, Algorithm and Logic Development, Schematic and PCB layout, Testing and Debugging.

Unit 3: Manufacturing

Design models and digital tools, Decision models, Prepare documents for manufacturing in standard format, Materials and safety data sheet, Final Product specifications sheet, Detail Engineering Drawings (CAD/CAM programming), Manufacturing for scale, Design/identification of manufacturing processes.

Unit 4: Environmental Concerns

Product life-cycle management, Disposal of product and waste.

Hands-on Activity Charts for Use of Digital Tools

		Hrs.
Activity 1	Prototyping/Assembly	4
Activity 2	Testing and evaluation	3
Activity 3	UI Programming	3
Activity 4	PCB Layout, Testing and debugging	3
Activity 5	CNC Programming	3
Activity 6	CNC Programming with CAM software	3
Activity 7	Product market and Product Specification Sheet	3
Activity 8	Documentation for the product	2

References:

1. Model Curriculum for "Product Design Engineer – Mechanical", NASSCOM (Ref. ID: SSC/Q4201, Version 1.0, NSQF Level: 7)
2. Eppinger, S., & Ulrich, K.(2015). Product design and development, McGraw-Hill Higher Education.
3. Green, W., & Jordan, P. W. (Eds.).(1999), Human factors in product design: current practice and future trends. CRC Press.
4. Sanders, M. S., & McCormick, E. J. (1993), Human factors in engineering and design. McGRAW-HILL Book Company.
5. Roozenburg, N. F., & Eekels, J. (1995), Product design: Fundamentals and Methods (Vol. 2). John Wiley & Sons Inc.
6. Lidwell, W., Holden, K., & Butler, J.(2010), Universal principles of designs, revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design. Rockport Publication.

Automobile Engineering

BTMEC506A	OEC 2	Automobile Engineering	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Identify the different parts of the automobile.
CO2	Explain the working of various parts like engine, transmission, clutch, brakes etc.,
CO3	Demonstrate various types of drive systems.
CO4	Apply vehicle troubleshooting and maintenance procedures.
CO5	Analyze the environmental implications of automobile emissions. And suggest suitable regulatory modifications.
CO6	Evaluate future developments in the automobile technology.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	1	2		2		1						
CO3	1	1		1	1							
CO4	2			3	1							
CO5		2			1	1	2					
CO6	1		2			2						

Course Contents:

Unit 1: Introduction
Vehicle specifications, Classifications, Chassis layout, Frame, Main components of automobile and articulated vehicles; Engine-cylinder arrangements, Power requirements, Tractive efforts and vehicle performance curves.

Unit 2: Steering and Suspension Systems
Steering system; Principle of steering, Centre point steering, Steering linkages, Steering geometry and wheel alignment, power steering.
Suspension system: its need and types, Independent suspension, coil and leaf springs, Suspension systems for multi-axle vehicles, troubleshooting and remedies.

Unit 3: Transmission System
Clutch: its need and types, Gearboxes: Types of gear transmission, Shift mechanisms, Over running clutch, Fluid coupling and torque converters, Transmission universal joint, Propeller shaft, Front and rear axles types, Stub axles, Differential and its types, Four wheel drive.

Unit 4: Brakes, Wheels and Tyres
Brake: its need and types: Mechanical, hydraulic and pneumatic brakes, Disc and drum type: their relative merits, Brake adjustments and defects, Power brakes, Wheels and Tyres: their types; Tyre construction and specification; Tyre wear and causes; Wheel balancing.

Unit 5: Electrical Systems
Construction, operation and maintenance of lead acid batteries, Battery charging system, Principle and operation of cutout and regulators, Starter motor, Bendix drive, Solenoid drive, Magneto-coil and solid stage ignition systems, Ignition timing.

Unit 6: Vehicle Testing and Maintenance
Need of vehicle testing, Vehicle tests standards, Different vehicle tests, Maintenance: trouble shooting and service procedure, over hauling, Engine tune up, Tools and equipment for repair and overhauling, Pollution due to vehicle emissions, Emission control system and regulations.

Texts:
1. Kripal Singh, "Automobile Engineering", Vol. I and II, Standard Publishers.
2. G. B. S. Narang, "Automobile Engineering", Dhanpat Rai and Sons.

References:
1. Joseph Heitner, "Automotive Mechanics", East-West Press.
2. W. H. Crouse, "Automobile Mechanics", Tata McGraw Hill Publishing Co.

Nanotechnology

BTMEC506B	OEC 2	Nanotechnology	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.
CO2	To impart basic knowledge on various synthesis and characterization techniques involved in Nanotechnology
CO3	To educate students about the interactions at molecular scale
CO4	Evaluate and analyze the mechanical properties of bulk nanostructured metals and alloys, Nano-composites and carbon nanotubes.
CO5	To make the students understand about the effects of using nanoparticles over conventional methods

Mapping of course outcomes with program outcomes

Course	Program Outcomes

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		3	3	2	1		3		1	3
CO2	3	2			3	3	2				1	3
CO3	1	1	1	3	2				2	1		1
CO4	1	1		3	3	2	1		3		1	3
CO5	1	1	1	3	2				2	1		1

Course Contents:

Unit 1: Scientific Revolutions
Types of Nanotechnology and Nano machines: the Hybrid nanomaterial. Multiscale hierarchical structures built out of Nano sized building blocks (nano to macro). Nanomaterials in Nature: Nacre, Gecko, Teeth. Periodic table, Atomic Structure, Molecules and phases, Energy, Molecular and atomic size, Surfaces and dimensional space: top down and bottom up.

Unit 2: Forces between Atoms and Molecules
Particles and grain boundaries, strong Intermolecular forces, Electrostatic and Vander Waals forces between surfaces, similarities and differences between intermolecular and inter particle forces covalent and coulomb interactions, interaction polar molecules.
Thermodynamics of self-assembly.

Unit 3: Opportunity at the Nano Scale
Length and time scale in structures, energy landscapes, Inter dynamic aspects of inter molecular forces, Evolution of band structure and Fermi surface.

Unit 4: Nano Shapes
Quantum dots, Nano wires, Nano tubes, 2D and 3D films, Nano and mesopores, micelles, bilayer, vesicles, bionano machines, biological membranes.

Unit 5: Influence of Nano Structuring
Influence of Nano structuring on mechanical, optical, electronic, magnetic and chemical properties-gram size effects on strength of metals- optical properties of quantum dots.

Unit 6: Nano Behaviour
Quantum wires, electronic transport in quantum wires and carbon nano-tubes, magnetic behavior of single domain particles and nanostructures, surface chemistry of Tailored monolayer, self-assembling.

Texts:

1. C. Koch, "Nanostructured materials: Processing, Properties and Potential Applications", Noyes Publications, 2002.
2. C. Koch, I. A. Ovidko, S. Seal and S. Veprek, "Structural Nano crystalline Materials: Fundamentals & Applications", Cambridge University Press, 2011.

References:

1. Bharat Bhushan, "Springer Handbook of Nanotechnology", Springer, 2nd edition, 2006.
2. Laurier L. Schramm, "Nano and Microtechnology from A-Z: From Nano-systems to Colloids and Interfaces", Wiley, 2014.

Energy Conservation and Management

BTMEC506C	OEC 2	Energy Conservation and Management	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Understand energy problem and need of energy management
CO2	Carry out energy audit of simple units
CO3	Study various financial appraisal methods
CO4	Analyse cogeneration and waste heat recovery systems
CO5	Do simple calculations regarding thermal insulation and electrical energy conservation

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		2	3			2	2		2
CO2	1	1	3	1	2	3			2	2		2
CO3	2	1	1							1		2
CO4	3	3			2	3						1
CO5			3			2						1

Course Contents:

Unit 1: Introduction
General energy problem, Energy use patterns and scope of conservation. Energy Management Principles: Need, Organizing, Initiating and managing an energy management program.

Unit 2: Energy Auditing
Elements and concepts, Types of energy audits, Instruments used in energy auditing.
Economic Analysis: Cash flows, Time value of money, Formulae relating present and future cash flows-single amount, uniform series.

Unit 3: Financial Appraisal Methods
Payback period, Net present value, Benefit-cost ratio, Internal-rate of return, Life cycle costs/benefits. Thermodynamics of energy conservation, Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system.

Unit 4: Cogeneration
Concept, Types of cogeneration systems, performance evaluation of a cogeneration system.
Waste Heat Recovery: Potential, benefits, waste heat recovery equipment's.

Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conservation methods.

Unit 5: Insulation and Heating
Industrial Insulation: Insulation materials, Insulation selection, Economical thickness of insulation.
Industrial Heating: Heating by indirect resistance, direct resistance heating (salt bath furnace), and Heat treatment by induction heating in the electric arc furnace industry.

Unit 6: Energy Conservation in Electric Utility and Industry
Energy costs and two part tariff, Energy conservation in utility by improving loadfactor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems, Importance of Power factor in energy conservation, Power factor improvement methods, Energy conservation in industries

Texts:
1. Callaghan, "Energy Conservation".
2. D. L. Reeg, "Industrial Energy Conservation", Pergamon Press.

References:
1. T. L. Boyen, "Thermal Energy Recovery", Wiley Eastern.
2. L. J. Nagrath, "System Modeling and Analysis", Tata McGraw Hill Publications.
3. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publications.

Machine Design Practice

BTPRL507	PCC 20	Machine Design Practice	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks External Exam: 20 Marks

Pre-Requisites: None

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

CO1	Apply design process to an open ended problem
CO2	Determine suitable material and size for structural component of machine/system
CO3	Apply iterative technique in design including making estimate of unknown values for first computation and checking or revisiting and re-computing
CO4	Choose logically and defend selection of design factors
CO5	Design of components for given part/system i.e. shaft, keys, coupling, links, screws, springs etc.
CO6	Work effectively as a part of design group/team
CO7	Have good communication skill, orally, graphically as well as in writing

Mapping of course outcomes with program outcomes

Course	Program Outcomes

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2			2	1				
CO2	1	3	2	1			1	1				1
CO3	3	2	2	1			1	1				1
CO4	2	2	2	2			1	1				1
CO5	3	3	2	1			2	1				1
CO6						1	1	1	2	2		2
CO7								1	1	2	2	3

List of Practicals/Experiments/Assignments

1. The term work shall consist of two design projects based on the syllabus of Machine Design I. Each design project shall consist of two imperial size sheets- one involving assembly drawings with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified, wherever necessary, so as to make it working drawing
2. A design report giving all necessary calculations for the design of components and assembly should be submitted in a separate file.
3. Two assignments based on topics of syllabus of Machine Design.

Production Processes Lab II

BTPRL508	PCC 21	Production Processes Lab II	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks External Exam: 20 Marks

Pre-Requisites: Manufacturing Processes

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

CO1	Identify Various Arc Welding Methods, Equipments and Electrodes.
CO2	Outline Welding Defects and Their causes, Destructive and Non destructive Testing of Welds
CO3	Calculate the roll separating force, Pressure and Power required for Rolling.
CO4	Determines Forces and Power required in forging and Extrusion
CO5	Estimate Bending Force, Spring back effect in bending and forces in Wire Drawing.
CO6	Classify various advanced forming processes.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	1				1							
CO2	1				1							1
CO3	1		1	1	1							
CO4	1		1	1	1							
CO5	1		1	1	1							
CO6	1				1							

List of Practicals/Experiments/Assignments

Any four experiments should be performed/demonstrated related to joining technologies as well as characterization and testing of the weld joints.

Any four experiments should be performed/demonstrated related to forming and forging processes.

1. Various Types of Joints requirements for Welding
2. Arc Welding.
3. Non Destructive Testing: Magnetic Inspection Testing
4. Non Destructive Testing: Ultrasonic Testing
5. Determine Roll pass Scheduling for Blooming Mill and Drawing of Grooved Rolls.
6. Design Simple Die for Cutting Operation.
7. Design and Drawing of Bending/Forming/Coining Dies.
8. Assignment on Sand Casting.
9. Design of Forging Dies.
10. Assignment on Extrusion Process.
11. Assignments based on the Topics Covered in the Theory Course.

Mechanical Measurement and Metrology Lab

BTPRL509	PCC 22	Mechanical Measurement and Metrology Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks External Exam: 20 Marks

Pre-Requisites: None

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

CO1	Demonstrate calibration process of pressure gauge, strain gauge, and micrometer and dial gauge indicator.
CO2	Measure displacement, flow rate, taper diameter and surface roughness with the help of various instruments.
CO3	Illustrate characteristics of thermocouples, RTD and thermistors.
CO4	Demonstrate the working principle of optical flat.
CO5	Demonstrate the working of tool maker's microscope.
CO6	Examine the gear features by gear rolling tester.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1			1	1					1		1
CO2	1			1	1					1		
CO3	1			1	1					1		
CO4	1				1					1		
CO5	1				1					1		
CO6	1				1					1		

List of Practicals/Experiments/Assignments

1. Calibration of pressure gauge using dead weight gauge calibrator
2. Measurement of displacement using LVDT
3. Calibration of strain gauge
4. Measurement of flow rate using orifice, venture and Rota meters and their error analysis
5. Measurement of flow rate using microprocessor based magnetic flow meter, vortex, Ultrasonic, turbine flow meters
6. Determination of characteristics of thermocouples, RTD, themistors
7. To calibrate the given micrometer using slip gauge as standard
8. Measurement of taper by sine bar
9. To calibrate a dial gauge indicator
10. Study and use of optical flat
11. Surface roughness measurement
12. Tool makers' microscope
13. To measure the major, minor and effective diameter by using floating carriage diameter measuring machine
14. Inspection of gear by Gear Rolling Tester

Field Training/ Internship/ Industrial Training II

BTPRF510	Project 2	Field Training/ Internship/ Industrial Training II	---	1 Credit

Examination Scheme:
End Semester Exam: 50 Marks

Pre-Requisites: None

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

CO1	To make the students aware of industrial culture and organizational setup
CO2	To create awareness about technical report writing among the student.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1	1			2		1			3	3
CO2		1	1			2		1			3	2

Students will have to undergo 4 weeks training programme in the Industry during the summer vacation after IVth semester examination. It is expected that students should understand the organizational structure, various sections and their functions, products/services, testing facilities, safety and environmental protection measures etc.

Also, students should take up a small case study and propose the possible solution(s).

They will have to submit a detailed report about the training programme to the faculty coordinator soon after joining in final year B.Tech. Programme. They will have to give a power point presentation in front of the group of examiners.

Semester VI

CAD/CAM/CIM

BTPRC601	PCC 23	CAD/CAM/CIM	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	List and describe the various input and output devices for a CAD work station
CO2	Carry out/calculate the 2-D and 3-D transformation positions (Solve problems on 2-Dand 3-D transformations)
CO3	Describe various CAD modeling techniques with their relative advantages and limitations
CO4	Describe various CAD modeling techniques with their relative advantages and limitations
CO5	Develop NC part program for the given component, and robotic tasks
CO6	Describe the basic Finite Element procedure
CO7	Explain various components of a typical FMS system, Robotics, and CIM
CO8	Classify parts in part families for GT
CO9	Describe and differentiate the CAPP systems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											1
CO2	3	2	1		2							1
CO3	1		1									1
CO4	3											1
CO5	1	3	3		1							1
CO6	3	1	1		1							1
CO7	3											1
CO8	3	1	2	3	1							1
CO9	2	1										1

Course Contents:

Unit 1: Computer Aided Design (CAD)

Hardware required for CAD: Interactive input output devices, Graphics software: general requirements and ground rules, 2-D curves like Line, Circle, etc. and their algorithms, 2-D

and 3-D transformations such as Translation, Scaling, Rotation and Mirror

Unit 2: Bezier and B-splines Curves
Equations and Applications, window and view port clipping algorithms, 3-D geometries, CSG, B-rep, wireframe, surface and solid modeling and their relative advantages, limitations and applications.

Unit 3: Computer Aided Manufacturing (CAM)
Numerical Control, Elements of a NC system, Steps in NC based manufacturing, Point to point, straight line and contouring control, Manual and Computer Assisted Part Programming, NC and APT programming, Adaptive control, Distributed Numerical Control.

Unit 4: Finite Element Methods
Introduction, Types of elements, Degrees of freedom, Field variable, Shape function, Boundary conditions, Meshing, Nodal displacements, Plain stress and plain strain problems, 1-D, 2-D and 3-D problems, Static, dynamic and thermal analysis, Preprocessors – solvers – postprocessor.

Unit 5: Flexible Manufacturing System
Introduction, Components of FMS, Group Technology, Part classification and families, Composite part, Types of FMS layouts, Advantages of FMS
Robotics: Robot configurations, Drives for robots, Sensors used in robotics, Programming technique, Programming languages, Applications, Latest development in robotics

Unit 6: Computer Aided Process Planning
Introduction, Retrieval and Generative CAPP systems, generation of Machining Data.
Computer Integrated Manufacturing: Introduction, Types of data, Types of interfaces, Computer network structures, Computerized production management systems, Inventory management, MRP, Operation scheduling, Process monitoring, Computer aided quality control, Testing/Inspection methods.

Texts:
1. Ibrahim Zeid, "CAD/CAM Theory and Practice", Tata McGraw Hill Publication,
2. M. P. Grover, Zimmer, "CAD/CAM/CIM", Prentice Hall India.

CNC Machines and Programming

BTPRC602	PCC 24	CNC Machines and Programming	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Demonstrate the basic principle of operation of NC/CNC machines.
CO2	Outline the constructional features of CNC machines.
CO3	Compare various drives and tooling used for CNC machines
CO4	Prepare a part program for producing a given product.
CO5	Simulate a part program for its verification.
CO6	Construct and suggest a maintenance plan for a specific machine tool.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1				1							
CO4	1			1	1							1
CO5	1			1	1							
CO6	1				1							

Course Contents:

Unit 1: Introduction to Numerical Control
Numerical Control: Introduction, Applications of NC/CNC, Benefits of NC/CNC, Limitations of CNC. Classification of NC/CNC systems: Based on type of Control (PTP\C\L).

Unit 2: Components of CNC System
Basic components of CNC system, Design considerations, structure, Antifriction LM guide-ways, spindles, balls crews.

Unit 3: CNC Drives and Tooling
CNC Drives and controls: Servomotors, Stepper motors, Linear motors, CNC Tooling, Pre-setter, Tool and work holding devices, Automatic Tool Changers, Automatic Pallet Changers.

Unit 4: CNC Programming
Part programming: Introduction, Part Program and its elements, Methods of Programming: Manual and Computer Assisted Part programming, APT and its variations.

Unit 5: Simulation of CNC Programming
Conversational and graphics based software, solids based part programming, free form surface machining, simulation and verification of CNC programs, and computer assisted part programming.

Unit 6: CNC Machines
Maintenance and installation of CNC systems, utilization of CNC machines.

Texts:

1. P. N. Rao, "CAD/CAM: Principles and Applications", Tata McGraw-Hill Publications, 2nd edition, 2004.

2. HMT Ltd, “Mechatronics”, Tata McGraw-Hill Publications, New Delhi, 1998.

References:

1. James Madison, “CNC Machining Handbook”, Industrial Press Inc, 1996.
2. Amitabha Ghosh, A. K. Mallik, “Manufacturing Science”, Affiliated East West Press, 2000.
3. www.nptel.com, IIT Khargapur, Manufacturing Processes
4. www.nptel.com,IIT Madras, CNC Machines

Industrial Engineering and Management

BTPRC603	PCC 25	Industrial Engineering and Management	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Identify the managerial functions and acquire skills required by a manager in an industry.
CO2	Identify and categorize the functions of different managerial positions in industry.
CO3	Demonstrate an ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
CO4	Select and suggest the fundamental motions and movements of man, material, resources to optimize the same.
CO5	Determine and justify the interactions between engineering, businesses, technological and environmental spheres in the modern society.
CO6	Suggest and outline the resource requirements in terms of manpower, equipments, capital and their inter-relationship in an industry focusing on human safety, security and comfort.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1						2	1
CO2	1				1				2	2	2	
CO3	1				1			2				
CO4	1				1			2				2
CO5	1				1			2				2
CO6	1				1			2				2

Course Contents:

Unit 1: Introduction

Managing and managers, management- science, theory and practice, functions of management, evolution of management theory, contributions of Taylor, Fayol and others.

Planning: The nature and purpose of planning, objectives, strategies, policies and planning premises, decision making.

Organizing: The nature and purpose of organizing, departmentation, Line/ staff authority and decentralization, effective organizing and organizational culture.

Unit 2: Human Resource Management

Staffing: Human resource management and selection, orientation, apprentice training and Apprentice Act (1961), performance appraisal and career strategy, job evolution and merit rating, incentive schemes.

Leading: Managing and human factor, motivation, leadership, morale, team building, and communication.

Controlling: The system and process of controlling control techniques, overall and preventive control.

Unit 3: Production/Operations Management

Operations management in corporate profitability and competitiveness, types and characteristics of manufacturing systems, types and characteristics of services systems.

Operations planning and Control: Forecasting for operations, materials requirement planning, operations scheduling.

Unit 4: Design of Operational Systems

Product/process design and technological choice, capacity planning, plant location, facilities layout, assembly line balancing, and perspectives on operations systems of the future.

Unit 5: Introduction to Industrial Engineering

Scope and functions, history, contributions of Taylor, Gibreth, Gantt and others.

Work Study and Method Study: Charting techniques, workplace design, motion economy principles.

Work Measurement: Stopwatch time study, micromotion study, predetermined time system (PTS), work sampling.

Unit 6: Ergonomics

Basic principles of ergonomics

Concurrent Engineering: Producibility, manufacturability, productivity improvement.

Total Quality Management: Just in time (JIT), total quality control, quality circles, six sigma.

Texts:

1. H. Koontz, H. Weirich, "Essentials of Management", Tata McGraw Hill book Co., Singapore, International Edition, 5th edition, 1990.
2. E. S. Buffa, R. K. Sarin, "Modern Production/Operations Management", John Wiley & Sons, New York, International Edition, 8th edition, 1987.
3. P. E. Hicks, "Industrial Engineering and Management: A New Perspective", Tata McGraw Hill Book Co., Singapore, International Edition, 2nd edition, 1994.

References:

1. J. L. Riggs, "Production Systems: Planning, Analysis and Control", John Wiley & Sons, New York, International Edition, 4thedition, 1987.
2. H. T. Amrine, J. A. Ritchey, C. L. Moodie, J.F. Kmec, "Manufacturing Organization and Management", Pearson Education, 6th edition, 2004.
3. International Labour Organization (ILO), "Introduction to Work Study", International Labour Office, Geneva, 3rd edition, 1987.
4. www.nptel.com.

Flexible Manufacturing Systems

BTPRC604A	PEC 1	Flexible Manufacturing Systems	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To understand Flexible Manufacturing Systems, Configurations, Workstations, Control systems, applications and benefits.

Pre-Requisites: None

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

CO1	Define FMS, its need, benefits and limitations.
CO2	Outline layout, configuration and optimization of FMS.
CO3	Outline the process of installation, interfacing and monitoring of FMS.
CO4	Propose suitable FMS configuration for a given application.
CO5	Identify AGV, ASRS, transfer and feeding mechanisms in FMS.
CO6	Summarize tool management and monitoring strategies in FMS.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1	1						
CO3	1				1	1						

CO4	1				1		1					
CO5	1				1				1			
CO6	1				1				1			1

Course Contents:

Unit 1: Overview of FMS
An overview, need for FMS, classification, benefits and limitations, components of FMS, Flexibility in manufacturing, Building blocks of FMS, FMS control, FMC Vs FMS.

Unit 2: Implementation of FMS
FM system development and implementation of an FMS, planning, description, layout and configuration, analysis and optimization of FMS, organization and information processing in manufacturing.

Unit 3: Software for FMS
Concepts of distributed numerical control, programmable controller's hardware configurations, FMS software, FMS instillation, and computer control of work center and assembly lines, functions of computers, computer process interface, and computer process monitoring.

Unit 4: Modeling and Simulation of FMS
Modeling, simulation and analysis of FMS design, Scheduling and loading of FMS, network, Economic considerations.

Unit 5: Automation in FMS
Automated material handling and storage, automated storage, automated flow lines, methods of work-part transport, transfer mechanisms, auxiliary support equipment, automation of machining operations, introduction and design of automated assembly systems, part feeding devices, automated inspection and testing, contact and noncontact inspection methods.

Unit 6: Tool Management

FMS fixtures, tool management, tool strategies, tool monitoring and fault detection, analysis methods for FMS, FMS development towards factories of the future

Texts/References:

1. D. J. Parish, Flexible Manufacturing Systems, Butter Worth-Heinemann Ltd., Oxford, 1993.
2. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall of India Ltd., 1989.
3. A.Kusiak, Intelligent Manufacturing Systems, Prentice Hall, Englewood Cliffs, New Jercy, 1990.
4. D.M.Considine, G.D.Considine, Standard Handbook of Industrial Automation, Chapman and Hall, London, 1986.
5. N.Viswanadhan, Y.Narhari, Performance Modeling of Automated Manufacturing Systems, Prentice Hall of India Ltd., 1992.
6. P.G.Ranky , The Design and Operation of FMS, IFS Publishers. UK, 1988.

7. W.W.Luggen , Flexible Manufacturing Cells and Systems, Prentice Hall, Eaglewood Chiffs, New Jercy, 1991.

Production Planning and Control

BTPRC604B	PEC 1	Production Planning and Control	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To gain an understanding and appreciation of the fundamental principles and methodologies relevant to planning, design, operation, and control of production systems. To reinforce analytical skills already learned, and build on these skills to further increase ones "portfolio" of useful analytical tools. To gain ability to recognize situations those suggest the use of certain quantitative methods to assist in decision making and learn how to think about, approach, analyze, and solve production system problems using both technology and skill people.

Pre-Requisites: None

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

CO1	Illustrate functions of PPC and basic concepts of product analysis.
CO2	Estimate output for a given data using various forecasting methods.
CO3	Determine the optimal production order quantity for a given data.
CO4	Estimate the machine output and process capacities in a multi-product system.
CO5	Solve the sequencing problems for the given data.
CO6	Estimate the inventory level by various methods for given data.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1			1	1							
CO3	1			1	1						1	
CO4	1			1	1						1	
CO5	1			1	1							
CO6	1			1	1							

Course Contents:

Unit 1: Product Development and Design

Introduction: Functions of PPC, types of production, production consumption cycle, coordination of production decisions. Product Design and Company Policy, Product

Analysis: Marketing Aspect, Product Characteristics, Economic Analysis, production Aspect.

Unit 2: Forecasting and Facility Layout

Introduction, Time Series Methods, Casual Methods, Forecast Errors. Facility Layout: Introduction, Flow Systems, Types of Layout: Product, Process, Group Layout, Computerized Layout Planning

Unit 3: Production Order

Purpose of production order, procedure for formulating production order, process outlines, process and activity charts, production master program, operation and route sheet, production order. Batch Production: Quantities in batch production, criteria for batch size determination, minimum cost batch size, production range, maximum profit batch size, maximum return and maximum rate of return economic batch size

Unit 4: Machine Output

Machine output, multi-machine supervision by one operator, machine interference, balancing of machine lines, analysis of process capacities in a multi -product system

Unit 5: Production and Operations Planning

Aggregate Planning, Strategies and techniques for Aggregate Planning, Production Planning in Mass Production Systems and Assembly Line Balancing, Sequencing problems such as 1 machine n jobs, 2 machines n jobs & its extension, m machines 2 jobs, scheduling jobs with random arrivals

Unit 6: Inventory Control

Inventory and its purpose, the relevant costs, selective inventory analysis (ABC analysis), Classical Inventory Model, EOQ with quantity discounts, EOQ for multiple items with constraints on resources, Safety Stock, determining safety stock when usage and lead time vary, Fixed Order Period Inventory Control System

Texts:

1. D.Bedworth and J.E Bailey, "Integrated Production Control: System-management, Analysis and Design", John Wiley, 1983.
2. A.Elsayed and T.O. Boucher, "Analysis and Control of Production Systems", Prentice Hall, 1985.
3. J. R. King, "Production Planning and Control", Pergamon Press, Oxford, 1975.

References:

1. P.F.Bestwick and K.Lockyer, "Quantitative Production Management", Pitman Publications, 1982.
2. A.C.Haxand D.Candea, "Production and Inventory Management", Prentice-Hall, 1984.
3. M.G.Korgaokar, "JIT Manufacturing", Macmillan, 1992.

Assembly Planning and Management

BTPRC604C	PEC 1	Assembly Planning and Management	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To gain an understanding and interest in the assembly line design practices prevalent in industry and ability to recognize situations in an assembly system environment those suggest the use of certain quantitative methods to assist in decision making. To learn how to think about, approach, analyze, and solve assembly system problems using people skills (predominantly) and technology.

Pre-Requisites: None

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

CO1	Illustrate key characteristics and types of assembly.
CO2	Classify the various methods of assembly sequence planning.
CO3	Outline the concept of assembly line design.
CO4	Solve simple assembly line balancing problems.
CO5	Formulate and solve generalized assembly line balancing problems.
CO6	Illustrate need and approaches for reconfiguration of assembly lines.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1	1			1							
CO4	1				1		1					
CO5	1				1		1					
CO6	1				1	1						

Course Contents:

Unit 1: Introduction to Assembly Planning

Assembling a product, manual and automatic assembly, robotic assembly, Liaison diagram, assembly process, key characteristics of assembly, variation risk and its management.

Unit 2: Assembly Sequence Planning

Introduction, assembly sequencedesign process, Bourjault method of generating all feasible sequences, cutest method, stability of subassemblies, softwares

Unit 3: Assembly Line Design
Process of Assembly Line Design (ALD), components of ALD, consideration of equipments, buffers etc. Introduction to assembly line balancing and defining assembly line balancing problem using precedence diagrams.

Unit 4: Simple Assembly Line Balancing Problem (SALBP)
Performance Characteristics, types of SALBP, optimal solution methods for SALBP, heuristics and meta-heuristics, introduction to Genetic Algorithm, applying simple genetic algorithmic approach to SALBP.

Unit 5: Generalized Assembly Line Balancing Problem (GALBP)
Considerations leading to GALBP, formulation and solution approaches for a few types of GALBP such as assignment restrictions, mixed model ALBP, U-line ALBP, parallelization, etc.

Unit 6: Reconfiguration
Need and importance of reconfiguration/rebalancing, approaches for reconfiguration.

Texts and References:
1. Daniel E. Whitney, "Mechanical Assemblies", Oxford University Press, 2004

2. Mikell P. Groover, "Automation: Production Systems and Computer Integrated Manufacturing", Second edition, Prentice Hall of India, 2002

Supply Chain Management

BTPRC604D	PEC 1	Supply Chain Management	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Study demand management, customer order decoupling, market and CPFR in SCM.
CO2	Understand managing operations, customization and optimization in SCM.
CO3	Acquire knowledge in procurement, MRP, inventory techniques in SCM.
CO4	Study logistics and transportation in SCM.
CO5	Describe need, tools, internet role, and demand management using IT in SCM.

CO6	Analyze the performance, SCOR and balance score card for SCM.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2							1				1	
CO3	1				1				1		1	
CO4	1				1				1		1	
CO5	1				1						1	
CO6	1				1		1				1	

Course Contents:

Unit 1: Introduction to Supply Chain Management
Building a strategic framework to analyze Supply Chains: Understanding the supply chain, supply chain performance, Supply chain drivers & obstacles.

Unit 2: Planning Demand & Supply in Supply Chains
Demand forecasting in supply chain, aggregate planning in supply chain, planning demand & supply in supply chains.

Unit 3: Planning & Managing Inventories in a Supply in Supply Chains
Managing economies of scale in a supply chain: cycle inventory, managing uncertainty in supply chain: safety inventory, determining optimal level of product availability.

Unit 4: Design Consideration in Supply Chain
Transportation, Network Design, & Information technology in a supply chain: Transportation in supply chain, facility decisions: network design in a supply chain, information technology in a supply chain.

Unit 5: Supply Chain Coordination Logistics in SCM
Coordinating in a Supply Chain & role of E-Business: Coordination in a supply chain, E-business & the supply chain. Logistics In Supply Chain Management: Introduction, Strategy, Transportation Selection, Trade-off, Models for Transportation and Distribution, Third Party Logistics, Overview of Indian Infrastructure for Transportation.

Unit 6: Financial Consideration in Supply Chain
Financial factors Influencing Supply Chain Decisions: Financial evaluation of supply chain decisions, the impact of financial factors on supply chain decisions, evaluating supply chain decisions using decision trees.

Texts:

1. A. S. Altekar, “Supply Chain Management” PHI
2. James Stock and Doug, “Logistics Management”

References:

1. Supply Chain Management for Global Competition
2. Emerging Trends in Supply Chain Management
3. Bowersox, “Logistics Management” TMH 2004

Quantitative Techniques in Project Management

BTMEC605A	OEC 3	Quantitative Techniques in Project Management	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Engineering Mathematics-I/II/III

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

CO1	Define and formulate research models to solve real life problems for allocating limited resources by linear programming.
CO2	Apply transportation and assignment models to real life situations.
CO3	Apply queuing theory for performance evaluation of engineering and management systems.
CO4	Apply the mathematical tool for decision making regarding replacement of items in real life.
CO5	Determine the EOQ, ROP and safety stock for different inventory models.
CO6	Construct a project network and apply CPM and PERT method.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	3	2				3	1	3	1
CO2	3	1	1	3	2				3	2	3	1
CO3	3	1	1	3	2				3	2	3	1
CO4	3	1	1	3	2	1			3	2	3	1
CO5	3	1	1	3	2	1			3	2	3	1
CO6	3	1	1	3	2	2			3	2	3	1

Course Contents:

Unit 1: Introduction

Introduction to Operations Research, Stages of Development of Operations Research, Applications of Operations Research, Limitations of Operations Research Linear programming problem, Formulation, graphical method, Simplex method, artificial variable techniques.

Unit 2: Assignment and Transportation Models
Transportation Problem, North west corner method, Least cost method, VAM, Optimality check methods, Stepping stone, MODI method, Assignment Problem, Unbalanced assignment problems, Travelling salesman problem.

Unit 3: Waiting Line Models and Replacement Analysis
Queuing Theory: Classification of queuing models, Model I (Birth and Death model) M/M/I (∞, FCFS), Model II - M/M/I (N/FCFS).
Replacement Theory, Economic Life of an Asset, Replacement of item that deteriorate with time, Replacement of items that failed suddenly.

Unit 4: Inventory Models
Inventory Control, Introduction to Inventory Management, Basic Deterministic Models, Purchase Models and Manufacturing Models without Shortages and with Shortages, Reorder level and optimum buffer stock, EOQ problems with price breaks.

Unit 5: Project Management Techniques
Difference between project and other manufacturing systems. Defining scope of a project, Necessity of different planning techniques for project managements, Use of Networks for planning of a project, CPM and PERT.

Unit 6: Time and Cost Analysis
Time and Cost Estimates: Crashing the project duration and its relationship with cost of project, probabilistic treatment of project completion, Resource allocation and Resource leveling.

Texts:

1. P. K. Gupta, D. S. Hira, "Operations Research", S. Chand and Company Ltd., New Delhi, 1996.
2. L. C. Jhamb, "Quantitative Techniques for managerial Decisions", Vol. I and II, Everest Publishing House, Pune, 1994.
3. N. D. Vohra, "Operations Research", Tata McGraw Hill Co., New Delhi.

References:

1. H. Taha, "Operations Research–An Introduction", Maxwell Macmillan, New York.
2. J. K. Sharma, "Operations Research–An Introduction", Maxwell Macmillan, New Delhi.
3. Harvey M. Wagner, "Principles of Operations Research with Applications to Managerial Decisions", Prentice Hall of India Pvt. Ltd., New Delhi, 2nd edition, 2005.
4. Rubin and Lewin, "Quantitative Techniques for Managers", Prentice Hall of India Pvt. Ltd., New Delhi.

Sustainable Development

BTMEC605B	OEC 3	Sustainable Development	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Explain the difference between development and sustainable development
CO2	Explain challenges of sustainable development and climate change
CO3	Explain sustainable development indicators
CO4	Analyze sustainable energy options
CO5	Understand social and economic aspects of sustainable development

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		2	3	3	3	2	2		2
CO2	1	1	3	1	2	3	3	3	2	2		2
CO3	2	1	1				3	2		1		2
CO4	3	3			2	3	3	2				1
CO5			3			2	3	2				1

Course Contents:

Unit 1: Introduction
Status of environment, Environmental, Social and Economic issues, Need for sustainability, nine ways to achieve sustainability, population, resources, development and environment.

Unit 2: Global Warming and Climate Change
Global Warming and climate Change since industrial revolution, Greenhouse gas emission, greenhouse effect, Renewable energy, etc.

Unit 3: Challenges of Sustainable Development and Global Environmental Issues
Concept of sustainability, Factors governing sustainable development, Linkages among sustainable development, Environment and poverty, Determinants of sustainable development, Case studies on sustainable development, Population, income and urbanization Health care, Food, fisheries and agriculture , Materials and energy flows.

Unit 4: Sustainable Development Indicators
Need for indicators, Statistical procedures Aggregating indicators, Use of principal component analysis, Three environmental quality indices.

Unit 5: Environmental Assessment
National environmental policy act of 1969, Environmental Impact Assessment, Project categories based on environmental impacts, Impact identification methods, Environmental impact assessment process.

Unit 6: Environmental Management and Social Dimensions
Revisiting complex issues, Sector policies concerning the environment, Institutional framework for environmental management, Achievements in environmental management, People's perception of the environment, Participatory development, NGOs, Gender and

development, Indigenous peoples, Social exclusion and analysis.

Texts:

1. J. Sayer, B. Campbell, "The Science of Sustainable Development: Local Livelihoods and the Global Environment", Biological Conservation, Restoration and Sustainability, Cambridge University Press, London, 2003.
2. J. Kirkby, P. O"Keefe, Timberlake, "Sustainable Development", Earth scan Publication, London, 1993.
3. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, "An introduction to sustainable development", Glen Educational Foundation, 2008.

References:

1. Jennifer A. Elliott, "An introduction to sustainable development". London: Routledge: Taylor and Francis group, 2001.
2. Low, N. "Global ethics and environment", London, Rout ledge, 1999.
3. Douglas Muschett, "Principles of Sustainable Development", St. Lucie Press, 1997.

Renewable Energy Sources

BTMEC605C	OEC 3	Renewable Energy Sources	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Explain the difference between renewable and non-renewable energy
CO2	Describe working of solar collectors
CO3	Explain various applications of solar energy
CO4	Describe working of other renewable energies such as wind, biomass

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		2	3	3	3	2	2		2
CO2	1	1	3	1	2	3	3	3	2	2		2
CO3	2	1	1				3	2		1		2
CO4	3	3			2	3	3	2				1

Course Contents:

Unit 1: Introduction

Energy resources, Estimation of energy reserves in India, Current status of energy conversion technologies relating to nuclear fission and fusion, Solar energy.

Unit 2: Solar Radiations

Spectral distribution, Solar geometry, Attenuation of solar radiation in Earth's atmosphere,

Measurement of solar radiation, Properties of opaque and transparent surfaces.

Unit 3: Solar Collectors

Flat Plate Solar Collectors: Construction of collector, material, selection criteria for flat plate collectors, testing of collectors, Limitation of flat plate collectors, Introduction to ETC.

Concentrating type collectors: Types of concentrators, advantages, paraboloid, parabolic trough, Heliostat concentrator, Selection of various materials used in concentrating systems, tracking.

Unit 4: Solar Energy Applications

Air/Water heating, Space heating/cooling, solar drying, and solar still, Photo-voltaic conversion.

Unit 5: Wind Energy and Biomass

Types of wind mills, Wind power availability, and wind power development in India. Evaluation of sites for bio-conversion and bio-mass, Bio-mass gasification with special reference to agricultural waste.

Unit 6: Introduction to Other Renewable Energy Sources

Tidal, Geo-thermal, OTEC; Mini/micro hydro-electric, Geo-thermal, Wave, Tidal System design, components and economics.

Texts:

1. Chetansingh Solanki, "Renewable Energy Technologies", Prentice Hall of India, 2008.

References:

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publications, New Delhi, 1992.
2. G. D. Rai, "Solar Energy Utilization", Khanna Publisher, Delhi, 1992.

Biology for Engineers

BTMEC606A	OEC 4	Biology for Engineers	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Explain origin of life and Evolution, Cells, Biomolecules-Lipids
CO2	Understand Biomolecules
CO3	Understand Cell structure and function and cell cycle
CO4	Explain Mendelian genetics
CO5	Understand and Explain DNA structure, DNA replication, Transcription, Translation

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		1		1			1		1
CO2	1	2	3		1		1			1		1
CO3	1	2	3		1		1			1		1
CO4	1	2	3		1		1			1		1
CO5	1	2	3		1		1			1		1

Course Contents:

Unit 1: Introduction
Origin of life and Evolution, Cells, Biomolecules-Lipids

Unit 2: Biomolecules
Carbohydrates, water, Amino acids and proteins, Enzymes, Nucleotides

Unit 3: Cell structure
Cell structure and function, Prokaryotes, Eukaryotes

Unit 4: Cell cycle
Cell division, mitosis, meiosis, culture growth,

Unit 5: Genetics
Mendelian genetics, genetic disorders, Mendelian inheritance principle, pedigree analysis, Non- Mendelian inheritance

Unit 6: DNA
Chromatin, DNA structure, DNA replication, Transcription, Translation.

Texts:
1. Arthur T. Johnson, "Biology for Engineers", CRC Press.

References:
1. N. A. Campbell, J. B. Reece, "Biology", International edition, Benjamin Cummings, New York, 7th edition or later, 2007 or later.
2. G. Karp, "Cell and Molecular Biology: Concepts and Experiments", Wiley, New York, 7th edition, 2013.

Solar Energy

BTMEC606B	OEC 4	Solar Energy	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Describe measurement of direct, diffuse and global solar radiations falling on horizontal and inclined surfaces.
CO2	Analyze the performance of flat plate collector, air heater and concentrating type collector.
CO3	Understand test procedures and apply these while testing different types of collectors.
CO4	Study and compare various types of thermal energy storage systems.
CO5	Analyze payback period and annual solar savings due to replacement of conventional systems.
CO6	Design solar water heating system for a few domestic and commercial applications.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	1	2				1						
CO3	2			1	1		2					
CO4	1	1										
CO5		2			1							
CO6			2	3		1	1					

Course Contents:

Unit 1: Solar Radiation
Introduction, spectral distribution, solar time, diffuse radiation, Radiation on inclined surfaces, measurement of diffuse, global and direct solar radiation.

Unit 2: Liquid Flat Plate Collectors
Introduction, performance analysis, overall loss coefficient and heat transfer correlations, collect or efficiency factor, collect or heat removal factor, testing procedures.

Unit 3: Solar Air Heaters
Introduction, types of air heater, testing procedure.

Unit 4: Concentrating Collectors
Types of concentrating collectors, performance analysis

Unit 5: Thermal Energy Storage
Introduction, sensible heat storage, latent heat storage and thermo chemical storage
Solar Pond: Solar pond concepts, description, performance analysis, operational problems.

Unit 6: Economic Analysis
Definitions, annular solar savings, payback period.

Texts:
1. J. A. Duffie, W. A. Beckman, “Solar Energy Thermal Processes”, John Wiley, 1974.

2. K. Kreith,J. F. Kreider, "Principles of Solar Engineering", Tata McGrawHill Publications, 1978.

References:

1. H. P. Garg, J. Prakash, "Solar Energy: Fundamentals and Applications", Tata McGraw Hill Publications, 1997.
2. S. P. Sukhatme, "Solar Energy Principles of Thermal Collection and Storage", Tata McGraw Hill Publications, 1996.

Human Resource Management

BTMEC606C	OEC 4	Human Resource Management	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Describe trends in the labor force composition and how they impact human resource management practice.
CO2	Discuss how to strategically plan for the human resources needed to meet organizational goals and objectives.
CO3	Define the process of job analysis and discuss its importance as a foundation for human resource management practice
CO4	Explain how legislation impacts human resource management practice.
CO5	Compare and contrast methods used for selection and placement of human resources.
CO6	Describe the steps required to develop and evaluate an employee training program
CO7	Summarize the activities involved in evaluating and managing employee performance.
CO8	Identify and explain the issues involved in establishing compensation systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					2						1	
CO2											3	
CO3										2		
CO4								2		2		
CO5									2	3		
CO6										1		3
CO7										2	2	
CO8											2	

Course Contents:

Unit 1: Introduction to Human Resource Management

Concept of management, concept of human resource management, personnel to human resource management, human resource management model, important environmental influences like government regulations, policies, labor laws and other legislation. **Acquisition of human resources:** Human resource planning, Demand for manpower, Weaknesses of manpower planning, job analysis, job specification, recruitment sources, recruitment advertising, the selection process, selection devices, equal opportunities: Indian and foreign practices, socializing the new employee

Unit 2: Development of Human Resources

Employee Training and Management Development: Training, Training and Learning, Identification of training needs, training methods, Manager Development, Methods for developing managers, evaluating training effectiveness

Career Development: Concept of career, value of effective career development, external versus internal dimensions to a career, career stages, linking career dimensions with stages

Unit 3: Motivation of Human Resources

Definition of motivation, Nature and Characteristics of Motivation, Theories of motivation: Maslow's Need Hierarchy Theory, Drucker Theory, Likert Theory, Herzberg Two Factor Theory, McClell and Theory, McGregor Theory X and Y, etc., Psychological approach.

Job Design and Work Scheduling: Design, Scheduling and Expectancy Theory, Job characteristics model, job enrichment, job rotation, workmodules, flex-time, new trends in work scheduling.

Unit 4: Performance Appraisal

Performance appraisal and expectancy theory; appraisal process, appraisal methods, factors that can destroy appraisal.

Rewarding the Productive Employee: Rewards and expectancy theory, types of rewards, qualities of effective rewards, criterions for rewards.

Unit 5: Maintenance of Human Resources

Compensation Administration: Concept of Compensation Administration, Job evaluation, Pay structures, Incentives compensation plans.

Benefits and Services Benefits: Something for everybody, Services, Trends in benefits and services.

Discipline: Concept of Discipline, types of discipline problems, general guidelines, disciplinary action, employment-at-will doctrine, disciplining special employee groups

Safety and Health: safety programs, health programs, stress, turn out.

Unit 6: Labor Relations

Unions, Major laborl egislation, goals of group representation.

Collective Bargaining: Objectives, scope, participants of collective bargaining, process of collective bargaining, trends in collective bargaining

Research and the future: What is research? Types of research, why research in human resource management, Secondary sources: where to look it up, Primary sources: relevant research methods, current trends and implications for human resource management.

Texts:

1. David A. DeCenzo, Stephen P. Robbins, "Personnel/Human Resources Management",

Prentice Hall of India Pvt. Ltd, 3rd edition,2002.
2. Trevor Bolton, "An Introduction to Human Resource Management", Infinity Books, 2001.

References:

1. Ellen E. Kossek, "Human Resource Management – Transforming the Workplace", Infinity Books, 2001.
2. G.S.Batra, R.C.Dangwal, "Human Resource Management New Strategies", Deep and Deep Publications Pvt. Ltd., 2001.
3. D. M. Silvera, "HRD: The Indian Experience", New India Publications, 2nd edition, 1990.

Metal Cutting Lab

BTPRL607	PCC 26	Metal Cutting Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks External Exam: 20 Marks

Pre-Requisites: Manufacturing Processes

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

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

- **Any 8 out of the following should be conducted**

1. Study of types of chips
2. Study of the effect of process parameters on cutting ratio and shear angle in oblique turning process

3. Study of the effect of process parameters on the surface roughness during oblique turning process
4. Study of the effect of cutting fluid on surface roughness during oblique turning process
5. Study of the effect of process parameters on tool wear during oblique turning process
6. Study of the effect of process parameters on cutting forces in oblique turning process
7. Study of the effect of process parameters on cutting forces in end milling process
8. To examine the effect of parameters on MRR and TWR in Electro Discharge Machining (EDM).
9. To evaluate machining accuracy in EDM.
10. Demonstration on Wire-EDM
11. Industrial visit to study manufacturing practices.

CAD/CAM/CIM Lab

BTPRL608	PCC 27	CAD/CAM/CIM Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks External Exam: 20 Marks

Pre-Requisites: None

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

CO1	Construct CAD part models, assembly model and drafting of machine elements using CAD software.
CO2	Evaluate stresses in components subjected to simple structural loading using FE software
CO3	Write NC programs for turning and milling
CO4	Describe case study of industrial robots

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1	1			1							
CO3	1				1							
CO4	1				1	1						

List of Practicals/Experiments/Assignments

1. Part modeling of machine elements using any one of the CAD software out of ProE, CATIA, Unigraphics or Autodesk Inventor Professional.
2. Assembly modeling of assembly or sub-assembly of engineering products using any one of the CAD software out of ProE, CATIA, Unigraphics or Autodesk Inventor Professional.
3. Drafting of Parts and Assembly of engineering assembly using any one of the CAD

software out of ProE, CATIA, Unigraphics, or Autodesk Inventor Professional.

4. Minimum 4 structural analysis problems to be solved using a CAE software like Ansys, Hyperworks, etc.
5. Minimum 2 Jobs (Programs) on CNC Turning operations
6. Minimum 2 Jobs (programs) on CNC Milling operation
7. Case Study of an Industrial Robot

CNC Machines and Programming Lab

BTPRL609	PCC 28	CNC Machines and Programming Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks External Exam: 20 Marks

Pre-Requisites: None

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

CO1	Identify various parts of CNC lathe and CNC milling machine.
CO2	Understand operations on CNC lathe and CNC milling machine.
CO3	Prepare part program using CNC simulator for CNC lathe and CNC milling.
CO4	Develop part program using MASTER CAM software for CNC lathe and CNC milling.
CO5	Develop canned cycle, pocket milling cycle for milling component.
CO6	Generate part model using CATIA/UG and build model using 3D printer.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1				1	1		1
CO2	2	1	1	1	1				1	1		1
CO3	2	3	1	3	2	1			2	2		1
CO4	2	2	1	3	2	1			2	2		1
CO5	2	2	1	3	2	1			2	2		1
CO6	2	2	1	3	2	1			2	2		1

List of Practicals/Experiments/Assignments

Each student shall be required to complete and submit the manual for the list of experiments. Each experiment will last for 2 turns.

1. To develop a manual part program of a given component on CNC Lathe using G and M codes.
2. To develop a manual part program of a given component on CNC Lathe using stock removal cycle.
3. To develop a manual part program of a given component on CNC Lathe using canned cycle.
4. To develop a manual part program of a given component on CNC Milling machine using G and M code.

5. To develop a manual part program of a given component on CNC Milling machine using pocket milling cycles.
6. To develop a manual part program of a given component on CNC Milling machine using canned drilling cycle.

Technical Project for Community Services

BTPRM610	Project 3	Technical Project for Community Services	0-0-4	2 Credits

Examination Scheme: Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Visit nearby places to understand the problems of the community
CO2	Select one of the problems for the study, state the exact title of the project and define scope of the problem
CO3	Explain the motivation, objectives and scope of the project
CO4	Evaluate possible solutions of the problem
CO5	Design, produce, test and analyze the performance of product/system/process
CO6	Modify, improve the product/system/process

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2	1	1		2		1
CO2		2								2	1	
CO3						1				2	1	
CO4		1	2				1	2				
CO5	1	1	2	3	1	1	1	2	1	1	1	
CO6			2	1	1		1	1				

Rationale

The role of technical institutes in giving technical and advisory services to the surrounding community need not be emphasized. It is desirable that each faculty member and student be involved in rendering services to community and economy. Moreover, as per Section (4) of the Act of this University, technical services to community, particularly the backward areas, is one of the basic objects of the University. In view of this, "Technical Project related to Community Services" has been included in the curriculum. This will ensure the participation of each student as well as faculty in this activity.

The weekly contact hours and the evaluation scheme for this project are as stated above. The nature of project work should be as given below in the course contents.

List of Practicals/Experiments/Assignments

The projects may be of varying nature such as a technical study/survey, design/development of a technology solution for an identified need, infusion/transfer of technology, etc. All this will be within the ambit of technology and expertise available within the University.
The student may form small groups, typically of 2 to 3 students, and carry out the project under the supervision of a faculty member.