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 Automobile 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 for the overall development of students.

Mission

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

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 automobile engineering including thermal, manufacturing and industrial systems to formulate design requirements.
PO3	Design, implement and evaluate automobile systems 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 mechanical 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. Automobile 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	Material Science and Metallurgy	3	1	--	20	20	60	100	4
BTAMC303	PCC 1	Fluid Mechanics and Machines	3	1	--	20	20	60	100	4
BTAMC304	PCC 2	Automotive Component Drawing and Computer Aided Drafting	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	--	--	--	--	--	--	Audit (AU/ NP)
BTAML307	ESC 12	Material Science and Metallurgy Lab	--	--	2	60	--	40	100	1
BTAML308	PCC 4	Fluid Mechanics and Machines Lab	--	--	2	60	--	40	100	1
BTAML309	PCC5	Automotive Component Drawing and Computer Aided Drafting Lab	--	--	4	60	--	40	100	2
BTAML310	PCC 6	Theory of Machines Lab	--	--	2	60	--	40	100	1
BTAMF311	Project 1	Field Training /Internship/Industrial Training I	--	--	--	--	--	50	50	1
		Total	15	4	10	340	100	510	950	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	
BTAMC401	PCC 7	Theory of Automotive Engines	3	1	--	20	20	60	100	4
BTAMC402	PCC 8	Engineering Thermodynamics	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								
BTAML407	PCC 11	Theory of Automotive Engines Lab	--	--	2	60	--	40	100	1
BTAML408	PCC 12	Engineering Thermodynamics Lab	--	--	2	60	--	40	100	1
BTAML409	PCC 13	Strength of Materials Lab	--	--	2	60	--	40	100	1
BTAML410	BSC 9	Numerical Methods Lab	--	--	2	60	--	40	100	1
		Total	15	4	10	400	100	500	1000	24
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
BTAMC502	PCC 15	Automotive Transmission Systems	3	1	--	20	20	60	100	4
BTAMC503	PCC 16	Automotive Chassis and Suspension	2	1	--	20	20	60	100	3
BTAMC504	PCC 17	Manufacturing Processes	2	1	--	20	20	60	100	3
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
BTAMC506A	OEC 2	Automotive Materials	3	--	--	--	--	--	--	Audit (AU/ NP)
BTMEC506B		Nanotechnology								
BTMEC506C		Energy Conservation and Management								
BTAML507	PCC 20	Machine Design Practice	--	--	2	30	--	20	50	1
BTAML508	PCC 21	Automotive Transmission Systems Lab	--	--	2	30	--	20	50	1
BTAML509	PCC 22	Automotive Chassis and Suspension Lab	--	--	2	30	--	20	50	1
BTAMF510	Project 2	Field Training /Internship/Industrial Training II	--	--	--	--	--	50	50	1
		Total	16	5	8	250	100	450	800	23

B. Tech. Automobile 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	
BTAMC601	PCC 23	Heat Transfer	3	1	--	20	20	60	100	4
BTAMC602	PCC 24	Automobile Electricals and Electronics	2	1	--	20	20	60	100	3
BTAMC603	PCC 25	Vehicle Dynamics	2	1	--	20	20	60	100	3
BTAMC604A	PEC 1	Design of Experiments	2	1	--	20	20	60	100	3
BTAMC604B		Industrial Engineering and Management								
BTAMC604C		Alternative Fuels for IC Engines								
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								
BTAML607	PCC 26	Heat Transfer Lab	--	--	2	30	--	20	50	1
BTAML608	PCC 27	Automobile Electricals and Electronics Lab	--	--	2	30	--	20	50	1
BTAML609	PCC 28	Vehicle Dynamics Lab	--	--	2	30	--	20	50	1
BTAMM610	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	Engineering Mathematics-III	BSC 7	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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-Hill Publishing 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 batchwise. 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	Material Science and Metallurgy	ESC 11	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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		

Course Contents:

Unit 1: Structure of Materials[08 Hours]

Crystal structures, indexing of lattice planes, Indexing of lattice directions, Imperfectionsin crystals - point defects, line defects, surface and bulk defects, Mechanism of plasticdeformation, deformation of single crystal by slip, plastic deformation of polycrystallinematerials

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 puremetal, plotting of equilibrium diagrams, lever rule, Iron-iron carbide equilibriumdiagram, critical temperatures, solidification and microstructure of slowly cooled steels,non-equilibrium cooling of steels, property variation with microstructures, classificationand application of steels,, specification of steels, transformation products of austenite,TTT diagram, 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, carbonitriding,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, opticalmetallurgical 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, dyepenetrant inspection, ultrasonic inspection, radiography, eddy current testing, acousticemission inspection.

Texts:

1. V. D. Kodgire and S.V. Kodgire, ―Material Science and Metallurgy for Engineers, Everest Publishing House, Pune, 24th edition, 2008.
2. W. D. Callister, Jr., ―Materials Science and Engineering: An Introduction‖, John Wiley and Sons, 5 th 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, 2nd edition, 1997.
5. R. A. Higgins, ―Engineering Metallurgy: Part I‖, ELBS, 6th edition, 1996.

References:

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

Fluid Mechanics and Machines

BTAMC303	Fluid Mechanics and Machines	PCC 1	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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
CO8	Evaluation of performance of compressors/turbines/pumps.

Mapping of course outcomes with program outcomes

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

CO7	2											
CO8	2	1										

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 offluid, variation of pressure, Pascal‘s law, pressure measurement by simple and differentialmanometers using manometric expression.

Fluid Statics: Hydrostatic forces on the plane and curved surfaces, centre of pressure, Buoyancy, centreof buoyancy, stability of floating bodies, metacentre and meta centric height its applicationin shipping.

Unit 2: Fluid Kinematics[08 Hours]

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

Unit3: Fluid Dynamics[08 Hours]

Momentum equation, development of Euler‘s equation, Introduction to Navier-Stokesequation, Integration of Euler‘s equation to obtain Bernoulli‘s equation, Bernoulli‘stheorem, Application of Bernoulli‘s, venture meter, orifice meter, rectangular andtriangular notch, pitot tube, orifices etc.

Unit 4: Types of Flow[08 Hours]

a) Laminar Flow: Flow through circular pipe, between parallel plates, Power absorbed inviscous 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 inturbulent flow, major and minor losses, HGL and TEL, flow through series and parallelpipes.

Unit 5: Dimensional Analysis[08 Hours]

a) Dimensional Analysis: Dimensional homogeneity, Raleigh‘s method, Buckingham‘s

theorem, Model analysis, similarity laws and dimension less numbers.

b) Introduction to boundary layer theory and its analysis.

c) Forces on Submerged bodies: Drag, lift, Drag on cylinder, Development of lift incylinder, Problems on submerged body.

Unit 6: Introduction to Fluid Machinery[08 Hours]

Principles of operations of centrifugal and axial pumps.Turbo blowers and turbines.Principles and working of gear, vane and reciprocating pumps.

Texts:

1. Modi and Seth, Fluid Mechanics and Hydraulic Machinery‖, Standard Book House, 10th edition, 1991.
2. Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics‖, John Wiley and Sons, 5th edition.

References:

1. V.L. Streeter, K. W. Bedford and E. B. Wylie, ―Fluid Dynamics‖, Tata McGraw-Hill, 9th edition, 1998.
2. S. K. Somand G. Biswas, ― Introduction to Fluid Mechanics and Fluid Machines, TataMcGraw-Hill, 2nd edition, 2003.

Automotive ComponentDrawing&ComputerAided Drafting

BTAMC304	Automotive ComponentDrawing& ComputerAided Drafting	PCC 2	2L-0T-0P	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2hrs/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 ofmachine elements.

Unit 2: Study of Machine Elements[04 Hours]

Study of simple machine elements and components such as screwed fasteners, shaftcouplings, 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, prismand 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 variousmachine tools, pumps, shaft couplings, joints, pipe fittings, engine parts, etc.

Unit 5: Production Drawing[04 Hours]

Types of production drawings, size, shape and description; limits, fits and tolerances,surface roughness and surface roughness symbols,

Unit 6: Computer Aided Drafting[04 Hours]

Introduction to Computer Aided Design and Drafting, Advantaged of CADD, study ofpreliminary AutoCAD commands like drawing, dimensioning, viewing commands.Drawing3D views in AutoCAD, Introduction to Auto LISP programming.

Texts:

1. N.D. Bhatt, Panchal, ―Engineering Drawing‖, Charotar Publishing House, Anand, India.
2. N.D. Bhatt, Panchal, ―Machine Drawing‖, Charotar Publishing House, Anand, India
3. Ajeet Sing, ―WorkingwithAutoCAD2000‖, 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 AutoLISP manuals from Autodesk Corp. U.S.A.
3. ISCode: SP46-1988, Standard Drawing Practices for Engineering Institutes.

Theory of Machines

BTPRC305	Theory of Machines	PCC 3	2L-1T-0P	3 Credits

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

Pre-Requisites: Applied Mechanics and Engineering Graphics

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

CO1	Select appropriate mechanism to design and develop a machine for an application
CO2	Analyze the mechanisms to determine velocity and acceleration of various links of the mechanism
CO3	Design and draw profile of the cam to obtain specified follower motion for an application
CO4	Analyze the governor to determine its height for the corresponding change in speed and sleeve displacement
CO5	Explain lower pair mechanisms and select them to meet the need where they are suitable
CO6	Explain and apply friction concepts in automotive and mechanical applications.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1 [06 Hours]
Definition of link, pair, kinematics chain, inversions, inversions of single and double slider crank chain, kinematic diagrams of mechanisms, equivalent linkage of mechanism, degree of freedom, Study of various mechanisms, Steering system & mechanism, suspension.

Unit 2[06 Hours]
Velocity and acceleration analysis and its purpose, velocity and acceleration diagrams using relative velocity method, Corioli's component of acceleration
Classification of gears, Terminology of spur gears, Conjugate action, Involute and cycloidal profile.

Unit 3[06 Hours]
Path of contact, contact ratio, Interference, Undercutting, Internal gears.
Helical gear terminology, Normal and transverse module, Torque transmitted by helical gears, Spiral gears, Efficiency of spiral gears, Worm and Bevel gear terminology.
Gear Trains: Velocity ratios, Types of gear trains, Tooth load, Torque transmitted and holding torque.

Unit 4[06 Hours]
Cams and Followers: Types of cams and followers, Analysis of motion, Jump and ramp of cam, Determination of cam profiles for a given follower motion
Flywheel: Turning moment diagram, Fluctuation of energy and speed, Determination of flywheel size for different types of prime movers and machines.

Unit 5 [06 Hours]
Friction and Lubrication: Dry friction, friction between nut and screw with different types of threads, Uniform wear theory and uniform pressure theory, Frication at pivot and collars, Friction in turning pair,
Lubrication, Viscosity, Viscous flow, Boundary lubrication, Thick film lubrication, Hydrostatic and hydrodynamic lubrications.
Friction Clutches: Single plate and multiplate clutch, Cone clutch, Centrifugal clutch, Torque transmitting capacity, Clutch operating mechanism.

Unit 6[06 Hours]
Brakes: Shoe brake, Internal and external shoe brakes, Block brakes, Band brakes, Band and block brakes, Braking torque.
Belt and Rope Drives: Flat belts, Effect of slip, Centrifugal tension, Crowing of pulley, Initial tension in belts. V- Belts

Text Books:

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

Reference Books:

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

Basic Human Rights

BTHM3401	Basic Human Rights	HSMC 3	2L-0T-0P	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	1	1		
CO2								2	1	2		
CO3								2	1	1		
CO4								2	3	3	2	1
CO5								2			1	
CO6								2	1	2		2

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.

Texts/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

BTAML307	ESC 12	Material Science and Metallurgy Lab	0L-0T-2P	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 and Machines Lab

BTAML308	Fluid Mechanics and Machines Lab	PCC 4	0L-0T-2P	1 Credit

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

Pre-Requisites: Mathematics, physics and Basic Mechanical Engineering.

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

CourseOutcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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
CO8												

List of Practical's/Experiments/Assignments (any eight)

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. Determinations of pressure drop in pipes of various cross-sections
5. Determinations of pressure drop 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 meta-centric 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. Demonstration of measurement using these instruments.

Automotive Component Drawing & Computer Aided Drafting Lab

BTAML309	Automotive Component Drawing&ComputerAided Drafting Lab	PCC5	0L-0T-4P	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

ListofPractical's/Experiments/Assignments:

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 assignments 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

BTAML310	Theory of Machines Lab	PCC 6	0L-0T-2P	1 Credit

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

Pre-Requisites: Engineering mathematics, Engineering graphics

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

CO1	Comprehend gyroscopic principle and effect of gyroscopic couple.
CO2	Apply balancing methods to balance rotating and reciprocating components
CO3	Identify and analyze vibrations of single degree of freedom systems.
CO4	Plot and interpret the polar diagram based on the experimental readings on Hooks

	joint.
CO5	Use principles of kinematics and dynamics in operation of various mechanisms and equipment.

Mapping of course outcomes with program outcomes

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

ListofPractical's /Experiments/Assignments

1. **Four sheets** (half imperial size)
   Graphical solution of problems on velocity, acceleration in mechanisms by relative velocity method, instantaneous centre of rotation method and Klein's construction. At least one problem containing Coriolis component of acceleration.

2. **Experiments (any2)**
   a) Experimental determination of velocity and acceleration of Hooke's joint.
   b) Determination of displacement of slider-crank mechanism with the help of model and to plot velocity and acceleration curves from it.
   c) Experiment on Coriolis component of acceleration.

3. **Assignment**
   Develop a computer program for velocity and acceleration of slider crank mechanism.

Semester IV

Theory of Automotive Engines

BTAMC401	Theory of Automotive Engines	PCC 7	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/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	Perform a primary thermodynamic analysis of Otto and Diesel cycle.
CO2	Select appropriate engine for specific application.
CO3	Select proper fuel system and subsystemsfor I C Engine. Compare mechanisms for variable valve timing.
CO4	Conduct performance testing of the I C Engine and portray operating characteristics of I C Engines.
CO5	Select proper lubricant and lubrication system for engine
CO6	Understand the latest developments in IC Engines and alternate fuels.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Fundamentals of IC Engines[08 Hours]

Nomenclature, engine components, Engine classification, firing order and four stroke cycle engines; fundamental difference between SI and CI engines; valve timing diagrams.

Power Cycles: Air standard Otto, Diesel and Dual cycles; Valve timing diagrams, Fuel-Air cycles, deviation of actual cycles from ideal cycles.

Unit 2: Combustion[08 Hours]

Introduction, important qualities and ratings of SI and CI Engines fuels; Combustion in S.I. Engines, flame speed, ignition delay, normal and abnormal combustion, effect of engine variables on flame propagation and ignition delay, Combustion in C.I. Engines, combustion of a fuel drop, stages of combustion, ignition delay, combustion knock; types of SI and CI Engine combustion chambers.

Unit 3: Engine Valve Mechanism[08 Hours]
Theoretical and actual valve timing diagram for 2 stroke/ 4 stroke and Petrol/Diesel Engines, Conventional Valve Mechanisms, Mechanisms for variable valve timings.

Unit 4: Various Engine Systems[08 Hours]
Starting systems, fuel supply systems, engine cooling system, ignition system, engine friction and lubrication systems, governing systems.

Unit 5: Engine Testing and Performance of SI and CI Engines[08 Hours]
Parameters, Type of tests and characteristic curves, Effect of load and Speed on mechanical, indicated thermal, break thermal and volumetric efficiencies, Heat balance sheet.
Super charging in IC Engine: Effect of attitude on power output, types of supercharging.

Unit 6: Alternative Potential Engines [08 Hours]
Stratified charge engine, VCR engine, Dual fuel engines, HCCI Engine, Green Engine,Engine Emissions & its effect on human being and environment. EURO and BHARAT emission norms,
Modern Trends in I C Engines.

Texts:

1. V.Ganeshan, "Internal Combustion Engines", Tata McGraw-Hill Publications, New Delhi, 3rd edition.

References:

1. J. B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw Hill Publications, New York, International Edition, 1988.
2. ASHRAE Handbook, "Fundamentals and Equipment", 1993.
3. ASHRAE Handbook – Applications, 1961.
4. ISHRAE Handbook
5. Prof. Ram Gopal, NPTL Lectures, www.nptel.com, IIT Kharagpur.
6. Carrier Handbook
7. R.C. Jordan and G. B.Priester, "Refrigeration and Air Conditioning", Prentice Hall of India Ltd., New Delhi, 1969.
8. J. L.Threlkeld, "Thermal Environmental Engineering", Prentice Hall, New York, 1970.

Engineering Thermodynamics

BTAMC402	Engineering Thermodynamics	PCC 8	3L-1T-0P	4 Credits

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

Pre-Requisites: Basic Mechanical Engineering, Engineering Mathematics, Engineering Chemistry

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

CO1	Illustrate the ideal gas, real gas, its deviation with compressibility chart.
CO2	Explain the use of Maxwell's relations.
CO3	Analysis thermodynamic second law for various processes.
CO4	Analyze gas turbine cycles.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit1: Fundamental Concepts and Definitions[08 Hours]

Thermodynamicsystems; properties, processes and cycles. Thermodynamic equilibrium, Quasi-static process, Macroscopic vs. Microscopic viewpoint, Work and heat Transfer: Work transferred and other types of work, Heat transfer, temperature and its measurement (principle of measurement, various instruments etc.)Zerothlaw of thermodynamics, specific heat and latent heat, point function, path function.

Unit2: First Law of Thermodynamics[08 Hours]

First law of thermodynamics for a closed system undergoing a cycle and change of state, Energy, different forms of energy, Enthalpy, PMM-I control volume, application of first law of steady flow processes (nozzle, turbine, compressor pump, boiler, throttle valve etc.

Unit-3: Second Law of Thermodynamics[08 Hours]

Limitation of first law of thermodynamics, cycle heat engine, refrigerator and heat pump, Kelvin- Plank and Clausius statements and their equivalence, Reversibility and Irreversibility, Carnot cycle, Carnot theorem, Absolute thermodynamic temperature scale.

Unit-4: Entropy[08 Hours]
Clausius inequality, entropy as a property of system.entropy of pure substance. T-sand h-s planes, entropy change in a reversible and irreversible processes, increaseof entropy principle, calculation of entropy changes of gases and vapours. Introduction to Available and unavailable energy:
P-v-t relations, equation of state, relation between Cp and Cv, other equations of state

Unit 5: Properties of Steam [08 Hours]
Dryness fraction, enthalpy, internal energy and entropy, steam table and Mollier chart, first law applied to steam processes.
Vapour Power Cycles:
Carnot vapour cycle, Rankine cycle, Ideal reheat, Rankine cycle, Introduction to cogeneration.
Introduction to Gas Power Cycles:
Air standard assumptions, Otto cycle, Diesel cycle, dual cycle, Stirling cycle, Ericsson cycle, Atkinson cycle, Brayton cycle.

Unit 6: Fuels and Combustion[08 Hours]
Types of fuels, calorific values of fuel and its determination, combustion equation for hydrocarbon fuel, determination of minimum air required for combustion and excess air supplied conversion of volumetric analysis to mass analysis, fuel gas analysis. Stoichiometric A/F ratio, lean and rich mixture, products of combustion, properties of engine fuels.

Texts:

1. P. K. Nag,"Engineering Thermodynamics", TataMcGrawHill,3rd edition, New Delhi, 2005.
2. Y.A.Cengel, M.A.Boles,"Thermodynamics–AnEngineeringApproach",Tata McGraw Hill,5th edition,2006.

References:

1. G.J. Van Wyle, R. E. Sonntag, "Fundamental of Thermodynamics", JohnWiley& Sons, 5th edition, 1998.
2. M. J. Moran, H. N. Shaprio, "Fundamentals of Engineering Thermodynamics", John Wiley and Sons,4th edition, 2004.

Strength of Materials

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

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1					1					
CO2	1	2	2	1	1	2						
CO3	1	3	1	1		1	2					
CO4	1	2	2		1	2						
CO5	2	2	1		1							
CO6	2	2	1	1								

Course Contents:

Unit 1:Simple Stresses and Strains [08 Hours]

Mechanical properties of materials, analysis of internal forces, simple stress and strain, 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, principle 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 in determinate 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& Sons, New Delhi.
2. F.L. Singer and 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	Numerical Methods in Mechanical Engineering	BSC 8	2L-1T-0P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2hrs/week Tutorial: 1hr/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.

Theory of Automotive Engines Lab

BTAML407	Theory of Automotive Engines Lab	PCC 11	0L-0T-2P	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	Demonstrate the construction and working of fuels supply system and its components, lubrication, cooling systems.
CO2	Handle instruments like tachometer, thermometer, digital temperature indicator etc.
CO3	Conduct the test on single cylinder and multi cylinder petrol & diesel engines (Constant Speed & Variable Speed Tests) plot the engine performance characteristics curves and interpret the curves.
CO4	Calculate B.P., I.P., F.P., air/fuel ratios and various engine efficiencies. Conduct the test and prepare heat balance sheet

Mapping of course outcomes with program outcomes

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

List of Practical's/Experiments/Assignments

A. Demonstration of physical systems in terms of constructional details and functions

1. 2 Stroke and 4 Stroke Engines
2. Carburetor.
3. Ignition system.
4. Fuel injection system.
5. Cooling System
6. 2 stage / 3 stage pressurised gas supply system. (LPG/CNG/Biogas/Hydrogen)
7. Visit to Industry related to automotive service station.

B. I C Engines (Any **Five** experiments from the list)

1. Trial on Diesel engine- variable speed/load test and energy balance.
2. Trial on Petrol engine- variable speed/load test and energy balance.
3. Trial on Petrol Engine- Morse Test.
4. Measurements of exhaust emissions of Petrol engine / Diesel engine.
5. Heat Balance test on diesel or petrol engines.
6. Experimental determination of Air fuel ratio.

Engineering Thermodynamics Lab

BTAML408	Engineering Thermodynamics Lab	PCC 12	0L-0T-2P	1 Credit

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

Pre-Requisites: Engineering Thermodynamics

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	Draw conclusions based on the results of the experiments
CO6	Draw performance curves of these machines.

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								

ListofPracticals/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. Trial on convergent/convergent-divergent type nozzle
8. Flue gas analysis using emission measuring instruments
9. Trial on centrifugal blower

Strength of Materials Lab

BTAML409	Strength of Materials Lab	PCC 13	0L-0T-2P	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	
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

BTAML410	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.

Automotive Transmission Systems

BTAMC502	PCC 15	Automotive Transmission Systems	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	Demonstrate the need of transmission and its classification.
CO2	Describe the construction and working of various types of clutches and gear boxes
CO3	Explain the working of advanced transmission systems.
CO4	Describe the working of final drive.
CO5	Select appropriate transmission system.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit –1
Clutches
Principle, Functions, General requirements, Torque capacity, Types of clutches, Cone clutch, Single-plate clutch, Diaphragm spring clutch, Multi-plate clutch, Centrifugal clutch, Electromagnetic clutch, Lining materials, Over-running clutch, Clutch control systems.

Unit – 2
Gear Box
Gear Box: Necessity of gear box, Resistance to motion of vehicle, Requirements of gear box, Functions of gear box, Types- Sliding mesh, Constant mesh, Synchromesh. Principle, construction and working of synchronizing unit, Requirements &applications of helical gears, Gear selector mechanism, Two-wheeler gear box, Lubrication of gear box, Overdrive gears, Performance characteristics.

Unit – 3
Drive Lines
Propeller shaft-universal joints, hooks and constant velocity U.J., Drive line arrangements – Hotchkiss drive & torque tube drive, Rear wheel drive, front wheel drive and four-wheel drive layouts and its advantages & limitations.

Unit – 4
Final Drive & Rear Axle
Purpose of final drive & drive ratio, Different types of final drives, need of differential, Constructional details of differential unit, Differential lock, Differential housing, Function of rear axle, Construction, Types of loads acting on rear axle, Axle types - semi-floating, full floating, three quarter floating.

Unit – 5
Fluid Flywheel, Torque convertor, Epicyclic Gear Boxes
Fluid Flywheel, Torque convertor: Operating principle, Construction and working of fluid flywheel, Characteristics, Advantages& limitations of fluid coupling, Torque convertor, and construction and working of torque converter, Performance characteristics, Comparison with conventional gear box.Epicyclic Gear Boxes: Simple epicyclic gear train, Gear ratios, Simple &

compound planet epicyclic gearing, Epicyclic gearboxes, Wilson epicyclic gear train - Construction and operation, Advantages, Clutches and brakes in epicyclic gear train, compensation for wear, performance characteristics.

Unit –6

Automatic Transmission

Principle of semi-automatic & automatic transmission, Hydromantic transmission, Fully automatic transmission, Semi-automatic transmission, Hydraulic control system, Continuous variable transmission (CVT) – operating principle, basic layout andoperation, Advantages and disadvantages.

Text Books:

1. Dr. Kripal Singh, "Automobile Engineering-Vol. 1", 13th Edition, Standard Publishers Distributors
2. N. K. Giri, "Automotive Mechanics", Khanna Publishers, Delhi, Eighth Edition

Reference Books:

1. Newton, Steed &Garrot, "Motor Vehicles", 13th Edition, Butterworth London
2. A. W. Judge, "Modern Transmission", Chapman & Hall Std., 1989
3. Chek Chart, "Automatic Transmission", A Harper & Raw Publications
4. J. G.Giles, "Steering, Suspension & Tyres", – Lliffe Book Ltd., London
5. W. Steed, "Mechanics of Road Vehicles", Lliffe Book Ltd
6. Heisler, "Vehicle and Engine Technology", Second Edition, SAE International Publication

Automotive Chassis and Suspension

BTAMC503	PCC 16	Automotive Chassis and Suspension	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: None

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

CO1	Elaborate the constructional details and operations of chassis systems like steering system, suspension system etc.
CO2	Interpret the underlying mechanics of the chassis systems.
CO3	Apply steering geometry for a given vehicular application.
CO4	Select/Configure components or subsystems for integration into main chassis system.

Mapping of course outcomes with program outcomes

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

CO1	2	1	1									
CO2	2			1	1							
CO3	2			2	1							
CO4	2		1		1							

Course Contents:

Unit-1:Front Axle and Steering System

Functions of front axle, Types of front axle, Construction, Stub axle and Wheel bearing, Front wheel steering Geometry – castor, Camber, King pin inclination, toe-in, toe-out, Centre point Steering, Self-returning property, Adjusting and checking of front wheel geometry, Ackerman and Davis steering linkages, Steering system layout, Steering gear boxes.

Unit-2: Vehicle Suspension Systems

Road irregularities and need of suspension system, Types of suspension system, Sprung and unspring mass, Suspension springs – requirements, types and characteristics of leaf spring, coils spring, rubber spring, air and torsion bar springs, Independent suspension for front and rear, Types, Hydro-elastic suspension, roll centre, use of anti-roll bar and stabilizer bar, Shock absorbers – need, operating principles and types, Active suspension.

Unit-3: Wheels and Tyres

Basic requirements of wheels and tyres, Types of road wheels, Construction of wheel assembly, wheel balancing, Tyre construction, material, types, tubeless, cross ply radial type, tyre sizes and designation, Aspect ratio, tyre trade pattern, tyre valve, Tyre inflation pressure, safety precautions in tyres, Tyre rotation and matching, Types of Tyre wear and their causes, Selection of tyres under different applications, tyre retreating hot and cold, factors affecting tyre performance.

Unit-4: Braking Systems

Function and requirements of braking system, Types of brakes, Elementary theory of shoe brake, drum brake arrangement, disc brake arrangement, self-energizing, brake friction material. brake linkages, hydraulic brake system and components, hydraulic brake fluids, air brakes, vacuum servo assisted brake, engine exhaust brake, parking brakes, dual power brake system, regenerative brake system, fail-safe brake, anti – lock brakes, anti-skid brakes, brake efficiency and testing, weight transfer, braking ratio.

Unit-5: Vehicle Safety Systems

Introduction, Electronic stability program system operation, overview, rollover mitigation system overview, active safety and passive safety, latest trends in traffic system for improved road safety, head restraints, introduction to the type of safety glass and their requirements, types of different mirrors and their location.

Unit-6: Vehicle Chassis

Introduction To chassis, chassis operating condition, chassis frame, vehicle components location. Manufacturing processes for chassis, causes of chassis failure

Text Book:

1. “Automobile Engineering” R. B. Gupta SatyaPrakashan New Delhi.
2. “Basic Automobile Engineering” C. P. NakraDhanpatRai Publishing Company (P) Ltd-New Delhi
3. “Automotive Mechanics” N.K. Giri 8th Edition Khanna Publishers New Delhi.

References:

1. “Motor Vehicles”, Newton, Steed and Garrot, 13th Edition, Butterworth London
2. “Vehicle and Engine Technology”, Heisler, Second Edition SAE International Publication.
3. “Advanced Vehicle Technology”, Heisler,Second Edition SAE International Publication.
4. “The Automotive Chassis”, J. Reimpell H. Stoll, J.W. Betzler, SAE International Publication.

Manufacturing Processes

BTAMC504	PCC 17	Manufacturing 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)

Pre-Requisites: None

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

CO1	Identify castings processes, working principles and applications and list various defects in metal casting
CO2	Understand the various sheet metal processes, working principles and applications
CO3	Classify the basic joining processes and demonstrate principles of welding, brazing and soldering.
CO4	Study center lathe and its operations including plain, taper turning, work holding devices and cutting tool.
CO5	Understand milling, drilling, boring, shaping and broaching operations
CO6	Describe the mechanical measurements techniques

Mapping of course outcomes with program outcomes

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

CO5	2		1		1	1				1		1
CO6	1				1	1				1		1

Course Contents:

Unit 1: Introduction to Manufacturing

What is manufacturing? Examples of manufacturing products, Classification of manufacturing processes, Selection of materials, Types of manufacturing strategies.Importanceofsheetmetalengineering,materialsused,desirableproperties ofmaterialsin sheet metalproducts.Shearingprocesseslikeblanking,piercing,andpunching.

Unit 2: Metal Casting Processes

Patterns, allowances, moulding sand properties and preparation, Cores, core prints, sand moulding procedure, Gating and riser design, melting practice and furnaces, solidification of metals, casting defects and inspection, Specialized casting processes such as shell mould casting, die casting, centrifugal casting, investment casting and permanent mould casting.

Unit 3: Joining Processes

Gas welding, gas cutting, Electric arc-welding with consumable and non-consumable electrodes (MMAW, GMAW, TIG, and SAW); solid state welding: resistance welding, spot and seam welding, thermit welding, friction welding, welding defects, Brazing and soldering.

Unit 4: Turning, Shaping, Milling and Planing

Lathe and its types, constructional features, lathe operations, taper turning, methods of taper turning, work holding and cutting tool, thread cutting, machining time and power estimation, shaper, Milling machine and its types, construction, milling operations, milling cutters, Planing machine sand their types and operations.

Unit 5: Drilling, Boring, Broaching

Drilling machine, its types, construction, twist drill, drilling time and power estimates, counter boring, spot facing, boring, reaming, tapping, and broaching, broach tool, broaching machine types, construction and operations.

Unit 6: Mechanical Measurements

Introduction to measurements, Errors in measurements, Measurement of temperature, pressure, velocity, Measurement of heat flux, volume/mass flow rate, Measurement of thermo-physical properties, radiation properties of surfaces, vibration and noise, Measurement of length, measurement of angle, Measurement of geometric forms, straightness, flatness, roundness

Texts:

1. P. N. Rao, "Manufacturing Technology, Foundry, Forming and Welding", Vol. 1, 3rd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2004.
2. P.N. Rao, "Manufacturing Technology, Metal Cutting and Machine Tools", Vol. 2, 2nd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2002.
3. Gayler J.F. and Shotbolt C.R. Metrology for Engineers, ELBS, Fifth Edition 1990

References:

1. M. P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes and Systems", Prentice Hall, Upper Saddle River, New Jersey, 1999.
2. S. Kalpakjian and S.R.Schmid, "Manufacturing Engineering and Technology", Addison Wesley Longman (Singapore) Pte. India Ltd., 4th edition, 2000.

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)

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 Outcomes	Program 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.

Automotive Materials

BTAMC506A	OEC 2	Automotive 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: Material science and metallurgy

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

CO1	The student shall gain appreciation and understanding Material properties chart and all parameters of chart.
CO2	Shall be able to know different types of electric and magnetic materials also non-metallic materials.
CO3	Student shall gain knowledge of various surface treatment used in automobile industries
CO4	Student shall gain knowledge of modern materials comes such as shape memory alloy etc.
CO5	Ability to select material of material from the material properties chart with considering such parameter modulus density, strength density and modulus strength.
CO6	Ability to select material for the automotive components

Mapping of course outcomes with program outcomes

Course 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								
CO6	1	1										

Course Contents:

Unit-I: Material Property Charts and Selection Criteria

Material Property Charts: Modulus-density, strength-density, modulus strength, specific stiffness and specific strength, fracture toughness, modulus fracture.
Selection Criteria- Shape factor, elastic extrusion, elastic body and twisting, failure, bending and twisting, efficiency of standard sections, material limits and shape factors.

Unit-II: Polymers
Physical and Mechanical properties of polymers and their composites, effect of processing on properties. Applications in engineering.
High Polymers: Classification of High polymers- production of high polymers- general methods- Some important plastics, their production, properties and uses- Polyethylene
PVC, Polystyrene, Teflon, Acrylics, Nylon, Polyesters, Phenol Formaldehyde Resins, Urea Formaldehyde Resins and silicones-compounding and moulding of High polymers.

Unit-III: Composite Materials
Composite Materials: Introduction, Types of composite materials, properties, advantages, orthotropic and anisotropic behaviour, Micromechanical and micromechanical analysis of composite material, Applications of composite materials

Unit-IV: Surface Modification of Materials
Mechanical surface treatment and coating - case hardening and hard facing, thermal spraying, vapor deposition, ion implantation, diffusion coating, electroplating and electro-less, conversion coating, ceramic and organic coatings, diamond coating.

Unit-V: Modern Materials and Alloys
Super alloys, refractory metals, shape memory alloys, dual phase steels, micro alloyed, high strength low alloy steel, transformation induced plasticity (trip) steel, merging steel, smart materials, metallic glass, quasi crystal and Nano crystalline materials., metal foams.

Unit–VI: Materials selection for automotive components
Criteria of selecting materials for automotive components viz cylinder block, cylinder head, piston, piston ring, gudgeon pin, connecting rod, crank shaft, crank case, cam, cam shaft, engine valve, gear wheel, clutch plate axle, bearings, chassis, spring, body panel - radiator, brake lining etc. application of non-metallic materials such as composite, ceramic and polymers in automobile.

Reference Books:

1. "Material Science and Engineering- An introduction", Callister W.D. (2006), Wiley – Eastern.
2. "Physical Metallurgy", Raghavan, V., (2003), Prentice Hall of India.
3. "Materials Selection in Mechanical Design", Michael F. Ashby, Butterworth Heinemann,2005.
4. "Mechanical Behavior of Materials", Thomas H. Courtney, (2000) McGraw Hill.
5. "Engineering Materials and their Applications", Flinn R. A. and Trojan P. K. (1999), Jaico.
6. "Surface Engineering for wear resistance", Kenneth Budinski– (1988) Prentice Hall.

7. "Introduction to physical metallurgy", Avner S.H., (2006) –Tata McGraw Hill.
8. Materials Science and Metallurgy", Daniel Yesudian C, Scitech Publications (Indian ,2004.)

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 Outcomes	Program 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 load factor, 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

BTAML507	PCC 20	Machine Design Practice	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	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	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 Outcomes	Program 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 Design of Machine Element.

Automotive Transmission Systems Lab

BTAML508	PCC 21	Automotive Transmission Systems Lab	0-0-2	1 Credit

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

Pre-Requisites: Automotive Transmission

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

CO1	Identify and list elements of various transmission systems.
CO2	Draw sketches /schematics of transmission systems.
CO3	Describe the operating principles, functions, constructional details and working of transmission systems.
CO4	Compare various configurations/subtypes of transmission systems.
CO5	Select appropriate configuration/types for transmission system requirements in automotive applications

Mapping of course outcomes with program outcomes

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

List of Practical's/Experiments/Assignments (Any 8 Experiment)

1. Demonstration of garage, garage equipment's & tools, preparation of different garage layouts.
2. Demonstration of washing & greasing of vehicle.
3. Engine oil change & periodic maintenance of vehicle.
4. Dismantling & assembly of Clutch (light / heavy duty vehicle).
5. Dismantling & assembly of Constant mesh gearbox and synchromesh gearbox.
6. Dismantling & assembly of Drive line (universal joint, propeller shaft, slip joint).
7. Dismantling & assembly Final drive & differential.
8. Rear axle hub greasing.
9. Dismantling & assembly of automatic transmission.
10. Dismantling & assembly of fluid flywheel & torque converter.

Automotive Chassis and Suspension Lab

BTAML509	PCC 22	Automotive Chassis and Suspension Lab	0-0-2	1 Credit

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

Pre-Requisites: Automotive Chassis Systems.

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

CO1	Identify and list elements of various chassis systems.
CO2	Draw sketches /schematics of chassis systems.
CO3	Describe the operating principles, functions, constructional details and working of chassis systems.
CO4	Compare various configurations/subtypes of chassis systems.
CO5	Select appropriate configuration/types for chassis system requirements in automotive applications

Mapping of course outcomes with program outcomes

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

List of Practical's/Experiments/Assignments

1.Demonstration of front wheel steering geometry
2.Demonstration of steering system layout
3.Experiment on Ackerman steering geometry
4.Demonstration of power steering
5.Demonstration of hydraulic brake and air brake systems
6.Demonstration of conventional & independent suspensions
7.Demonstration of suspension dampers
8.Demonstration of wheel and tyre assembly

Field Training/ Internship/ Industrial Training - II

BTAMF510	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

Heat Transfer

BTAMC601	PCC 23	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

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

CO1	Explain the laws of heat transfer and deduce the general heat conduction equation and to explain it for 1-D steady state heat transfer in regular shape bodies
CO2	Describe the critical radius of insulation, overall heat transfer coefficient, thermal conductivity and lumped heat transfer
CO3	Interpret the extended surfaces
CO4	Illustrate the boundary layer concept, dimensional analysis, forced and free convection under different conditions
CO5	Describe the Boiling heat transfer, mass transfer and Evaluate the heat exchanger and examine the LMTD and NTU methods applied to engineering problems
CO6	Explain the thermal radiation black body, emissivity and reflectivity and evaluation of view factor and radiation shields

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				1			
CO2	3	2			1							
CO3	3	1			2		2		1			
CO4	3	3		1	1				1			
CO5	3	3	3		1		2					
CO6	2	3		2	2		2		1			

Course Contents:

Unit 1: Introduction

Heat transfer mechanism, conduction heat transfer, Thermal conductivity, Convection heat transfer, Radiation heat transfer, laws of heat transfer

Steady State Conduction: General heat conduction equation, Boundary and initial conditions, One-dimensional steady state conduction: the slab, the cylinder, the sphere, composite systems.

Unit 2: Overall Heat Transfer and Extended Surfaces

Thermal contact resistance, Critical radius of insulation, Electrical analogy, Overall heat transfer coefficient, Heat source systems, Variable thermal conductivity, Extended surfaces.

Unsteady State Conduction: Lumped system analysis, Biot and Fourier number, Heisler chart **(No numerical examples)**.

Unit 3: Principles of Convection

Continuity, Momentum and Energy equations, Hydrodynamic and Thermal boundary layer for a flat plate and pipe flow. Dimensionless groups for convection, relation between fluid friction and heat transfer, turbulent boundary layer heat transfer.

Unit 4: Forced Convection

Empirical relations for pipe and tube flow, flow across cylinders, spheres, tube banks.

Free Convection: Free convection from a vertical, inclined and horizontal surface, cylinder and sphere.

Unit 5: Boiling and Condensation

Film-wise and drop-wise condensation, pool boiling regimes, forced convection boiling (Internal flows).

Introduction to Mass Transfer: Introduction, Mechanism of diffusion, Fick's law of mass transfer, mass diffusion coefficient.

Heat Exchangers: Types of heat exchangers, the overall heat transfer coefficient, Analysis of heat exchangers, the log mean temperature difference (LMTD)method, the effectiveness-NTU method, selection of heat exchangers, Introduction to TEMA standard.

Unit 6: Radiation Heat Transfer

Introduction, Thermal radiation, Black body radiation, radiation laws, Radiation properties, Atmospheric and Solar radiation, The view factor, Radiation heat transfer from black surfaces, gray surfaces, diffuse surfaces, Radiation shields and the radiation effect.

Texts:

1. F. P. Incoropera, D. P. Dewitt, "Fundamentals of Heat and Mass Transfer", John-Wiley, 5th edition, 1990.
2. S. P. Sukhatme, "A Textbook on Heat Transfer", Tata McGraw Hill Publications, 3rd edition.

References:

1. Y. A. Cengel, "Heat Transfer – A Practical Approach", Tata McGraw Hill Publications ,3rd edition, 2006.
2. J. P. Holman, "Heat Transfer", Tata McGraw Hill Publications, 9th edition, 2004.

Automobile Electricals and Electronics

BTAMC602	PCC 24	Automobile Electricals and Electronics	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	Describe the role of the electrical and electronics in controlling various automotive functions and subsystems.
CO2	Select automotive electrical components like battery, alternator and starting motor for particular application.
CO3	Apply concept to design automotive electrical systems.
CO4	Select and justify sensors and actuators used for automotive systems.
CO5	Explain the roll of engine and vehicle management systems to control enhance the performance for minimum emission.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction to automotive electrical systems

Automotive electricity generation, storage & distribution systems, wiring harness, circuit diagrams and symbols, 12/24/42 volt system, positive earth and negative earth, earth return and insulated return systems, Multiplexed wiring systems, Electromagnetic compatibility & interference, Introduction of Controlled Area Networks (CAN) protocols.

Battery:

Principle of lead acid battery, Types, Constructional details, Recharging the battery, Battery ratings, Battery Performance, Battery capacities, Battery efficiency, Battery tests, Battery failures, Alkaline battery, maintenance free batteries, hybrid batteries.

Unit 2: Charging, Starting & Ignition System

Magnetos Constant current & voltage systems, Current & voltage regulator, Semiconductor type regulator, Alternator withr egulator, starting system with layout, selection of motor, matching

battery, Drive mechanisms, Ignition coil, Distributor, Cam angle & Contact angle gap, Advance mechanisms, Ballast Resistance, Limitations of coil ignition, Transistorized Ignition systems, Spark plugs, types, construction.

Unit 3: Automotive Accessories & Lighting Systems
Vehicle lighting System: Head, Indicator, Fog lamps, Brake lights, Gas discharge, LED lighting, Dash board Indicators: Fuelgauge, oil pressure gauge, Temperature gauges, Speedometer, Warning Lights, Electric horn, Horn relay, Wind shield wipers, and Power window.

Unit 4: Automotive Sensors & Actuators
Working principle of sensors, Types of sensors, Airflow rate sensor, angular position sensor, Throttle angle sensor, Temperature sensor, MAP sensors, sensors feedback control, Principle of actuator, Types of actuators, engine control actuators, Solenoid actuators, motorized actuators.

Unit 5: Engine Management Control System (EMS)
Layout and working (open loop and closed loop control), ECU and microcontroller, group and sequential injection techniques, fuel system components, cold and warm start system, idle speed control, acceleration / deceleration and full load enrichment and fuel cut-off, fuel control MAPs. Electronic Ignition system and spark timing control.

Unit 6: Vehicle Management System
ABS system with layout and working, Electronic control of suspension – Damping control, Electric power steering, Supplementary Restraint System of air bag system, crash sensor, seat belts, Cruise control, Vehicle security systems alarms, vehicle tracking system, Collision avoidance, Radar warning system, Introduction to Global Positioning Systems.

Text Books:
1. P. L. Kohli, "Automotive Electrical Equipments", Tata McGraw Hill Pub. Co. Ltd.
2. Tom Denton, "Automobile Electrical & Electronic Systems", SAE International.

Reference Books:
1. Bechfold SAE 1998, "Understanding Automotive Electronics".
2. V. A. W. Hilliers, "Fundamentals of Automotive Electronics", Hatchin, London
3. Tomwather J. R., Cland Hunter, "Automotive Computer & Control System", Prentice Inc. NJ
4. Robert N. Brandy, "Automotive Computers & Digital Instrumentation", Prentice Hall Eaglewood, Cliffs, NJ
5. Young, Griffithe, "Automobile Electrical & Electronic Equipment's", The English Language Book Co., London.

Vehicle Dynamics

BTAMC603	PCC 25	Vehicle Dynamics	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	Appreciate significance of vehicle dynamics for a typical road vehicle.
CO2	Calculate dynamic longitudinal and transverse axle load transfer for a vehicle in motion.
CO3	Determine the acceleration and braking performance of a vehicle when provided with specifications.
CO4	Evaluate handling characteristics of a vehicle for given set of data.
CO5	Apply ride concepts while designing a suspension system for a vehicle.
CO6	Evaluate the tire performance.

Mapping of course outcomes with program outcomes

course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	1	1	1	1		1					
CO2	2	2	2		1							
CO3	1	2	2		1							
CO4	2	2	2	1		1	1					
CO5	1	2	2		1							

Course Contents:

Unit I: Concept of Vibration

Definitions, Modelling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments.

Unit II: Performance Characteristics of Road Vehicles

Steady State Operation: Various external forces acting on vehicle,Nature of the forces and factors affecting the forces, Tractive effort &Power available from the engine, Equation of motion, Maximum tractiveeffort, Weight distribution, Stability of vehicle on slope, Roadperformance curves, Acceleration, Gradibility& Drawbar Pull.

Transient Operation: Inertia effect, Equivalent mass, Equivalentmoment of inertia, Equivalent ungeared system, Time to producesynchronizing during gear change, Effect of engine flywheel onacceleration, Dynamics of vehicles on Banked tracks, Gyroscopic Effects,Net driving power.

Unit III: Tyre

Importance of rubber tyre in automobile vehicle, Tubbedtyre& tubeless tyre, Cross ply tyre, Radial ply tyre, Tyre tread design, Aspect ratio, Ply rating, Rolling resistance of tires.

Unit IV: Braking Performance

Basic equations, Braking forces, Tyre road friction, Brake proportioning, ABS systems, Braking efficiency, Rear wheel lock up, Pedal force gain

Unit V: Handling Characteristics

Low speed cornering, High speed cornering, Cornering equations, Understeer gradient, Static margin, Suspension effects on cornering, Experimental measurements of understeer gradient

Unit VI: Ride Characteristics

Ride dynamic system, Excitation sources, Vehicle suspension properties, Suspension isolation, Suspension stiffness, Suspension damping, Suspension non linearities, Active control, Wheel hop resonances, Rigid body bounce/pitch motions, bounce/pitch frequencies, Olley criterion, dynamic index.

Text Books

1. Gillespie T. D. (1992), Fundamentals of Vehicle Dynamics, SAE International.
2. Wong J. Y. (1979), Theory of Ground Vehicles, Willey & Sons.

Reference Books

1. Pacejka H. B. (2012), Tyre and Vehicle Dynamics, Butterworth Hienmann
2. N. K. Giri (2004), Automotive Mechanics, Khanna Publishers, 9th Edition.
3. G. Genta (1997), Motor Vehicle Dynamics, World Scientific.
4. Rajamani Rajesh (2011), Vehicle Dynamics and Control, Springer.

Design of Experiments

BTAMC604A	PEC 1	Design of Experiments	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: Engineering mathematics-I

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

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.

CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of experiments.

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	3	2	1	3	2	1			1	2	1	1
CO3	3	2	1	3	2	1			1	2	1	1
CO4	3	3	1	3	2	1			1	2	1	1
CO5	2	3	1	2	3	2			1	2	1	1

Course Contents:

Unit 1: Introduction
Modern quality control, quality in engineering design, history of quality engineering, The Taguchi Approach to quality: Definition of quality, loss function, offline and online quality control, Taguchi`s quality philosophy.

Unit 2: Full Factorial Designs
traditional scientific experiments, two factor design, three factor design, replicating experiments, factoring reactions, normal plots of estimated effects, mechanical plating experiments, four factor design, Taguchi design and western design.

Unit 3: Fractional Factorial Design
Fractional factorial design base done ight run experiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over sixteen run experimental design, blocking two level designs, other two level designs, Necessity to use more than two level, factors at three and four levels.

Unit 4: Taguchi Robust Design
Construction of orthogonal array, Additive model for factor effects, Signal to noise ratios, linear graphs, Taguchi Inner and outer arrays: Noise factors, experimental designs for control and noise factors.

Unit 5: Evaluating Variability
Necessity to analyze variability, measures of variability, the normal distribution, Analysis of variance in engineering design, using estimated effects as test statistics, analysis of variance for two level designs

Unit 6: Computer Software for Experimental Design
Role of computer software in experimental design, summery of statistical packages, example of use of software packages.

Texts:

1. M. S. Phadke, "Quality Engineering using Robust Design", Prentice Hall, Englewood Cliffs, NewJersey,1989.
2. R.H. Lochner and J.E. Matar, "Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design", Chapman and Hall, London, 1983.

References:

1. D.C. Montgomery, "Design and Analysis of Experiments", John Wiley and Sons, New York, 5th edition, 2004.
2. Peter Goos, Bradley Jones, "Optimal Design of Experiments: A Case Study Approach", Wiley Publishers, July 2011.
3. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", 4th Edition, Wiley, January 2016.

Industrial Engineering and Management

BTAMC604B	PEC 1	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	Impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering
CO2	Produce ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
CO3	Understand the interactions between engineering, businesses, technological and environmental spheres in the modern society.
CO4	Understand their role as engineers and their impact to society at the national and global context.

Mapping of course outcomes with program outcomes

Course	Program Outcomes

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1											2	1
CO2									2	2	2	
CO3								2				
CO4								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, micro motion 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 and 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, 4th edition, 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.

Alternative Fuels for IC Engine

BTAMC604C	PEC 1	Alternative Fuels for IC Engine	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	Modify automotive engine to operate by using various alternative fuels.
CO2	Analyze engine performance and emission characteristics by using alternative fuels.
CO3	Suggest advance engine technology for alternative fuels.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-1:

Conventional Fuels and Need for alternative fuels
Need for alternative fuels, applications, various alternate fuels etc.
Comparison of properties of fuels, quality rating of SI and CI engine fuels, fuel additives for SI and CI engines,

Unit-2:
Alternative Fuels I – Gaseous Fuels
Introduction to CNG, LPG, Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, and engine/vehicle modifications required.

Unit-3:
Biofuels
Biodiesel, Biogas, ethanol, Methanol. Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, engine/vehicle modifications required.

Unit–4:
Hydrogen
Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, engine/vehicle modifications required.

Unit-5:
Fuel Cell Technology
Operating principles, Types, construction, working, application, advantages and limitations.

Unit-6:
Layout of Electric vehicle and Hybrid vehicles
Advantages and drawbacks of electric and hybrid vehicles, System components, Electronic control system – Different configurations of Hybrid vehicles, Power split device. High energy and power density batteries – Basics of Fuel cell vehicles.

Texts:
1. AyhanDemirbas, "*Biodiesel A Realistic Fuel Alternative for Diesel Engines"***,** Springer-Verlag London Limited 2008, ISBN-13: 9781846289941

References:
1. "Alternative Fuels", Dr. S. S. Thipse, Jaico publications.
2. "Engine Emission", B.P Pundir, Narosa publication.
3. "Internal Combustion Engines", V. Ganesan, Tata McGraw Hill.
4. "Automotive Emission Control", Crouse, W.M. and. Anglin, A.L, McGraw Hill.
5. "IC Engines", Dr. S. S. Thipse, Jaico publications.
6. "Engine Emissions, pollutant formation", G. S. Springer and D.J. Patterson, Plenum Press.
7. ARAI vehicle emission test manual.
8. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, "The Biodiesel Handbook", AOCS Press Champaign, Illinois 2005.

9. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997, ISBN 0-76-80-0052-1.
10. Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).
11. Science direct Journals (Biomass & Bio energy, Fuels, Energy, Energy conversion Management, Hydrogen Energy, etc.) on biofuels.
12. Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2013.

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	Program Outcomes

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 3	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 3	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 3	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.

Heat Transfer Lab

BTAML607	PCC 26	Heat Transfer 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	Understand the various heat transfer mode of heat transfer and its application and verify
CO2	Learn the experimental methodology
CO3	Describe the concept the terms like least count, calibration of the instruments

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		3	2							
CO2	3	3		3	2		2					
CO3	3	3		3	2		2					

List of Practicals/Experiments/Assignments

Any eight experiments from the list:

1. Determination of thermal conductivity of a metal rod.
2. Determination of thermal conductivity of insulating powder.
3. Determination of conductivity of a composite slab.
4. Temperature distribution on a fin surface.
5. Determination of film heat transfer coefficient for natural convection.
6. Determination of film heat transfer coefficient for forced convection.
7. Determination of heat transfer coefficient for cylinder in cross flow in forced convection.
8. Performance of Double pipe Heat Exchanger/Shell and Tube Heat Exchanger.
9. Determination of emissivity of a metal surface.
10. Determination of Stefan Boltzman's constant.
11. Determination of critical heat flux.
12. Calibration of measuring instruments pressure gauge, thermocouple, flow-meteretc.

Automobile Electricals and Electronics Lab

BTAML608	PCC 27	Automobile Electricals and Electronics 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 the construction and working of various automotive electrical systems.
CO2	Test automotive batteries, alternators, starting motors, auto electric components and carryout head light beam alignment.
CO3	Diagnosis the automotive electrical faults with the help of ECU diagnostic systems.

Mapping of course outcomes with program outcomes

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

List of Practical's/Experiments/Assignments

(**Minimum eight out of which Experiment No. 10 is compulsory**.)

1. Demonstration of automotive electrical and electronic systems layout.
2. Study/Demonstration and testing of battery performance parameter.
3. Demonstration and testing of alternators.
4. Demonstration and testing of starting motors & Electronic ignition system.
5. Demonstration of dash board panel instruments & controls.
6. Demonstration of headlight beam alignment.
7. Testing of auto electrical components on multifunctional tester.
8. Testing of CDI coil, spark plug and armature.
9. Study of ECU diagnostic system for fault finding.
10. Visit to any authorized service station for On Board Diagnosis.

Vehicle Dynamics Lab

BTAML609	PCC 28	Vehicle Dynamics 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	
CO2	
CO3	

Mapping of course outcomes with program outcomes

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

List of Practical's/Experiments/Assignments (Any 10)

1. Determination of the center of gravity location for a vehicle.
2. Determination of brake force distribution for a vehicle.
3. Demonstration of steering system and measurement of steering geometry angle and their impact on vehicle performance.
4. Multi body simulation for steering and suspension components using any FEA or MBD software.
5. Analysis of vehicle vibration signature using any analysis software.
6. To study the shock absorber and plot the transmissibility curve.
7. To verify analytically and experimentally traction requirement for a vehicle.
8. To plot the torque requirement of a vehicle with respect to change in gradability.
9. To study Low speed maneuverability parameters of a vehicle.
10. To perform modal analysis of a suspension system.
11. To determine the natural frequency of damped vibration of single degree freedom system and to find it's damping coefficient.
12. To determine the frequency response curve under different damping conditions for single degree freedom system of vibration

Technical Project for Community Services

BTAMM609	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.