Civil, Electrical & Mechanical Engineering Department

1st Semester

Teaching Scheme

Division A

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
MA 181001	Mathematics (Calculus)	3	2	0	5
PH 181001	Physics-I	2	1	0	3
HS 181001 / HS 181002	Indian English Literature & Language / Functional English & Comprehension	3	0	2	4
CE 181001 / EE 181001 / ME 181001	I to I civil/Elec/Mech	2	0	0	2
PH 181101	Physics Laboratory	0	0	3	1.5
CH 181001	Chemistry	3	1	0	4
GE 181001	Engineering Graphics	2	0	3	3.5
CH 181101	Chemistry Laboratory	0	0	3	1.5
	Total	**15**	**4**	**11**	**24.5**

Division B

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
MA 181001	Mathematics (Calculus)	3	2	0	5
PH 181001	Physics-I	2	1	0	3
HS 181001 / HS 181002	Indian English Literature & Language / Functional English & Comprehension	3	0	2	4
CE 181001 / EE 181001 / ME 181001	I to I civil/Elec/Mech	2	0	0	2
PH 181101	Physics Laboratory	0	0	3	1.5
CS 181001	Computer Science	2	1	3	4.5
GE 181002	Manufacturing Science and Workshop	2	0	3	3.5
	Total	**14**	**4**	**11**	**23.5**

Civil, Electrical & Mechanical Engineering Department

2nd Semester

Teaching Scheme

Division A

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
MA 181002	Mathematics (ODE+Linear Algebra with V. calculus)	4	2	0	6
PH 181002	Physics-II	3	2	0	5
EE 181002	Basic Electrical And Electronics Engineering	2	1	2	4
CS 181001	Computer Science	2	1	3	4.5
GE 181002	Manufacturing Science and Workshop	2	0	3	3.5
	Total	**13**	**6**	**8**	**23**

Division B

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
MA 181002	Mathematics (ODE+Linear Algebra with V. calculus)	4	2	0	6
PH 181002	Physics-II	3	2	0	5
EE 181002	Basic Electrical And Electronics Engineering	2	1	2	4
CH 181001	Chemistry	3	1	0	4
GE 181001	Engineering Graphics	2	0	3	3.5
CH 181101	Chemistry Laboratory	0	0	3	1.5
	Total	**14**	**6**	**8**	**24**

Mathematics Curriculum for Semester - I

I	Course Code	**MA 181001**			
II	Course Title	**Mathematics I : Calculus**			
III	Credit Structure	L	T	P	C
		3	2	0	5
IV	Course Content	1. Limit, Continuity, Limit at infinity, infinite limits, asymptotes, limit of sequences, Continuity and differentiability, IVT 2. Linear Approximation and differentials, Maximum and Minimum Values, The Mean Value Theorems, Increasing and decreasing functions, concavity and curve sketching ,Indeterminate Forms and L'Hospital's Rule, Taylor's theorem 3. Area, Riemann sums, the definite integral, the fundamental theorem of calculus 4. Application of Definite integrals-Areas between Curves, Volumes 5. Volumes by Cylindrical Shells, Work, Average Value of a Function, Arc Length, Area of a Surface of Revolution, Improper Integrals. 6. Three-Dimensional Coordinate Systems, Equations of Lines and Planes, Cylinders and Quadric Surfaces, Cylindrical Coordinates, Spherical Coordinates 7. Functions of Several Variables, Limits and Continuity, Partial Derivatives, Tangent Planes and Linear Approximations, The Chain Rule, Directional Derivatives and the Gradient Vector 8. Vector functions, Vector Functions and Space Curves, Derivatives and Integrals of Vector Functions, Arc Length and Curvature, Motion in Space: Velocity and Acceleration 9. Vector fields, Gradient, Curl and Divergence 10. Extreme values and saddle points of functions of several variables, Constrained optimization, Lagrange Multiplier Method.			
V	Text/References	1. Thomas, G.B., and Finney, R.L., Calculus and Analytic Geometry, 9th Edition, ISE Reprint, Addison-Wesley, 1998. 2. Stewart, J., Calculus, 5th Edition, Thomson, 2003. 3. Marsden, J.E., Tromba, A.J., and Weinstein, A., Basic multivariable calculus, Springer India, 2004. 4. Apostol, T.M., Calculus, Volumes 1 and 2, 2nd Edition, Wiley Eastern, 1980. 5. Hughes-Hallett et al, Calculus - Single and Multivariable (3rd Edition), John- Wiley and Sons 2003			

Mathematics Curriculum for Semester II

I	Course Code	**MA 181002**			
II	Course Title	**Mathematics II: Linear Algebra with vector calculus and ODE**			
III	Credit Structure	L	T	P	C
		4	2	0	6
IV	Prerequisites	MA 1001			
V	Course Content	**Linear Algebra with Vector Calculus:** Double Integrals over Rectangles, Iterated Integrals, Double Integrals over General Regions, changing the order of integration, Change of Variables in Multiple Integrals, Double Integrals in Polar Coordinates, Applications of Double Integrals Triple Integrals, Triple Integrals in Cylindrical Coordinates, Triple Integrals in Spherical Coordinates, Applications Line Integrals, The Fundamental Theorem for Line Integrals, conservative vector fields and path independence, Green's Theorem Parametric Surfaces and Their Areas, Surface Integrals, Stokes' Theorem, The divergence theorem Vectors in , Systems of Linear equations, Matrices and Gauss elimination, Elementary matrices, Determinants and rank of a matrix Eigenvalues and eigenvectors, Characteristic polynomials, Eigenvalues of special matrices, Multiplicity, Diagonalizability Abstract vector spaces, Subspaces, Linear independence, dependence, basis and dimension Linear transformations, Matrix of a linear transformation, Change of basis and similarity, Rank-nullity theorem Inner product spaces, Gram-Schmidt process, Orthonormal Bases, Diagonalization, Spectral theorem, Quadratic forms **ODE:** Exact equations, Integrating factors and Bernoulli's equation Orthogonal trajectories; Lipschitz condition, Picards theorem, Reduction of order Linear ODEs with constant coefficients, Cauchy-Euler equations Wronskians, Abel-Liouville formula, Method of undetermined coefficients, Method of variation of parameters Laplace transforms, Shifting theorems, Convolution theorem			
V	Text/References	1. Anton, H., Elementary linear algebra with applications, 8th edition, John Wiley & Sons, 1995. 2. David Poole, Linear Algebra:A modern Introduction, Cengage Learning, 4th edition 3. Apostol, T.M., Calculus, Volume 2, 2nd Edition, Wiley Eastern, 1980. 4. Boyce, W.E., and DiPrima, R., Elementary Differential Equations, 9th Edition, John Wiley & Sons, 2005. 5. Kreyszig, E., Advanced Engineering Mathematics, (9th Edition), Wiley India 6. Strang, G., Linear algebra and its applications, 4th Edition, Thomson, 2006.			

Physics Curriculum for Semester I

I	Course Code	**PH 181001**			
II	Course Title	**Physics - I**			
III	Credit Structure	L	T	P	C
		2	1	0	3
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Special Theory of Relativity: Problems with classical physics, Inertial and non-inertial frames of reference, Postulates of special theory of relativity, Galilean and Lorentz transformation, Length contraction and Time dilation, Relativistic addition of velocities, Energy momentum relationships. Quantum Mechanics: Black-body radiation, Photoelectric effect and Compton effect, Wave nature of matter, Davisson-Germer experiment, Group and Phase velocities, Heisenberg's uncertainty principle, Schrodinger equation, Wave function and Normalization, Probability density and probability, Operators, Expectation values, Eigenvalues and Eigenfunctions, Particle in infinite and finite square wells, Particle in one, two and three dimensional box, Degenerate states, Potential barrier, Tunneling through a barrier, Eigenvalue and Eigenfunction of 1D simple harmonic oscillator without complete derivation.			
VI	Text/References	1. C. Richtmyer and Kennard, Introduction to Modern Physics, 6th Edition, McGraw-Hill, 1969. 2. R. Eisberg and R. Resnick, Quantum Physics, 2nd Edition, John Wiley 2002. 3. H.S. Mani and G.K. Mehta, Introduction to Modern Physics, 1st Edition, East-west Press Pvt. Ltd.-New Delhi, 2000. 4. A. Beiser, Concepts of Modern Physics, 6th Edition, Tata McGraw Hill Education Pvt. Ltd., 2009. 5. R. P. Feynman, R.B. Leighton, and M. Sands, The Feynman Lectures on Physics -Vol III, Narosa Publishing House, 2010. 6. R.A. Serway, C.J. Moses and C.A. Moyer, Modern Physics, 3rd Edition, Thomson Learning, Inc. 2005.			

Physics Curriculum for Semester II

I	Course Code	**PH 181002**			
II	Course Title	**Physics- II**			
III	Credit Structure	L	T	P	C
		3	2	0	5
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Vector Calculus: Gradient, Divergence, Curl and Laplacian, Line, Surface and Volume integrals, Gauss-divergence and Stokes theorems, Spherical polar and Cylindrical coordinate systems. Electrostatics: Electric field and Gauss's law, Electrostatic potential, Multipole expansion, Electrostatic energy, Conductors, Uniqueness theorem, Laplace's solution, Image method, Electrostatic boundary conditions, Electrostatic Fields in matter, Capacitors. Magnetostatics: Lorentz force law, Continuity equation, The Biot- Savart's law, Ampere's law, Magnetic vector potential, Magnetism in materials, Magnetostatic boundary conditions. Electrodynamics: Electromotive force, Faraday's law and Lenz's law, Inductance, Displacement current, Maxwell's equations, Electromagnetic (EM) waves in vacuum and media.			
VI	Text/References	1. D. J. Griffiths, Introduction to Electrodynamics, 3rd Edition, PHI Learning, 2009. 2. J. R. Reitz, F. J. Milford, R.W. Christy: Foundations of Electromagnetic Theory, 4th Edition, Pearson Addison Wesley, 2009. 3. A. Mahajan, A. Rangwala, Electricity and Magnetism, 1st Edition, Tata McGraw Hill, 1988. 4. E. M. Purcell, Berkeley Physics Course, Electricity and Magnetism, Volume 2, 2nd Edition, Tata McGraw Hill, 2007. 5. R. P. Feynman, R.B. Leighton, and M. Sands, The Feynman Lectures on Physics -Vol II, Narosa Publishing House, 2010.			

Physics Practical Curriculum for Semester I

I	Course Code	**PH 181101**			
II	Course Title	**Physics Laboratory**			
III	Credit Structure	L	T	P	C
		0	0	3	1.5
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	1. Compound Pendulum: Determine the acceleration due to gravity and the radius of gyration of the given compound pendulum. 2. Young's Modulus by Koenig's Method: Determine Young's modulus of the material of a rectangular bar by Koenig's method. 3. Thermal Conductivity by Lee's Disc: Measure the thermal conductivity of a poor conductor by electrically heated Lee's disc apparatus. 4. Kundt's Tube: Measure the velocity of sound in air using Kundt's tube apparatus and calculate the "γ" of air at room temperature. 5. Helmoltz Coil: Verify the principle of superposition and to examine the uniformity of the magnetic field produced by Helmholtz coils. 6. Fresnel's Biprism: Determine the wavelength of light using Fresnel's bi- prism. 7. Hydrogen Spectrum: Measure the wavelengths of visible spectral lines in Balmer series of atomic hydrogen and to determine the value of Rydberg's constant. 8. Grating Spectrometer: Determine the wavelengths of spectral lines of mercury and the angular dispersive power of a diffraction grating. 9. Single Slit Diffraction: Study the diffraction at a single slit and verify Heisenberg's uncertainty principle. 10. Four Probe Method: Study the resistivity of the semiconductor by Four Probe Method at different temperatures and determine the band gap. 11. Photoelectric Effect: Determine the value of Planck's constant using photoelectric effect. 12. Hall Effect: Determine the carrier concentration and type of carrier using Hall effect.			
VI	Text/References	1. Practical Physics, G. L. Swuires, 4th Edition, Cambridge University Press,2012. 2. Physics, Vols 1 & 2, D. Holliday, R. Resnick and K. S.Krane, John Wiley and Sons, 5th Edition, 2002. 3. Optics, Ajoy Ghatak, 5th Edition, Tata McGraw Hill, 2012. 4. Introduction to Geometrical and Physical Optics, B. K. Mathur, Gopal Printing, 1967. 5. Introduction to Solid State Physics, C. Kittle 8th Edition, Wiley Publications,2004.			

Chemistry Curriculum for Semester I & II

I	Course Code	**CH 181001**			
II	Course Title	**Chemistry**			
III	Credit Structure	L	T	P	C
		3	1	0	4
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Chemical Kinetics: Rate laws, Rate constant and equation, order and molecularity, Complex reactions, Arrhenius equation, collision theory, Reaction cross section, Harpoon mechanism, Organic reaction mechanism Catalysis: Homogeneous and Heterogeneous Catalysis, Adsorption, Biocatalysis, Important Industrial applications (at least two), Catalytic converter Basics of Spectroscopy: Rotational, Vibrational and Electronic spectroscopy Basics of Electrochemistry, Fuel Cell, Corrosion and its prevention Water and its treatment Polymer: Classification, Molecular weight and MWD, Thermal and mechanical properties, Compounding of polymer, Commodity plastic and engineering plastic			
VI	Text/References	1. Elements of Physical Chemistry, P.W. Atkins & De Paula, Oxford, 2017. 2. Heterogeneous Catalysis, D. K. Chakravarty & B. Vishwanathan, New Age International, 2011. 3. Polymer Science - V. R. Gowarikar, N. V. Viswanathan & Jayadev Sreedhar, New Age International, 2006 (reprint). 4. Organic Chemistry, R. T. Morrison & R. N. Boyd, Pearson Education India, 2010. 5. Fundamentals of molecular spectroscopy, C. N. Banwell & E. M. McCash, McGraw Hill Education (India) Private Limited, 2013 6. Spectroscopy of Organic compounds, P. S. Kalsi, New Age International, 2007. 7. Applications Of Absorption Spectroscopy Of Organic Compounds, J. R. Dyre, Prentice Hall India Learning Private Limited, First Edition, 1978. 8. Heterogeneous Catalysis: Principles & Applications, G. C. Bond, Clarendon Press ; New York : Oxford University Press, 1987 9. Engineering Chemistry, Jain and Jain, Dhanpat Rai Publishing Company, 2015 10. A text book of Engineering Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Limited, 2017 11. Chemical kinetics, K. J. Laidler, Pearson Education India, 2003.			

Chemistry Practical Curriculum for Semester I & II

I	Course Code	**CH 181101**			
II	Course Title	**Chemistry Laboratory**			
III	Credit Structure	L	T	P	C
		0	3	0	1.5
IV	Prerequisite (if any)	Nil			
V	Course Content	1. Complexometric Titration: To estimate hardness of a given water sample bycomplexometric method 2. Estimation of Acetamide: To estimate Acetamide present in a given solution by hydrolysis method 3. Organic preparation: To prepare acetanilide from aniline 4. Organic preparation: To prepare p-nitro acetanilide from acetanilide 5. Chemical Kinetics (Hydrolysis of an Ester): To determine the rate constant and order of reaction for acid catalyzed hydrolysis of methyl acetate 6. Potentiometric titration: To determine the normality of hydrochloric acid potentiometrically 7. Conductometric titration: To determine the strength of sodium hydroxide solution conductometrically 8. Conductometric titration: To determine the milk adulteration by conductivity measurements. 9. pH metric titration: To determine the strength of HCl solutions in mixture using pH meter 10. Iodometry: To Determine Dissolved Oxygen of a given Water Sample by Winklers Iodometric Method 11. Iodimetric Titration: To determine the strength of given ascorbic acid solution by titrating against standard 0.1 N iodine solution 12. Chemical Oxygen Demand: To determine the Chemical Oxygen Demand (COD) for a given polluted water sample			
VI	Text/References	1. D.P. Shoemaker, C.W. Garland and J.W. Nibler: Experiments in Physical Chemistry, McGraw Hill International Edition, 1996 2. V.D. Athawale and P. Mathur: Experimental Physical Chemistry, 1st Edition, New Age International Publication, New Delhi, 2001. 3. J.B. Yadav: Advanced Practical Physical Chemistry, Goel Pub., Meerut, 2003 4. S. M. Khopkar: Basic Concepts of Analytical Chemistry, 3rd Edition, New Age International Publication, New Delhi, 2008 5. P. Samnani: Experiments in Chemistry, Anmol Publication Pvt. Ltd. New Delhi, 2007			

Civil Infrastructure Curriculum for Semester I

I	Course Code	**CE 181001**			
II	Course Title	**Introduction to Civil Infrastructure**			
III	Credit Structure	L	T	P	C
		2	0	0	2
IV	Prerequisite (if any)	None			
V	Instructor(s)				
VI	Course Content	**Unit 1:** Introduction to Infrastructure scenario in India. Urban and Rural infrastructure in India. Bird-eye view to various specializations in Civil Engineering discipline and their practical relevance for the infrastructural development.Basics of infrastructure planning. **Unit 2:** Role of Civil Engineering in the following infrastructure sectors: a) Transportation infrastructure b) Hydraulic infrastructure c) Building infrastructure d) Water supply and wastewater infrastructure e) Energy infrastructure f) Smart Infrastructure **Unit 3:** Environmental and sustainability aspects for the design of infrastructure, New challenges for the future infrastructure development			
VII	Text/References	1. Irrigation and Hydraulic Structure S K Garg, 1st Edition, Khanna Publishers. 2. Environmental Engineering - N.N.Basak, 1st Edition, Mcgraw Higher Ed. 3. Highway Engineering S K Khanna and C E Justo, 10th Edition, Nem Chand Brothers. 4. Railway Engineering - Satish Chandra and Agrawal, Oxford University Press. 5. Building Planning and Drawing: SS Bhavikatti and M. V. Chitawa, I K International Publishing House Pvt. Ltd. 6. Reinforced Concrete Design by S. N. Sinha, Tata McGraw Hill. 7. Steel Structures-Design and Practice, N. Subramanian, Oxford University Press. 8. Textbook of Geotechnical Engineering by B M Das, Cengage Learning. 9. Building Materials, S. S. Bhavikatti, Vikas Publishing House. 10. Smart Civil Structures by You-Lin Xu and Jia He, CRC Press, Taylor and Francis. Open source information/literature available through World Wide Web, MOOCS, NPTEL, and Institution Library etc.			

Electrical Infrastructure Curriculum for Semester I

I	Course Code	**EE 181001**			
II	Course Title	**Introduction to Electrical Infrastructure**			
III	Credit Structure	L	T	P	C
		2	0	0	2
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Introduction to electrical infrastructure requirements in transportation systems, Electrical Energy Scenario, Basics of Electrical Drives, Basic characteristics of DC and 3-phase induction motors, Electrical Traction Systems (Railways, Metro-rails, Tramways), electric power generation, transmission and distribution systems, Information and Communication, environmental aspects, energy considerations, conventional power plants, Renewable energy infrastructure: Solar Parks, Wind Farms, Biogas plants etc., laws of illumination, factory and street lighting, hybrid electric vehicles and electric vehicles, emergency power systems, Central Emergency Power Stations (CEPS), Central Power Stations (CPS) and Central Energy Plant (CEP), Power Control and Monitoring Systems (PCMS).			
VI	Text/References	1. ”Utilization of Electric Power & Electric Traction” by J.B.Gupta, Katson Publishers. 2. ”Fundamentals of Internal Combustion Engines” by H.N. Gupta, PHI Publications. 3. Utilization of Electrical Power by Soni, Bhatnagar and Gupta			

Mechanical Infrastructure Curriculum for Semester I

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 181001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Introduction to Mechanical Infrastructure</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>IV</td><td>Prerequisite, if any</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Unit 1: History and overview
Overview of infrastructure requires all of engineering, Classification and different sectors of infrastructure, Developmental role of mechanical infrastructure, Some historically important people and their contributions in infrastructure (Marquis of Pombal, Isambard Kingdom Brunel, Mokshagundam Visvesvaraya, etc.).
Unit 2: Introduction to Transportation Infrastructure.
Railway Infrastructure:
Introduction to the railway industry, their impacts on the society and on the environment, types of coaches, engine and machines in railway engineering. Involvement in country GDP, Future need of country, creation and maintenance of railway infrastructure.
Airways Infrastructure:
Introduction to airway infrastructure, need and importance of air transport, basic working and control method of airplane, construction and working of jet engines, method to reduce cost of air transport, socio-economic impact of airways infrastructure, creation and maintenance of airway infrastructure.
Roadways infrastructure:
Introduction to roadways infrastructure, need and importance of road transport, basic working and control method of commercial and noncommercial vehicle, creation and maintenance of roadway infrastructure.
Water transport infrastructure:
Introduction to water transport infrastructure, need and importance of water transport, basic working and control method of commercial and non- commercial water vehicles, creation and maintenance of water transport infrastructure.
Unit 3: Introduction to Energy Infrastructure:
Introduction, types of energy, source of energy, conventional and non-conventional source of energy, working principle thermal, solar, hydroelectric, wind and nuclear power plant, recent advancement and challenge to meet the demand for aforesaid power plant, energy distribution, energy transport, its use for human comfort and maintenance of power plant.
Unit 4: Case Studies
Different case studies in the field of related infrastructures and one case study assignment for the students.
Unit 5: Field visits
Field visit to industrial establishment such as power plants, manufacturing and maintenance industry and submission of final report.</td></tr>
<tr><td>VI</td><td>Textbooks/References</td><td colspan="4">1. Donaldson, Dave. Railroads of the Raj: Estimating the impact of transportation infrastructure. No. w16487. National Bureau of Economic Research, 2010.
2. Banister, David. Transport and urban development. Routledge, 2003.
3. Nag, P. K. Power plant engineering. Tata McGraw-Hill Education, 2002.
4. Drbal, Larry, Kayla Westra, and Pat Boston, eds. Power plant engineering. Springer Science & Business Media, 2012.
5. Vasigh, Bijan, and Ken Fleming. Introduction to air transport economics: from theory to applications. Routledge, 2016.
6. Ashford, Norman, and Paul H. Wright. Airport engineering. New York: Wiley, 1979.</td></tr>
</table>

Engineering Graphics Curriculum for Semester I & II

I	Course Code	**GE 181001**			
II	Course Title	**Engineering Graphics**			
III	Credit Structure	L	T	P	C
		2	0	3	3.5
IV	Prerequisite (if any)	Nil			
V	Course Content	Introduction to the engineering design process and the importance of technical. Graphics/Drawings; Integrated design and 3D modelling, visualization - sketching & computer aided drawing, geometrics - geometry construction, shape description, multi-view drawings - orthographic projection, isometric views, axonometric projections, auxiliary & section views; Dimensioning; Assembly drawings.			
VI	Text/References	1. Ostrowsky, O., Engineering Drawing with CAD Applications, Elsevier Science & Technology, 1989 2. Banach, D. T., and Jones, T., Autodesk Inventor 2011 Essentials Plus, Cengage Learning, Inc, 2010 3. Jensen, C. H., Helsel, J. D., and Short, D. R., Engineering Drawing and Design, 7th edition, McGraw Hill, 2007			

Basic Electrical and Electronics Engineering Curriculum for Semester II

I	Course Code	**EE 181002**			
II	Course Title	**Basic Electrical And Electronics Engineering**			
III	Credit Structure	L	T	P	C
		2	1	2	4
IV	Prerequisite (if any for the students)	No			
V	Course Content	Elements in an Electrical circuit: R, L, C, Voltage and current sources (independent and dependent/controlled sources with examples). DC circuits, KCL, KVL, Network theorems, Mesh and nodal analysis. Step response in RL, RC, RLC circuits. Basics of semiconductor physics,P-N junction,diode characteristic,diode circuits - clippers.Characteristics of BJTs.Common Emitter,Common collector configurations of BJTs,biasing of BJTs and its small signal modeling.Basics of operational amplifiers.			
VI	Text/References	1 R. J. Smith and R. C. Dorf, Circuits, Devices and Systems, Wiley, 5th edition, 1992. 2 E. Hughes, Electrical Technology, Pearson, 7th edition. 3 Bobrow, Fundamentals of Electrical Engineering, Oxford Univ Press. 4 Hayt, W. H., Kemmerly, J. E., Durbin, S. M., Engineering Circuit Analysis, sixth edition, Tata Mc-Graw Hill, 2006. 5 R. Prasad, Fundamentals of Electrical Engineering Book, Prentice Hall India Learning Private Limited; Third edition (2014)			

Computer Science Curriculum for Semester I & II

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">CS 181001</td></tr>
<tr><td>II</td><td>Title of Course</td><td colspan="4">Computer Science</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>3</td><td>4.5</td></tr>
<tr><td>IV</td><td>Prerequisite(for the student)</td><td colspan="4">Concept of algorithm</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">1. Introduction to the state of the art in computing focusing on hardware and its architecture, operating systems, memory management. Numeric information representation in computers : 2s complement representation of integers and IEEE 754 standard for representing floating point numbers. ASCII and Unicode systems for representing character data.
2. Computers, algoritms and programming. A programmers view of a computer system. Lower Level and higher level programming languages, general characteristics of programming languages and classification of programming constructs.
3. Scalar and non-scalar data, variables, types and objects. Arithmetic, relational, logical and assignment operators. Strings, string operations and slicing.
4. Data structures, supported operations. Mutable and immutable types. Lists, tuples, dictionaries and sets. Iterables and iterative traversal of sequential structures.
5. Conditional and iterative control structures. Nested controls. Break and continue statements.
6. Library modules and their use. User defined functions and modular programming. Developing function libraries. Recursive functions.
7. Algorithms and their implementation. Introduction to algorithmic complexity and computational complexity. Euclids algorithm, prime number programs.
8. Classes and objects. Object oriented programming. Inheritance.
9. Scientific and engineering computation examples. Numpy and Scipy libraries. Computations with multi-dimensional arrays.
10. Reading and writing files. Matplotlib library for plotting graphs, and displaying images. Handling CSV files with Pandas library.</td></tr>
<tr><td>VI</td><td>Text Books and web resources</td><td colspan="4">1. John V Guttag, Introduction to Computation and Programming Using Python, 2 Edition, Prentice Hall India & MIT Press, 2014.
2. Mark Lutz . Learning Python: Powerful Object-Oriented Programming: 5th Edition, OReilly/SPD, 2013
3. https://docs.python.org/3/ Python 3.6 online documentation.
4. https://docs.python.org/3/tutorial/index.html Python online tutorial
5. Python tutorials with Jupyter notebooks</td></tr>
<tr><td>VII</td><td>MOOCs</td><td colspan="4">1. www.edx.org, Introduction to Computer Science and Programming Using Python, Free online course offered by Eric Grimson, John Guttag from MIT.
2. www.coursera.org Programming for Everybody (Getting Started with Python), Charles Severance, University of Michigan</td></tr>
<tr><td>VIII</td><td>Software Resources</td><td colspan="4">Jupyter notebooks</td></tr>
</table>

Manufacturing Science and Workshop Curriculum for Semester I & II

I	Course Code	**GE 181002**			
II	Course Title	**Manufacturing Science and Workshop**			
III	Credit Structure	L	T	P	C
		2	0	3	3.5
IV	Prerequisite, if any	NIL			
V	Course Content	**Introduction to manufacturing processes:** Brief history of manufacturing, product design and concurrent engineering, Selection of materials, significance of material properties with respect to selection of manufacturing processes. **Safety:** Importance of safety and general Safety considerations in manufacturing. **Traditional Manufacturing process:** ***Fitting Tools & Equipment,*** practice in filing, making 'V' Joints, Square, Dovetail joints and key making plumbing. **Carpentry Tools and Equipment-** Planning practice, Making Half Lap, Dovetail, Mortise & Tenon joints. **Principles of heat treating;** annealing, normalizing, hardening and tempering. **Casting Process:** Basic concepts of castings, patternmaking, types of Pattern, Pattern allowances, Moulding sand, Types and properties of Moulding sand, cores, elements of gating system, Defects in casting system, special types of casting processes. **Metal Forming Process:** Basic concepts of plastic deformation. Hot & cold working. Common bulk deformation processes (Rolling,Forging, Extrusion and Drawing). Common sheet metal forming processes. **Machining Process :** Mechanics of cutting, cutting forces and power, cutting tool materials and cutting fluids, Tools geometry, Tool life: wear and failure ***Traditional machining process:*** Turning process, Lathe and lathe operations, Boring and Boring Machine, Drilling and Drilling machines, Milling and Milling Machines, Planing and shaping, Broaching and Broaching machines, Grinding & other Finishing processes. **Welding & Other Joining Processes:** Fundamentals & classification of Joining processes, Welding- Gas arc & resistance welding, Brazing and soldering, Adhesive bonding, Mechanical fastening. **Manufacturing of Polymer and Powder Products:** Classification of polymers, Introduction to extrusion, injection molding, blow molding, compression and transfer molding. Powders & Green compacts from powders including slip casting of ceramics. Sintering. **Modern Trends in Manufacturing:** ***Non-Traditional machining process:*** Need of Non-Traditional machining process, Working principle, advantages and disadvantages of ECM (Electro chemical machining), EDM (Electrical-discharge machining), LBM (Laser Beam Machining), EBM (Electron Beam Machining). ***Non Traditional Forming Process:*** Working principle, advantages and disadvantages of Explosive Forming process ***Non-Traditional Joining process*** Working principle, advantages and disadvantages of LBW (Laser Beam welding process) ***Fabrication of Microelectronic devices:*** Semiconductors and silicon, crystal growing and wafer preparation, film deposition, Lithography, etching, Diffusion and ion implantation, Printed Circuit Boards. ***Additive manufacturing:***Introduction to the Basic Principles of Advanced/Additive Manufacturing. Advantages, disadvantages and its application. ***Automation of manufacturing process and operations:*** Automation, Numerical control: Advantages and Disadvantages of NC system, comparison between conventional and NC machines, Adaptive control. Industrial Robots: structure of robot and its application in manufacturing. Computer-aided manufacturing, Computer integrated manufacturing systems			

VI	Text/References	1. Schey, J. A., Introduction to Manufacturing Process, 3rd Edition, McGrawHill, 2000. 2. Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology, 7th Edition, Pearson, 2018. 3. B. S. Nagendra Parashar, R. K. Mittal, Elements of Manufacturing Processes, PHI, 2016. 4. Singh, D. K., Fundamentals Of Manufacturing Engineering, Ane Books Pvt Ltd, new Delhi, 2nd Ed., 2009. 5. Hajra Choudhary, S. K., Elements of Workshop Technology, Media Promotors & Publishers Pvt Ltd, 12th Edition, 2002.

Indian English Literature & Language for Semester I

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">HS 181001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Indian English Literature & Language</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>IV</td><td>Course Coordinator</td><td colspan="4">Dr. Meera Vasani</td></tr>
<tr><td>V</td><td>Course Objective</td><td colspan="4">To have in depth practice of extensive reading and writing</td></tr>
<tr><td>VI</td><td>Course Contents</td><td colspan="4">Literature Units: (Can be revised every year)
The Last Tonga Ride (Ruskin Bond)
I have Three Visions for India (A P J Abdul Kalam)
The shroud (Munshi Premchand)
First Selfie in Space (Sujata Reddy)
My Birth Place (Nirad C. Chaudhuri)
A Wrong Man in Workers Paradise (Rabindranath Tagore)
Toasted English (R. K. Narayan)
Crime and Punishment (R. K Narayan)
Grammar of Anarchy (B R Ambedkar)
Punishment in Kindergarten (Kamala Das)
Grammar:
Idioms & Phrases, Synonyms, Antonyms, One word substitution, Technical Vocabulary, Homophones, Direct-Indirect, Punctuation
Writing:
Report Writing
Letter Writing
Precis
Note-making
Paragraph Writing
Statement of Purpose</td></tr>
<tr><td>VII</td><td>Text/References</td><td colspan="4">T. Vijay Kumar, K. Durga Bhavani, YL Srinivas (Ed); English in Use; Macmilan Education
J Kumar Singh, F Bharateeya, D Trivedi (Ed); College Collage; Macmillan Education
H. Raviya, A. Pandya, et.al (Ed); Mosaic; Macmillan
Spectrum- A textbook for college students; Macmillan education
Thomas L. Means, Ed. D.; English and Communication for colleges; Cengage
M. Hemamalini; Technical English; Wiley
Grammar books for practice</td></tr>
</table>

Functional English & Comprehension for Semester I

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">HS 181002</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Functional English & Comprehension</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisites (if any)</td><td colspan="4">Basic knowledge of English.</td></tr>
<tr><td>IV</td><td>Course Coordinator</td><td colspan="4">Dr. Meera Vasani</td></tr>
<tr><td>V</td><td>Course Objective</td><td colspan="4">• To understand the use of basic grammar.
• To comprehend the concepts written in the second language.
• Make them more towards the correct usage of grammar in both verbal and written communication.
• Introduce them with the phonetics so as to lead them to the correct pronunciation of words.</td></tr>
<tr><td>VI</td><td>Course Contents</td><td colspan="4">Part I. Grammar Topics :
• Articles; Tenses; Prepositions; Modals; Moods of Verb; Concord
• Active Passive; Direct-Indirect; Punctuation
• Idioms and phrases; phrasal verbs; Synonyms; Antonyms; words often confused; homophones;.
• Common errors;
• Jumbled Sentences;
• Comprehensions
Part II. Writing Section:
• Email writing
• Sentence Completion
• Paragraph Completion
• Notice writing
• Note Making
• Message writing
• Letter Writing
Lab Activities: Grammar exercises; Comprehension exercises; general etiquettes; greetings; self-introduction; basic conversation;</td></tr>
<tr><td>VII</td><td>Text/References</td><td colspan="4">1. Competitive English; Edi. Pradyumansinh Raj; Azhar Siddiqui, Shaili Kaviya ad.; Macmillan Publisher India Pvt. Ltd.; latest edition.
2. Technical English: Vocabulary and Grammar. By Nick Brieger & Alison Pohl. Publication Details: Cengage Learning, 2014.
3. Grammar Books with exercises</td></tr>
</table>

BACHELOR OF TECHNOLOGY

Mechanical Engineering Department

Semester - III

Course Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
HS 192001	Introduction to sociology	3	0	0	3
MA 192001	Mathematics-III (Complex Analysis and Differential Equations II)	4	2	0	6
ME 192001	Engineering mechanics	3	2	0	5
ME 192002	Thermodynamics	3	1	0	4
ME 192501	Metrology (honors)	0	1	2	2
ME 192003	Engineering Materials	3	1	2	5
	Total	**16**	**7**	**4**	**25**

Mechanical Engineering Department

Semester : III

I	Course Code	**HS 192001**			
II	Course Title	**Introduction to Sociology**			
III	Credit Structure	L	T	P	C
		3	0	0	3
IV	Prerequisite(If any for the student)	Nil			
V	Course Coordinators	Dr. Shukkoor. T			
VI	Course Content	**Unit- 1** **Sociology:** Origin and Development; Nature, Scope and Significance; Founders of Sociology; Sociological Perspectives **Unit-2** **Basic Concepts:** Society, Community, Social Structure, Status and Role; Culture, Norms and Values, Socialization; social stratification, Groups- Types of group, Social organisations; Social control; Deviance, Social change, Social protests, Social movements **Unit-3** **Social Institutions- Features and Functions:** Family, Education, Economy, Religion, State **Unit-4** **Social Problems- definition and characteristics:** Corruption, Unemployment, Poverty **Unit- 5** **Sociology of Science and Technology:** Society and Technology: Technology and Development, The Social Construction of Technology, Technology and Social Relations, Social responsibilities of scientists and technocrats, Gender and Technology			

VII	Text/References	1. Giddens, Anthony (2013): Sociology (seventh edition), Cambridge, Polity Press 2. Das,Veena (2005): Handbook of Indian Sociology, New Delhi: Oxford University Press 3. Harlambos, M. (2014): Sociology: Themes and Perspectives, London: Harper Collins 4. MacIver and Page (1974): Society: An Introductory Analysis, New Delhi: Macmillan & Macmillan 5. Inkeles, Alex (1987): What is Sociology? New Delhi: Prentice-Hall of India 6. Johnson, Harry M. (1995): Sociology: A Systematic Introduction, New Delhi: Allied Publishers 7. Ahuja, Ram (2001): Indian Social System, New Delhi: Rawat Publication. 8. Ahuja, Ram (2003): Society in India, New Delhi: Rawat Publication. 9. Abercrombie, N., Hill, S., Turner, B.S: Dictionary of Sociology (2005): Penguin Reference
VIII	Evaluation scheme for the course	Assignments : 25 % (First assignment-10 %, second assignment-15%) Mid semester examination: 25 % End semester examination: 50%

Mechanical Engineering Department

Semester : III

I	Course Code	**MA 192001**			
II	Course Title	**Mathematics-III (Complex Analysis and Differential Equations II)**			
III	Credit Structure	L	T	P	C
		4	2	0	6
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Complex Analysis: Definition and properties of analytics functions; Cauchy-Riemann equations, Harmonic functions; Power series and their properties;Elementary functions; Cauchys theorem and its applications; Taylor series andLaurent expansions; Residues and the Cauchy residue formula; Evaluation ofimproper integrals; Conformal mappings. Differential Equations:Laplace transforms, Shifting theorems, Convolution theorem,Review of power series and series solutions of ODEs; Legendres equationand Legendre polynomials; Regular and irregular singular points, method ofFrobenius; Bessels equation and Bessels functions; SturmLiouville problems;Fourier series; DAlembert solution to the Wave equation; Classification oflinear second order PDE in two variables; Vibration of a circular membrane;Fourier Integrals, Heat equation in the half space			
VI	Text/References	1. Kreyszig, E., Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, 1999. 2. Boyce, W.E., and DiPrima, R., Elementary Differential Equations, 8thEdition, John Wiley & Sons, 2005. 3. Churchill, R.V., and Brown, J.W., Complex variables and applications, 7thedition, McGrawHill, 2003. 4. Churchill, R.V., and Brown, J.W., Fourier series and boundary value Problems, 7th Edition, McGraw-Hill, 2006. 5. Howie, J.M., Complex Analysis, Springer-Verlag, 2004. 6. Ablowitz, M.J., and Fokas, A.S., Complex variables: Introduction and Applications, Cambridge University Press, 1998(Indian Edition).			

Mechanical Engineering Department

Semester : III

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Engineering Mechanics</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>2</td><td>0</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Course contents:
Unit-I: Introduction
Introduction to engineering mechanics, assumptions, methods of analysis-scalars and vectors, Force system-coplanar and non-coplanar forces, collinear-non-collinear forces, concurrent forces, and non-concurrent forces, moment of force and couple, free body diagram.

Unit-II: Forces in Engineering Systems
Forces in beams: Types of loading-Concentrated load, Uniformly distributed load, Uniformly varying load, Random loads, Types of Support: Free, Fixed, Hinged, SFD, BMD, Truss Analysis: Assumptions, analysis of forces in truss-method of joints, method of sections, conditions of equilibrium, nature of force system.
Friction: Introduction, laws of friction, angle of repose, cone of friction, friction on plane and inclined surfaces, wedge, belt friction, application of friction to engineering problem.

Unit-III: Centroid, Center of gravity and Moment of Inertia
Definitions: Center of gravity, centroid, center of mass, Centroid of standard sections, centroid of composite sections, centroid of wires, moments of inertia, parallel axis theorem, perpendicular axis theorem, radius of gyration, moment of inertia for standard and composite sections.

Unit-IV: Motion
Introduction to dynamics-kinematics and kinetics, Rectilinear motion: Determination of position, distance travelled, uniform motion, effect of increasing/decreasing velocity/acceleration, motion under gravity, relative motion, Curvilinear motion: Resolution of velocity and acceleration, tangential and normal components, radius of curvature, radial and transverse components of acceleration, Projectile Motion: Independence of horizontal and vertical motion, properties of projectile motion, projectile on inclined surfaces.

Unit-V: Kinetics of Particles
D'Alemberts Principle: D'Alemberts principle, D'Alemberts principle in normal and tangential components, motion of connected bodies, simple machines, circular motion, centripetal force, motion of vehicle on a level circular track, motion of vehicle on a banked circular track.
Work and Energy: work of force, energy, work of constant force in rectilinear motion, work of force exerted by spring, mechanical efficiency.</td></tr>
</table>

VI	Text/References	**Textbooks:** 1. Engineering Mechanics-Statics and Dynamics, S Rajasekaran and G Sankara Subramanian, 3rd Edition, Vikas Publishing House Pvt. Ltd. 2. A Textbook of Engineering Mechanics, R K Bansal, Laxmi Publications **Reference Books:** 1. Engineering Mechanics-Statics and Dynamics, Irving Shames and G. Krishna Rao, 4thEdition, Pearson. 2. Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt Limited, 2009

Mechanical Engineering Department

Semester : III

I	Course Code	**ME 192002**			
II	Course Title	**Thermodynamics**			
III	Credit Structure	L	T	P	C
		3	1	0	4
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	**Introductory Concepts and Definitions:** Areas of Application of Thermodynamics, Different Approaches in the study of Thermodynamics, System, Surroundings, Types of Systems, Intensive and Extensive Properties, Thermodynamic equilibrium, Energy, Heat & Work. **First Law of Thermo-dynamics:** Path and point Function, Perpetual Motion Machine, Analysis of Closed Systems. Constant Pressure Process, Constant Volume Process, Specific Heat, Constant Temperature Process, Adiabatic Process. Polytropic Process, First Law of Thermodynamics for a Continuous System, Steady-state Flow Processes, Application of Steady State Flow Processes, Throttling Process, Application of Throttling Process. **Properties of Pure Substances:** Thermodynamic Properties of Fluids, Pure substance, Equations of State, Ideal Gas, The Van der Waals Constants, Phase-Change Process of Pure Substances, Steam Tables. **Second Law of Thermodynamics, Entropy and Availability:** Limitations of First Law of Thermodynamics, Heat Engine, Heat Pump, Refrigerator, KELVIN PLANCK STATEMENT, Clausius Statement of the Second Law, Reversibility, Irreversibility and Carnot cycle, Carnot Engine, Carnot's Principles (Theorems), Clausius Inequality, Entropy, Principle of Entropy Increase, calculation of entropy change. Temperature Entropy Diagram & Second Law Analysis of a Control Volume, TdS Equations, Entropy change of an incompressible substance, criterion of equilibrium, Thermodynamic definition of temperature, pressure and chemical potential, Thermodynamic potentials, Availability & Irreversibility, Availability Function and Irreversibility. **Introduction to Combustion** Introducing Combustion, Fuels, Modeling Combustion Air, Products of Combustion, Energy and Entropy Balances for Reacting Systems, Conservation of Energy. Enthalpy for Reacting Systems, Enthalpy of Combustion and Heating Values, Adiabatic Flame Temperature, Absolute Entropy and the Third Law of Thermodynamics, Evaluating Gibbs Function for Reacting Systems. **Thermodynamic Cycles:** Overview of thermodynamics, Carnot Cycle, limitation of Carnot cycle, Steam Power Cycles: Rankine Cycle, Reheat Cycle, Regenerative Cycle, Binary Vapor Cycle. Gas Power Cycles: Air standard Cycles; Otto Cycle, Diesel Cycle, Dual Cycle, Comparison of Otto, Diesel & Dual Cycles, Brayton Cycle, gas power cycles with reheat, intercooling, regenerative cycle, and various combinations. Gas Turbine-Steam Turbine (GT-ST) Combine Cycle.			

VI	Text/References	1. Thermodynamics:An Engineering Approach: Cengel Y and Boles M. McGraw Hill India, 2011. 2. Fundamentals Of Engineering Thermodynamics: Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey, Willey Publication, Eighth Eddition, 2014. 3. Introduction to Thermodynamics: Rao Y V C. Orient Longman, 2009. 4. Engineering Thermodynamics: Nag P K. McGraw Hill India, 2013. 5. Fundamentals of Thermodynamics: Borgnakke C and Sonntag R E. Wiley, 2009.

Mechanical Engineering Department

Semester : III

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192501</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Metrology Lab</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>1</td><td>2</td><td>2</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">List of Experiments::
1. Measurement of linear / Angular dimensions of a part using precision/non precision measuring instruments
2. Measurement of angle using Sine bar
3. Measurement of alignment using Autocollimator.
4. Measurement of Screw threads Parameters using Two wire or Three-wire method.
5. Measurement of gear tooth profile using gear tooth Gear tooth micrometer
6. Calibration of Micrometer using slip gauges
7. Calibration of Pressure Gauge
8. Calibration of Thermocouple
9. Calibration of LVDT
10. Calibration of Load cell
11. Determination of modulus of elasticity of a mild steel specimen using strain gauges.
12. Measurement of coordinate using CMM.</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">1. Doeblein, E.O., “Measurement Systems, Application Design”, McGraw Hill.
2. Mahajan M. S., “Textbook of Metrology”, Dhanpatrai publication.
3. Kumar, D.S., “Mechanical Measurements and Control”, Metropolitan, New Delhi</td></tr>
</table>

Mechanical Engineering Department

Semester : III

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192003</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Engineering Materials</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>2</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introductory Concepts and Definitions Introduction, Materials in Engineering design, the evolution of engineering materials, the families of engineering materials, modern materials, properties of engineering materials; Fundamentals, Atomic bonding, Crystalline structure-perfection/imperfection, diffusion in solids.

Engineering Materials: Structural materials and their behavior: Metals and alloys, ceramics and glasses, polymers, composites, conductors, semiconductors, optical and magnetic materials, mechanical and thermal behavior, electrical behavior, optical behavior, magnetic behavior; Corrosion and degradation of engineering materials;

Phase transformation and Heat treatments of steels: Classification of steels with applications, Theory of Heat Treatment, Phase diagram and phase transformation, TTT, CCT diagram and its implication to heat Treatment, Different heat treatments- Annealing, Normalizing, Hardening, Tempering surface treatment etc. Strengthening Mechanisms.

Material selection and design consideration: materials and industrial design, material property charts, material selection strategy and procedure, economic, advanced materials, environmental and societal issues related to engineering materials; case studies related to few engineering products/equipments.

Laboratory Experiments:
1. Tension test
2. Three point bending test
3. Compression test
4. Impact test
5. Hardness test
6. Microscopy
7. Group Project</td></tr>
</table>

VI	Text/References	1. Callister: Materials Science and Engineering: An Introduction, 6th Edition. 2. Mechanical Metallurgy by George E Dieter 3. Mechanical Behaviour and Testing of Materials by A K Bhargava and C P Sharma.

Mechanical Engineering Department

Semester : IV

Teaching Scheme for Mechanical Engineering – Semester IV

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
MA 192002	Introduction To Numerical Methods	3	1	0	4
ME 192004	Fluid Mechanics And Machines	3	1	2	5
ME 192005	Manufacturing Processes	3	1	3	5.5
ME 192006	Strength Of Materials	3	2	0	5
ME 192007	Applied Thermodynamics	3	1	2	5
ME 192008	Intro.To Design And Innovation	4	0	0	4
	Total	**19**	**6**	**7**	**28.5**

Mechanical Engineering Department

Semester : IV

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">MA 192002</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Introduction To Numerical Methods</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">NIL</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Interpolation by polynomials, divided differences, error of the interpolating polynomial, piecewise linear and cubic spine interpolation, Numerical differentiation, Numerical integration, composite rules, error formulae, Solution of a system of linear equations, Gauss elimination, Gauss Seidel methods, partial pivoting, row-echelon form, LU factorization, Cholesky's method, matrix norms, Solution of non-linear equations, Bisection and Secant methods, Picard iteration, Newton's method, Numerical solution of ordinary differential equations, Euler and Runge-kutta methods, multi- step, predictor-corrector methods, Difference equations, Stability, Finite difference methods, Eigen value problem, Gershgorin's theorem, Power and inverse power methods, QR method, Explore to software packages like R, MATLAB.</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">1. S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An algorithmic Approach, McGraw Hill, 1980.
2. C. E. Froberg, Introduction to Numerical Analysis, Addison-Wesley, 1981.
3. E. Kreyszig, Advanced Engineering Mathematics, Wiley India.
4. K. Atkinson and W. Han, Elementary Numerical Analysis, Wiley India, 2004.
5. Ward Cheney & David Kincaid, Numerical Mathematics and Computing, Cengage Learning, India Private Limited.
6. Steven C. Chapra & Raymond P. Canale. Numerical Methods for Engineers, McGraw Hill, 2012.</td></tr>
</table>

Mechanical Engineering Department

Semester : IV

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192004</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Fluid Mechanics And Machines</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>2</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">Laws of motion, Thermodynamics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Properties of Fluids:
Introduction, Fluid properties and classification; concept of viscosity, compressibility and Elasticity, Surface tension and capillarity. Newton's law of viscosity, dynamic viscosity, classification of fluids, kinematic viscosity, variation of viscosity with temperature, Surface tension and capillarity.
Fluid Statics:
Pascal law, Hydrostatic law, Relative equilibrium, Pressure measurements- atmospheric pressure, Absolute pressure, Gauge pressure, and Vacuum pressure, Piezometer, Mano-Meters, Forces on immersed bodies: Drag and Lift.
Fluid Kinematics:
Fluid flow methods of analysis of fluid motion, Streamlines, Path lines, Streak lines and Stream tubes. Types of fluid flow-Steady and unsteady flow, Uniform and non-uniform flow, Laminar and turbulent flow, Reynolds number, Reynolds experiment, Rotational and Irrotational flow, Subcritical, critical and Supercritical flow, Compressible and Incompressible flow, One, Two and three dimensional flow, Circulation and vorticity, Stream function and Flownet.
Fluid Dynamics:
Equation of Motion: Euler's equation, Bernoulli's equation, Energy correction factor, Coefficients of contraction, velocity and discharge, Differential head meters, Free vortex motion, Analysis of free liquid Jet, Cavitation. Linear momentum equation, Force on pipe junctions and bends, Forces on moving plates and vanes due to fluid flow, Angular momentum, Forced vortex.
Flow Measuring Devices:
Measurement of discharge-Venturimeter, Orifice meter, mouth pieces, Nozzle meter, Rotometer, Weirs, Flow under sluice gates. Time of empting tanks with or without inflow. Measurement of velocity-Pitot tube.
Hydraulic Machines: Turbines: classification of tribunes, Impulse and Reaction turbines, characteristic curves, draft tubes, Pumps: classification of pumps, centrifugal pump, efficiency and power, Output of centrifugal pumps, characteristics curves.
Pipe Hydraulics:
Review of the basic equations: continuity, momentum, and energy. Flow through closed conduits: Laminar flow, Turbulent flow.
Pipe Flow Problems: Losses in pipe flow, pipes in series, pipes in parallel, branching pipes, siphons, multi-reservoir problems, pipe networks, unsteady flow in pipes, water hammer analysis.
Compressible Fluid Flow
Compressible Flow Preliminaries, Compressible Flow Through Nozzles and Diffusers, Momentum Equation for Steady One-Dimensional Flow, Velocity of Sound and Mach Number, Determining Stagnation State Properties, Analysis of One-Dimensional Steady Flowing Nozzles and Diffusers, Exploring the Effects of Area Change in Subsonic and Supersonic Flows, Effects of Back Pressure on Mass Flow Rate, chocking conditions, concept shock, Flow Across a Normal Shock.</td></tr>
</table>

VI	Text/References	1. Fluid mechanics, Frank M White 2. Introduction to fluid mechanics, Fox & McDonald, 3. Brief introduction to fluid mechanics, Munson, Young et al. 4. Fluid Mechanics: Fundamentals and Applications, Yunus Cengel, John Cimbala 5. Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House
VII	Laboratory Sessions	1. Momentum equation: Impact of a jet 2. Energy Equation: Verification of Bernoulli's theorem 3. Friction losses in pipes 4. Minor losses in pipe fittings 5. Pipes in series and parallel 6. Drag and Lift on Airfoil 7. Flow measurement: In pipes, using Venturimeter and orifice meter 8. Forces on immersed bodies: Fall velocity 9. Unsteady flow in pipes: Water Hammer

Mechanical Engineering Department

Semester : IV

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192005</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Manufacturing Processes</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>3</td><td>5.5</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">Engineering Mechanics; Basic Metrology</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Classification of Metal Removal Processes and Machine tools: Introduction to Manufacturing and Machining, Basic working principle, configuration, specification and classification of machine tools. Turning, milling, drilling, boring, abrasive processes, super-finishing processes etc. Mechanics of Machining (Metal Cutting) and Machinability: Geometry of single point cutting tools, Conversion of tool angles from one system to another, Mechanism of chip formation, Orthogonal and oblique cutting, Use of chip breaker in machining, Machining forces and Merchant's Circle Diagram (MCD), Analytical and Experimental determination of cutting forces, Dynamometers for measuring cutting forces, Cutting temperature – causes, effects, assessment and control, Control of cutting temperature and cutting fluid application, Concept of Machinability and its Improvement, Failure of cutting tools and tool life, Cutting Tool Materials of common use Advanced Cutting Tool Materials.

Casting: Introduction, Solidification- Solidification of pure metals and alloys; nucleation and growth in alloys; solidification of actual castings; progressive and directional solidification; centerline feeding resistance; rate of solidification; Chvorinov's Rule, Risering- Riser design, Gating- Gating systems and their characteristics; the effects of gates on aspiration; turbulence and dross trap, Patterns, Inspection and Quality Control.

Metal Forming and Sheet Metal Working: Elastic and plastic deformation. Concept of strain hardening. Hot and cold working processes -rolling, forging, extrusion, swaging, wire and tube drawing. Machines and equipment for the processes. Analysis of stress and strains, Yield criteria, Parameters and force calculations. Test methods for formability. Specific roll pressure, Rolling load, Rolling torque, Blanking, Punching, piercing, bending, drawing etc. Analysis of drawing of circular wires, Forces in blanking, Stresses and strains in bending.

Welding: Introduction: Principle of welding, general applications such as construction of bridges, towers, automobiles & electronic circuits, etc. Classification of welding processes, Soldering and brazing. Welded Joints: Introduction to AWS standards. Manual metal arc (MMA) or shielded metal arc (SMA) welding, Submerged arc welding (SAW). Gas metal arc welding (GMAW) or MIG/MAG welding, TIG welding, Resistance welding. Current–voltage characteristic of arc, Effects of change in arc current for change in arc length, Heat flow characteristics.</td></tr>
</table>

	Course Content	**Introduction to Plastics & their Processing:** Introduction to plastics, Injection moulding, Extrusion, Blow moulding, calendaring, etc. **Jigs and Fixtures:** Purposes of jigs and fixtures and their Design principles, Design and Application of typical jigs and fixtures. **Laboratory Experiments:** 1. Cutting forces measurement during machining using Dynamometer. 2. Determination of surface roughness after various machining operations. 3. Making of Single point cutting tool using tool & cutter grinder and study of tool signature. 4. Tool wear measurement using toolmaker's microscope. 5. To produce various welding joints using MIG and SPOT welding. 6. Fabrication of different sheet metal objects using development of surfaces. 7. Experiments on press working (Hydraulic and Manual). 8. Demonstration of various Jigs and Fixtures.s 9. Fabrication project.
VI	Text/References	1. Serope Kelpekijian & Stefan R. Schmidt. Manufacturing Processes for Engineering Materials, 2007 2. Shaw.M.C. Metal cutting principles, Oxford Clare Don Press, 1984. 3. Bhattacharya.A, Metal Cutting Theory and Practice, Central Book Publishers, India, 1984. 4. Boothroid D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 1989. 5. Fundamentals of Metal casting, Flinn, Addison Wesley. 6. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 2004 7. ASM Handbook Vol.6. Welding Brazing & Soldering, 2003

Mechanical Engineering Department

Semester : IV

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192006</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Strength of Materials</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>2</td><td>0</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">-</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Stress Measures
Introduction - Analysis of mechanical systems, Rigid and deformable solids, Equilibrium conditions, Simple stresses- Tension, Compression and Shear, Thermal stresses, Stresses on oblique planes, principal stresses and principal planes, State of stress-2D plane stress & strain, 3D. Mohr's circle of stress, Residual Stresses.

Strain measures
Fundamental definition of strain, Volumetric strains, Poisson's ratio, Multiaxial loading-Genaralized Hooke's law, Bulk and Shear Modulii, Saint Venant's principle.

Failure Theories
Microscopic and Macroscopic failures, Yield surface, Rankine, Von Mises and Tresca criterion.

Torsion Torsion formula, stresses and deformation in circular and hollows shafts – Angle of twist in elastic range, statically indeterminate shafts, combined stresses due to axial and torsional loads.

Energy Methods
Strain Energy, Strain-Energy Density, Elastic Strain Energy for Normal and Shearing Stress, Impact Loading, Work and Energy under a Single Load, Deflection under Single and multiple loads, Castigliano's theorem and applications

Elastic stability
Notion of stability of equilibrium, elastic instability and buckling, Euler load.</td></tr>
<tr><td>VI</td><td>Text/References/
Recommended</td><td colspan="4">Recommended Books

1. S1) Ferdinand Beer, E. R. Johnston and John Wolf, 'Mechanics of Materials', Tata McGraw Hill, 3rd edition, 2004.

Reference Books

1. William Hosford, Solid Mechanics, Cambridge University press, 2010.

2. Sadhu Singh, 'Strength of Materials', Khanna Publishers, 8th edition 2003.

3. R. K Bansal 'Strength of Materials' Laxmi Publications, 4th ed 2007</td></tr>
</table>

Mechanical Engg. Department

Semester : IV

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192007</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Applied Thermodynamics</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>2</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">Thermodynamics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Vapour Power and Steam Turbines: Steam Generator: Mounting and Accessories, Circulation, fuels and combustions. Steam Nozzles: Types of nozzles, critical pressure ratio and condition for maximum discharge, nozzle efficiency. Steam Turbine: Principle and types of steam turbines, compounding of steam turbines, velocity diagram and analysis of steam turbine, condition for maximum efficiency, degree of reaction, reheat factor, governing of steam turbine – throttle, nozzle and bypass governing, Losses in steam turbine, cogeneration. Back pressure, pass out and mixed pressure turbine.

Internal Combustion Engine and Gas Turbines: Fuels, Fuel air cycle, actual cycle, SI and CI engines, Combustion in SI and CI engines, Carburetors, Fuel injection, MPFI, performance analysis of the IC engine, Lubrication and cooling system, Hybrid engine
Gas Turbine: Principle and Classification, optimum pressure ratio for maximum thermal efficiency, work ratio, air rate, effect of operating variables on the thermal efficiency and work ratio, and air rate, analysis of gas turbine.

Gas Compressors
Compressor: Classification; single and multistage; effect of intercooling in reciprocating compressors; volumetric efficiency and power requirement. Centrifugal compressor: classification, energy transfer equations, elementary theory, vector diagram efficiencies; elementary analysis of axial compressors. Roots blower, performance analysis.</td></tr>
</table>

VI	Text/References	**Textbooks** 1. P.K. Nag, "Engineering Thermodynamics" – Tata McGraw-Hill Publishing Company Ltd., 4th Ed., 2008. 1. ichael J. Moran, Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey; Fundamentals Of Engineering Thermodynamics:, Willey Publication, Eighth Edition, 2014. 2. T. D. Eastop & A. McConkey, "Applied Thermodynamics" – Pearson Education, 5th Ed., 2008. 3. Rayner J., "Basic Engineering Thermodynamics" – Pearson Education, 5th Ed., 2008. 4. Claus Borgnakke & Richard E. Sonntag, "Fundamentals of Thermodynamics", John Wiley & Sons, 7th Ed., 2009. 5. M.J. Moran and H.N. Shapiro, Fundamentals of Engineering Thermodynamics (6th Edition), Wiley (ISBN: 978-471-78735-8). 6. Y.A. Cengel and M.A. Boles, Thermodynamics: An Engineering Approach (6th Edition), Tata McGraw Hill, New Delhi, 2008. (ISBN: 0070262179). Reference Books
VII	Laboratory Sessions	1. Study of Various Types of Boilers 2. To Study Boiler Mountings & Accessories 3. To study the working of impulse and reaction steam turbines. 4. To find dryness fraction of steam by separating and throttling calorimeter. 5. To study the constructional details & working principles of two-stroke petrol/ four-stroke petrol Engine. 6. To study the constructional details & working principles of two-stroke Diesel / four-stroke Diesel Engine. 7. Analysis of exhausts gases from petrol/diesel engine 8. To find the indicated horse power (IHP) on multi-cylinder diesel engine / petrol engine 9. To prepare variable speed performance test of petrol engine/diesel engine and prepare the curve (i)bhp, ihp, fhp Vs Speed (ii) Volumetric efficiency & indicated specific fuel consumption Vs Speed.

Mechanical Engg. Department

Semester : IV

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192008</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Introduction to Design & Innovation</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction: Introduction to design, modern product development process, reverse engineering and redesign, examples of product development process.
Product Development Process Tool: Product development teams, team structures, team building, team evaluation, product development planning, scheduling tools.
Scoping Product Development: What to develop? Mission statement, Technical questioning, technical feasibility, S curve
Concept of ideal design, conceptualizing product: Identifying the customer needs, understanding the customer needs, organizing & prioritizing customer needs, affinity diagram, customer use pattern
Establishing Product Function: Functional decomposition, FAST method, creating function structure, function structure modelling process.
Product tear down and experimentation: Tear down process, tear down methods, application of product tear down.
Benchmarking & Engineering Specification: Benchmarking approach, example, supporting tool for benchmarking, intended assembly cost analysis, function form diagram, setting product specifications, specification process, house of quality/quality function deployment(QFD).
Concept generation: Concept generation process, traditional brainstorming, brain ball method, C sketch/6-3-5 method, example.
Concept selection: Concept selection process, Pugh concept selection chart, concept screening and concept scoring.
Concept embodiment: process of concept of embodiment, advanced method, FMEA
Industrial design: Goal, importance of ID, assessment of quality of product based on ID, ID process, design challenges that ID face, technological or user driven products based on ID.</td></tr>
<tr><td>VI</td><td>Project</td><td colspan="4">Open Ended Projects which will trigger the innovation of students towards design improvement or design modification, updatation of system or product.
Students will be encouraged to perform projects which can improve any system/product/machine/technology.
Students will be advised to apply the product design process and various tools that is discussed in the class to develop/improve any system/product.</td></tr>
<tr><td>VII</td><td>Textbooks</td><td colspan="4">1. Kevin Otto and Kristin Wood, “Product Design: Techniques in Reverse Engineering and New Product Development”, 1/e, 2004, Pearson Education, New Delhi
2. Engineering Design, 5th Edition by George E. Dieter and Linda C. Schmidt. McGraw Hill, 2013.</td></tr>
</table>

VIII	References	1. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", Tata McGraw-Hill Edition, New Delhi, 2003 2. Engineering Design: A Project Based Introduction, 4th Edition by Clive L. Dym, Patrick Little, and Elizabeth J. Orwin. Wiley India, 2015.

BACHELOR OF TECHNOLOGY

Mechanical Engineering Department

Semester - V

Course Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
HS 203001	HSS – 3 (Advanced English)	3	0	0	3
ME 203001	Advanced Manufacturing Processes	2	1	3	4.5
ME 203002	Introduction to Machine Design	3	1	0	4
ME 203003	Theory of Machines & Mechanisms	3	1	2	5
ME 203004	Heat and Mass Transfer	3	1	2	5
	Total	**14**	**4**	**7**	**21.5**

Mechanical Engineering Department

Semester - V

I	Course Code	**HS 203001**			
II	Course Title	**HSS – 3 (Advanced English)**			
III	Credit Structure	L	T	P	C
		3	0	0	3
IV	Prerequisites (if any)	Nil			
V	Course Coordinator	Dr Meera Vasani & Dr Wati Longkumer			
VI	Course Objective	-To develop oral skills with emphasis on conversational practice -To advance writing skills through guided composition -To equip the students with the basics right of communication and presentation skills for academic and professional purposes -To assist the second language learners acquire fluency in both spoken and written English to communicate information with clarity, precision and confidence especially in the professional sphere.			

VII	Course Contents	**Remedial grammar:** -Basic language structures with focus on practice, and the use of fundamental grammatical elements. -Reading Comprehension -Guided and free composition essays of expository, descriptive, narrative, argumentative, and reflective types. **Speaking & Writing:** Rhetorical devices- Logos/Pathos/Ethos **Reading:** What is Reading? Types of Reading Critical reading **Writing:** Preparing technical project report: Abstract, Acknowledgment Report Writing CV/Resume/Bio-data **Literature:** Short essays/articles -Bon Bibi Legend and 'Ethnic Cleansing' of India's Forests: Amitav Ghosh -The Danger of a Single Story: Chimamanda Ngozi Adiche -Mother Tongue: Amy Tan -List of 7 Rules for Beginning Writers: V.S. Naipaul (more to be included, if needed) Classic Short stories -The Cactus: O Henry -A Child's Dream of a Star: Charles Dickens -The Man who could work miracles: HG Wells -My Own True Ghost Story: Rudyard Kipling -The Music on the Hill: Suki -Rain: W. Somerset Maugham -A School Story: M R James (more to be included, if needed)

Mechanical Engineering Department

Semester : V

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 203001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Advanced Manufacturing Processes</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>3</td><td>4.5</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Manufacturing Processes</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction to Advanced Manufacturing Processes; Sustainable manufacturing; Unconventional machining processes and their comparative evaluation; Fundamentals of Additive manufacturing; Advanced analysis of steels and non-ferrous alloys; Advanced modeling tools for manufacturing; Foundations of industrial finite element codes for heat treatment, machining and forming processes. Simulation of different manufacturing processes with FE packages and their experimental validation. Plastics and Composite material manufacturing. Introduction to micro/nano manufacturing. Industry oriented project.
Laboratory Experiments:
1. Basic practical skills on mechanical machining, data acquisition, filtering and analysis skills.
2. Simulation of forming and machining processes using FE package DEFORM 3D and their experimental validation.
3. Use of ANSYS and MATLAB for analyzing and solving manufacturing problems.
4. Creating 3D models of components using different CAD software and building prototypes using 3D printing machine.
5. Experimental investigation of weld quality using TIG and MIG welding techniques.
6. Demonstration on Wire-cut EDM.
7. Demonstration on Ultrasonic machining setup.
8. Composite manufacturing.</td></tr>
</table>

VI	Text/References	1. Ghosh and Mallik, Manufacturing Science, EWP Private Ltd. 2. Hassan Abdel, Gabad El Hoffy, Advanced Manufacturing Processes, McGraw Hill. 3. V.K.Jain, Advance Machining Processes, Allied Publisher Bombay. 4. Pandey P.C., Shan H.S., Modern Machining Processes, Tata McGraw-Hill Education. 5. Weller E.J., Non-traditional Machining Processes, Society of Manufacturing Engineers, Publications. 6. Stephen P. Campbell, The Science and Engineering of Micro-fabrication, Oxford University Press. 7. Gibson, Rosen, Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Springer, 2009. 8. Davim, J.P, Machining Composite Materials, Wiley-ISTE, 2009. 9. Fluhrer, J. SFTC Inc. DEFORM 3D User's Manual. 10. Works, M. Matlab User Manual Version r2015b. Math Works Incorporation, Natick, MA.

Mechanical Engineering Department

Semester : V

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 203002</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Introduction to Machine Design</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Fundamentals of machine design: Design philosophy, Engineering Materials, Brief overview of design and manufacturing
Stresses in machine elements: Simple stresses, Compound stresses in machine parts, Strain analysis
Design for Strength: Design for static loading, Stress Concentration, Design for dynamic loading, Low and high cycle fatigue, Endurance limit
Fasteners: Types of fasteners: Pins and keys, Cotter and knuckle joint, Threaded Fasteners, Design of bolted joints
Couplings: Introduction, types and uses, Design procedures for rigid and flexible rubber-bushed couplings
Power Screws: Power Screw drives and their efficiency, Design of power screws
Design of Springs: Introduction to Design of Helical Springs, Design of Helical Springs for Variable Load, Design of Leaf Springs
Design of Shaft: Shaft and its design based on strength, Design of shaft for variable load and based on stiffness
Design of Permanent Joints: Riveted Joints Types and Uses, Design of Riveted Joints, Welded Joints Types and Uses, Design of Welded Joints, Design of Adhesive Joints Design of Joints for Special Loading: Design of Eccentrically Loaded Bolted/Riveted Joints, Design of Eccentrically Loaded Welded Joints, Design of Joints with Variable Loading
Design of clutches: Design of friction clutches, Design of Centrifugal clutches.</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">1. Design of Machine Elements by Bhandari V. B., Third Edition, McGraw Hill Education, 2010.
2. Shigleys Mechanical Engineering Design by Budynas R. G., and Nisbett J. K., Tenth Edition, McGraw Hill Education, 2016.
3. Machine Design An Integrated Approach by Norton R. L., Fifth Edition, Pearson India, 2013.
4. Design of Machine Elements by Spotts M. F., Shoup T. E., and Hornberger
5. L. E., Eigth Edition, Pearson India, 2003.
6. A Textbook of Machine Design by Kurmi R. S., and Gupta J. K., S. Chand Publishers, 2005.</td></tr>
</table>

Mechanical Engineering Department

Semester : V

I	Course Code	**ME 203003**			
II	Course Title	**Theory of Machines & Mechanisms**			
III	Credit Structure	L	T	P	C
		3	1	2	5
IV	Prerequisite(If any for the student)	None			
V	Course Objective	This course introduces students to the basic concepts of mechanisms and ma chines and their kinematic analysis. The theoretical foundation, upon which advanced courses such as Machine Design, Dynamics and Vibration, and Robotics are built ,is developed.			
VI	Course Content	**Introduction:** Definitions of Machine, Mechanism, Links, and Pairs; Classifi cation of Mechanisms; Mobility - Kutzbach Equation and Griibler's Criterion; Kinematic Inversion; Grashof 's Law **Kinematic Analysis and Synthesis:** Position and Displacement, Velocity, Acceleration - Graphical and Analytical Methods; Coupler-Curve Generation; Instantaneous Centres of Velocity and Acceleration; Aronhold-Kennedy The orem of Three Centres; Type, Number and Dimensional Synthesis; Function Generation, Path Generation, and Body Guidance; Coupler Curve Synthesis **Cams, Gears, and Mechanism Trains:** Classification of Cams and Follow ers, Displacement Diagrams, Graphical Layout of Cam Profiles, Standard Cam Motions; Fundamental Law of Toothed Gearing, Spur Gears, Helical Gears, Bevel Gears, Worms, and Worm Gears; Parallel-Axis Gear Trains, Epicyclic Gear Trains, Differentials **Introduction to Robotics:** Kinematics of Open Chains, Topological Arrangement of Robotic Arms, Forward and Inverse Kinematics **Laboratory Work:** Graphical Analysis of Selected Planar Mechanisms; Cams and Gears; Computer Modelling; Mechanism Design Group Project			
VII	Text/References	1. John J. Dicker Jr., Gordon R. Pennock, and Joesph E. Shigley, Theory of Machines and Mechanisms, Fourth Edition (International Version),Oxford University Press, 2015. 2. Amitabha Ghosh, and Ashok K. Mallik, Theory of Mechanisms and Ma chines, Third Edition, East West Press Private Limited, 1998. 3. Robert L. Norton, Kinematics and Dynamics of Machinery, First SI Edition, McGraw Hill Higher Education, 2008. 4. S. S. Rattan, Theory of Machines, Fourth Edition, McGraw Hill Higher Education, 2014.			
VIII	Course Outcome	Upon completion of this course, students will be able to use graphical, analytical, as well as basic computational approaches to synthesize planar and simple spatial mechanisms. They will be well equipped to tackle advanced topics involving design and analysis of robots and robotic manipulators.			

Mechanical Engineering Department

Semester : V

I	Course Code	**ME 203004**			
II	Course Title	**Heat and Mass Transfer**			
III	Credit Structure	L	T	P	C
		3	1	2	5
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Introduction, Modes of heat transfer: Conduction, Convection, Radiation, Material properties of importance in heat transfer, Thermal conductivity, Specific heat capacity. Conduction: One Dimensional steady-state conduction through homogeneous and composite plane walls, One-dimensional steady-state conduction through cylinders and spheres, Critical thickness of insulation, Heat transfer from fins of uniform cross section, Heat conduction in bodies with heat sources, Transient heat conduction, Lumped system analysis, Numerical methods in heat conduction. Convection: Free and Forced, Fundamentals, Velocity and thermal boundary layer, Conservation equations for mass, momentum and energy, solution of boundary layer equations. Non-dimensional numbers, Laminar and turbulent flows, External forced convection: Drag and heat transfer, parallel flow over flat plates, flow across cylinders and spheres, Internal forced convection: Mean velocity and mean temperature, entrance region, constant heat flux and temperature condition in pipe flow, HagenPoiseuille flow, Turbulent flow and heat transfer, Natural/free convection: Equation of motion of Grashof number, natural convection over surfaces and inside enclosures Thermal Radiation, Kirchoffs law; Plancks distribution law, Wiens displacement law. Stefan-Boltzmanns relation, Configuration factors, Radiant interchange between black and grey surfaces, Radiation shielding solar radiation. Heat exchanger, Combined heat transfer analysis, overall heat transfer co-efficient, Types of heat exchangers, LMTD and NTU methods of heat exchanger design, Simple heat exchanger calculations. Boiling and condensation, Boiling heat transfer: pool boiling and flow boiling, Condensation heat transfer, film condensation Mass Transfer, Introduction, analogy between heat and mass transfer, mass diffusion, Ficks Law, boundary conditions, Steady mass diffusion through a wall, cylinder and sphere, Transient mass diffusion, mass transfer in a moving medium, diffusion of vapor through a stationary gas: Stefan Flow.			

		Laboratory Experiments: 1. Heat Conduction and Convection Through Extended Surface 2. Unsteady State Heat Transfer 3. Heat Transfer in Natural Convection 4. Laws of Radiant Heat Transfer and Radiant Heat Exchange 5. Dropwise and Filmwise Condensation 6. Heat Transfer Through Lagged Piple 7. Critical Heat Flux 8. Parallel and Counterflow Heat Exchanger 9. Diffusion in Liquids and Gases
VI	Text/References	1. Holman JP and Bhattacharya S, Heat Transfer, 10th Edition, McGraw Hill Education. 2. Incropera, F.P. and DeWitt, D.P., Principles of Heat and Mass Transfer, 7th Edition, Wiley publications. 3. Nag, P.K. (2002). Heat and Mass Transfer, TMH. 4. Thirumaleshwar, M. (2006). Fundamentals of Heat and Mass Transfer, Pearson education. 5. Ghoshdastidar, P.S. (2004). Heat Transfer. Oxford University Press. 6. Arora, Domkundwar, S. and Domkundwar, A. (1988). A Course in Heat & Mass Transfer, Dhanpat Rai & Co. 7. Incropera, F.P. and DeWitt, D.P. (2002). Fundamentals of Heat and Mass Transfer, John Willy & Sons, New York, NY. 8. John R.Howell& Richrd O Buckius, Fundamentals of Engg. Thermodynamics, McGraw Hill International. 9. Holman, J.P. (1997). Heat Transfer, 9th edition, McGraw-Hill. 10. Mills, A.F. (1999). Basic Heat and Mass Transfer. Prentice-Hall

Mechanical Engineering Department

Semester - VI

Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
HS 3001	Introduction to Economics	3	0	0	4
ME 3006#	Theory of Machines & Mechanisms	3	1	2	5
ME 3007	Refrigeration & Air − Conditioning	3	1	2	5
ME 3008#	CAD/CAM	2	1	3	4
ME 3009	Automotive Systems	3	0	2	4
ME 3010	Operations Research & Project Management	3	1	0	4
	Total	**17**	**4**	**9**	**26**

The curriculum locations of ME 3006 and ME 3008 will be exchanged with Semester V subjects ME 3004 (Introduction to Machine Design) and ME 3005 (Dynamics & Vibration) from Academic Year 2017 − 18.

Mechanical Engineering Department

Semester : VI

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">HS 3001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Introduction to Economics</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite (if any for the student)</td><td colspan="4">None</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Exploring the subject matter of Economics, Supply and Demand: How Markets Work, Markets and Welfare, The Households, The Firm and Perfect Market Structure, Imperfect Market Structure, Input Markets, Exploring International Economics, Introduction to Macroeconomics, Introduction to National Income Accounting, The Classical System: The Full-Employment Model, The Simple Keynesian Model, Money in the Modern Economy, In ation, Exploring the Macroeconomics of an Open Economy</td></tr>
<tr><td>VI</td><td>Text/Reference Books</td><td colspan="4">1. Karl E. Case and Ray C. Fair (2007), Principles of Economics, 8th edition, Pearson Education Inc., ISBN 81-317- 1587-6 (hereafter Case & Fair, 2007, 8e).
2. Joseph E. Stiglitz and Carl E. Walsh (2006), Economics, International Student Edition, 4th Edition, W.W. Norton & Company, Inc., New York, ISBN 0-393- 92622-2 (hereafter Stiglitz & Walsh, 2006, 4e).
3. N. Gregory Mankiw (2007), Economics: Principles and Applications, 4th edition, India edition by South-Western, a part of Cengage Learning, Cengage Learning India Private Limited, ISBN-13:978-81-315-0577-9 (hereafter, Mankiw, 2007, 4e).</td></tr>
</table>

Mechanical Engineering Department

Semester : VI

I	Course Code	**ME 3006**			
II	Course Title	**Theory of Machines & Mechanisms**			
III	Credit Structure	L	T	P	C
		3	1	2	5
IV	Prerequisite (if any for the student)	None			
V	Course Objective	This course introduces students to the basic concepts of mechanisms and machines and their kinematic analysis. The theoretical foundation, upon which advanced courses such as Machine Design, Dynamics and Vibration, and Robotics are built, is developed.			
VI	Course Content	**Introduction:** Definitions of Machine, Mechanism, Links, and Pairs; Classification of Mechanisms; Mobility − Kutzbach Equation and Grübler's Criterion; Kinematic Inversion; Grashof's Law **Kinematic Analysis and Synthesis:** Position and Displacement, Velocity, Acceleration − Graphical and Analytical Methods; Coupler-Curve Generation; Instantaneous Centres of Velocity and Acceleration; Aronhold-Kennedy Theorem of Three Centres; Type, Number and Dimensional Synthesis; Function Generation, Path Generation, and Body Guidance; Coupler Curve Synthesis **Cams, Gears, and Mechanism Trains:** Classification of Cams and Followers, Displacement Diagrams, Graphical Layout of Cam Profiles, Standard Cam Motions; Fundamental Law of Toothed Gearing, Spur Gears, Helical Gears, Bevel Gears, Worms, and Worm Gears; Parallel-Axis Gear Trains, Epicyclic Gear Trains, Differentials **Introduction to Robotics:** Kinematics of Open Chains, Topological Arrangement of Robotic Arms, Forward and Inverse Kinematics **Laboratory Work:** Graphical Analysis of Selected Planar Mechanisms; Cams and Gears; Computer Modelling; Mechanism Design Group Project			
VII	Textbooks/ References	1. John J. Uicker Jr., Gordon R. Pennock, and Joesph E. Shigley, Theory of Machines and Mechanisms, Fourth Edition (International Version), Oxford University Press, 2015. 2. Amitabha Ghosh, and Ashok K. Mallik, Theory of Mechanisms and Machines, Third Edition, East West Press Private Limited, 1998. 3. Robert L. Norton, Kinematics and Dynamics of Machinery, First SI Edition, McGraw Hill Higher Education, 2008. 4. S. S. Rattan, Theory of Machines, Fourth Edition, McGraw Hill Higher Education, 2014.			
VIII	Course Outcome	Upon completion of this course, students will be able to use graphical, analytical, as well as basic computational approaches to synthesize planar and simple spatial mechanisms. They will be well equipped to tackle advanced topics involving design and analysis of robots and robotic manipulators.			

Mechanical Engineering Department

Semester : VI

I	Course Code	**ME 3007**			
II	Course Title	**Refrigeration & Air-Conditioning**			
III	Credit Structure	L	T	P	C
		3	1	2	5
IV	Prerequisite (if any for the student)	Knowledge of basic thermodynamics and thermodynamic cycles.			
V	Course Objective	The course is designed to give an in-depth study of theory of advanced refrigeration and air-conditioning and their applications. The techniques of analysis and design of refrigeration and air conditioning systems will also be discussed. This course will help the students to understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components. It will also provide knowledge on design aspects of Refrigeration & Air conditioning systems.			

VI	Course Content	Introduction & Review, the second law interpretation, the Carnot principle, Limitation of Carnot cycle, COP, Refrigerants, Designation of refrigerants, comparative study, selection of refrigerant, Chemical and physical requirements. Gas cycle refrigeration, reversed Brayton cycle, Aircraft refrigeration, Joule-Thomson coeffi- cient and inversion curve, reversed Stirling cycle, air liquefaction. Vapour compression system, Limitations and Modification in reversed Carnot Cycle, Vapour compression cycle, Vapour compression system calculation, Effect of operating conditions on Vapour compression cycle. Actual Vapour compression cycle, Multi stage compression, Multi evaporative systems, Cascade systems, Dry Ice. Introduction and analysis to CO2 trans-critical cycle. Refrigeration components, Compressors, Principle and performance of reciprocating compressor, rotary and centrifugal compressors, selection criteria of compressor in refrigeration. Condensers Types, Heat transfer in condensers, Wilson's plot. Evaporators Types, Heat transfer in evaporators, augmentation of boiling heat transfer. Expansion Valves, Types of expansion devices, constant pressure and thermostatic expansion valve, capillary tube design. Vapor absorption system, Single effect water - Lithium Bromide absorption chiller, Vapour absorption system, Double effect H2O-LiBr2 absorption system, Electrolux refrigerator. Psychrometry of air-conditioning processes, Psychrometric properties, psychrometric chart, Basic processes in conditioning of air, Psychrometric processes in air-conditioning equipment, cooling tower, Summer air-conditioning, Winter air-conditioning. Analysis of cooling towers. Load Calculations – Cooling & Heating, Design conditions, solar radiations, heat transfer through building structure, Heat gains, cooling and heating load estimate, Psychrometric calculations and selection of air-conditioning apparatus cooling and dehumidification. Transmission and distribution of air, Friction loss and dynamic losses in ducts, Air ow through simple duct system, air duct design Transmission and distribution of air in rooms, centrifugal and axial ow fans and fan arrangements. Application of Refrigeration & Air Conditioning Systems, Food processing by refrigeration and storage, transportation refrigeration, Cooling and heating of foods, freeze drying and heat drying of foods. **Laboratory Experiments:** 1. Experiments on Vapour compressor system with Multi Condenser, Multi Evaporator Multi, and Expansion Valve to Conduct COP 2. Experiment on Ice plant. 3. Experiments on Heat pump with vapour compression systems. 4. Experiments on Trans-critical CO2 refrigeration systems for heating cooling. 5. Experiments on Vapour Absorption system. 6. Experiments on Cooling tower experiments. 7. Experiments on Air conditioning Experiments for year round application with direct and indirect operation. 8. Study / demonstration of actual domestic refrigerator and Air conditioning

VII	Course Outcome	Upon completion of this course, the students can demonstrate the operations in different Refrigeration & Air conditioning systems and also be able to design Refrigeration & Air conditioning systems.
VIII	Textbooks/ References	1. Arora, C.P., Refrigeration and Air Conditioning, 3rd edition, McGraw Hill, New Delhi, 2012. 2. Roy J. Dossat, Principles of Refrigeration, 4th edition, Pearson Education Asia, 2009. 3. Stoecker, W.F. and Jones J. W., Refrigeration and Air Conditioning, McGraw Hill, New Delhi, 1986. 4. ASHRAE Hand book, Fundamentals, 2012. 5. Jones W.P., Air conditioning engineering, 5th Edition, Elsevier Butterworth-Heinemann, 2001. 6. Manohar Prasad, Refrigeration and air-conditioning, Wiley Eastern Ltd, 1983. 7. Edward G. Pita, Air Conditioning Principles and Systems, 4th Ed., Pearson Education Asia, 2003.

Mechanical Engineering Department

Semester : VI

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 3008</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">CAD/CAM</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>3</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite (if any for the student)</td><td colspan="4">None</td></tr>
<tr><td>V</td><td>Course Objective and Scope</td><td colspan="4">1.Basic introduction on hardware and software requirement of CAD.
2.Understand the mathematical and physical principles underlying geometric modelling.
3.Complete practical exposure on geometric modelling using CAD modelling tools.
4.Understanding in brief about Computer aided manufacturing.</td></tr>
<tr><td>VI</td><td>Course Content</td><td colspan="4">Computer Aided Design
1. Introduction of Computer Aided Design; The Design Process
2. Product Life Cycle; Application of CAD
3. Hardware Requirements of CAD: Principles of interactive computer graphics; Overview of hardware available for use in CAD
4. Geometric Modeling – Curves: Types of mathematical representation of curves; Analytical Curves – Lines, Circle, Ellipse, Parabola, Hyperbola; Synthetic Curves – Hermite cubic splines, Bezier Curves, B-splines, NURBS
5. Geometric Modeling – Surfaces: Analytical Surfaces; Surfaces of Revolution; Mathematical Representation of Surfaces, Surface Model, Surface Entities, Surface Representation; Parametric Representation of Surfaces, Plane Surface, Rule Surface; Surface of Revolution; Tabulated Cylinder
6.
6. Solid Modeling: Solid Representation; Boundary Representation (B-rep); Constructive Solid Geometry (CSG)
7. 2-D and 3-D Geometric Transformations: Translation, Rotation, Scaling; Mirror Concatenation; Coordinate Tranformations
Computer Aided Manufacturing
1. Product Data Exchange: Graphics Standards – GKS, Bitmaps, Open GL; Data Standards – IGES, STEP, CALS, DXF, STL; Communication Standards – LAN, WAN
2. Engineering Tolerance and Geometric Tolerance
3. Computer Aided Process Planning: CAPP Benefits, Models, Approach; Hybrid CAPP
4. Computer Integrated Manufacturing: Integrating CAD/CAM/NC; Machine Tools; NC Programming; Tool Path Generation; Tool Path Verification</td></tr>
</table>

VII	Textbooks/ References	1. Rogers D. F. and J. A. Adams, "Mathematical Elements of Computer Graphics", Tata McGraw-Hill, New York, 2004. 2. Ibrahim Zeid, "Mastering CAD/CAM", Tata McGraw-Hill, New Delhi, 2005. 3. P. Radhakrishnan, S. Subramanyan, V. Raja, "CAD/CAM/CIM" New Age international Publishers. 4. CAD/CAM by Chirs McMohan and Jimmy Browne, Pearson.

Mechanical Engineering Department

Semester : VI

I	Course Code	**ME 3009**			
II	Course Title	**Automotive Systems**			
III	Credit Structure	L	T	P	C
		3	0	2	4
IV	Prerequisite (if any for the student)	None.			
V	Course Content	1. General layout of automobile, Engine classification, Engine geometry Brake Performance, Indicated Performance, Friction Relationships among performance parameters, Constant volume (Otto) Constant pressure (Diesel) Limited pressure (Dual) Comparisons of ideal cycle results. 2. Air and Fuels Combustion Stoichiometry Dissociation Equilibrium combustion products Practical chemical equilibrium First law analysis of closed reacting systems Heating value and enthalpy of formation Adiabatic ame temperature First law analysis of open reacting systems Combustion efficiency, Fuel/Air Cycle Analysis. 3. SI Engine Fuel System: Carburettor working principle. Requirements of an automotive carburettor; Starting, idling, acceleration and normal circuits of carburettors, compensation, Maximum power devices, constant choke and constant vacuum carburettors. Fuel feed systems, Mechanical and electrical pumps. Petrol injection. 4. Spark-Ignition Engine Combustion Features of process Flame structure and propagation Factors affecting burning rate Abnormal combustion and knock Combustion chamber design, Nature and extent of SI engine Emissions problems and control strategies. 5. Cooling and Lubrication System: Need for cooling system. Types of cooling system, Liquid cooled system, Thermosyphon system, Pressure cooling system. Lubrication system, Mist lubrication system, Wet sump and dry sump lubrication. Properties of lubricants. Properties of coolants. 6. Fuel Injection System: Requirements, Air and solid injection, function of components, Jerk and distributor type Pumps. Pressure waves, Injection lag, Unit injector, Mechanical and Pneumatic governors. Fuel injector-types of injection nozzle, Spray characteristics, injection timing, pump calibration. 7. Diesel Engine Combustion Features of diesel combustion process Ignition delay Knock in diesel engines Nature and extent of CI engine Emissions problems and control strategies. 8. Automotive: The Future Engine development prospects Stratified charge, direct injection systems Homogeneous charge, compression ignition Low temperature diesel combustion Advanced electronic-controlled engines Hybrids and fuel cells.			

VI	Text/Reference Books	1. Internal Combustion Engine Fundamentals by John B. Heywood. 2. The Internal Combustion Engine in Theory and Practice: Volumes 1 & 2, by Charles Fayette Taylor. 3. Engineering Fundamentals of the Internal Combustion Engine by Willard W. Pulkabrek. 4. Fundamentals of Internal Combustion Engines by P. W. Gill, J. H. Smith, and E. J. Ziury. 5. Internal Combustion Engines by V. Ganesan.

Mechanical Engineering Department

Semester : VI

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 3010</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Operations Research & Project Management</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite (if any for the student)</td><td colspan="4">None</td></tr>
<tr><td>V</td><td>Course Objective</td><td colspan="4">To understand the different types of decision making environments and the appropriate decision making approaches and tools to be used and to develop critical thinking and objective analysis of decision problems. This course will provide students with:

• ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively

• knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry</td></tr>
</table>

VI	Course Content	**UNIT I** **Introduction:** Origin and development of operations research, general methodology of OR, applications of OR to industrial problems. **UNIT II** **Introduction to linear programming:** Different types of models, formulation of linear programming problems (LPPs), productmix problems, deterministic models, graphical solution. **Linear Programming (Simplex Method):** Various steps in solving or problems using simplex method (a) Maximization problems, (b) Minimization problems, minimisation problems (all constraints of the type $<$), BIG 'M' method. Minimising case − constraints of mixed types ($<$ and $>$), Maximisation case-constraints of mixed type. **Duality and Sensitivity:** Duality and its concept, dual linear programming, application of elementary sensitivity analysis. **UNIT III** **Transportation problem:** Balanced Transportation Problem, Unbalanced Transportation Problem, Method of Solution, Degeneracy and the Transportation Problem, Testing the Solution for Optimality, Solution of Unbalanced Transportation Problem, Maximization and the Transportation Techniques. **Assignment Model:** Assignment Table, Method of Solving Assignment Problems. **UNIT IV** **Network optimization:** Network Optimization Models,Example, The Terminology of Networks, The Shortest-Path Problem, The Minimum Spanning Tree Problem , The Maximum Flow Problem. **PERT/CPM:** Using a Network to Visually Display a Project, Scheduling a Project with PERT/CPM, Dealing with Uncertain Activity Durations, An Evaluation of PERT/CPM. **UNIT V** **Queuing Theory:** Queuing systems and concepts, classification of queuing situations; Kendall's notation, solution of queuing problems, single channel, single stage, finite and infinite queues with Poisson arrival and exponential service time, applications to industrial problems. **Forecasting:** Judgmental Forecasting, Time Series, Forecasting Errors **Inventory Model:** Components, Deterministic, Continuous-Review, Models, Deterministic, Periodic-Review Model
VII	Textbooks/ References	1. Taha H. A., 2008. Operations Research, 8th edition, Pearson Education, New Delhi. 2. Hillier F. S., Lieberman G. J., 2012. Introduction to Operations Research, 9th edition, McGraw-Hill Higher Education, New Delhi. 3. Ronald L. Rardin, 1997. Optimization in Operations Research, Pearson Education, Prentice Hall. 4. Sharma S. D., 2010. Operations Research, 16th edition, Merrath: Kedarnath Ramnath Publication.

VIII	Course Outcome	Upon completion of the subject, students will be able to: • recognize the importance and value of Operations Research and formulate a managerial decision problem into a mathematical model in solving practical problems in industry. • understand Operations Research models and apply them to real-life problems.

Mechanical Engineering

Semester VII

Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
HS 4001	Infrastructure Planning and Management	3	0	0	4
ME 4001	Industrial Hydraulics and Automation	3	1	3	6
ME 4501	B. Tech Project I	0	0	3	4
ME 400X	Open Elective - I	3	0	0	4
ME 400X	Open Elective - II	3	0	0	4
	Total	**12**	**1**	**6**	**22**

Open Electives

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
ME 4002	Computational Heat Transfer	3	0	0	4
ME 4003	Power Plant Engineering	3	0	0	4

Mechanical Engineering Department

Semester : VII

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">HS 4001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Infrastructure Planning and Management</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Completed introductory course in Economics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">
Basics of Infrastructure
Understanding of Infrastructure, Types of Infrastructure, Role of Infrastructure, Infrastructure scenarios in India and problems of Infrastructure Development in India Urban Infrastructure in India
An overview of Urban Infrastructure in India, Models of Urban Governance, Municipal Finances, Major municipal reforms, Framework for Urban Infrastructure Delivery, Quality of water supply and services, Models of Urban governance, Municipal governance, Urban renewal projects
Rural Infrastructure in India
Road development scenario in India, The state of rural infrastructure in India, Infrastructure and rural growth, Characteristics of rural India, Strategies to improve infrastructure in rural areas, Government initiatives for rural infrastructure improvement, Role of private sector in infrastructure development.
Key Issues of provision of Infrastructure system
Leadership and strategy issues in the funding, financing, development and delivery of new infrastructure in the country Issues regarding the design and technology to be used, priority of location of infrastructure development, cost and level of risks that we have to tolerate Infrastructure Investment and Finance
Background behind investment and funding required for the financial planning of the infrastructure Various forms of funding available for infrastructure (public, private and combined) Privatization in Infrastructure Projects
Overview of history of privatization, The Benefits of Infrastructure Privatization, Problems with Infrastructure Privatization, Privatization of road Transportation Infrastructure in India
Supply and Demand for Infrastructure
Issues of demand and supply management
Evaluation of Infrastructure Investments
Cost- benefit analysis
Stages of an infrastructure project Lifecycle
Risk and Risk management framework for infrastructure project implementation
• Legal contractual Issues in Infrastructure Projects
• Environmental issues in infrastructure development
• Challenges in Construction and Maintenance of Infrastructure
Infrastructure Asset Management
Management of infrastructure both at individual as well as network/system level Concepts, theory and methods for infrastructure asset management and asset performance requirements Smart Infrastructure
The will be done via the case studies on smart cities. These case studies will include both Indian and international cases, with emphasis on Indian cases.
</td></tr>
</table>

VI	Text/References	1. Goodman AS, Hastak M (2006). Infrastructure Planning Handbook: Planning, Engineering, and Economics. McGraw Hill ASCE Press. Chapter 1 2. World Bank (2012). Transformation through Infrastructure. Selected pages handed out in class. 3. World Bank (2006). Infrastructure at the Crossroads: Lessons from 20 Years of World Bank Experience. 4. ULI and Ernst & Young (2013) Infrastructure 2013: Global Priorities, Global Insights, The Urban Land Institute, Washington DC. Available free: initiative/infrastructure-2013-explores-global-infrastructure-priorities/ 5. Lee (2009) New Delhi Water and Power. Harvard Kennedy School of Government Case Program #1891

Mechanical Engineering Department

Semester : VII

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 4001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Industrial Hydraulics and Automation</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>3</td><td>6</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Fluid Mechanics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction to Industrial Hydraulic Systems. Comparison with Pneumatics. Fields of applications. Advantages & limitations.

Review of basic fluid mechanics.Pumps-types of positive displacement pumps. Relief & safety Valve. Power Pack. Hydraulic oils. Pipes.

Valves-Pressure, flow & direction Control valves. Types & applications.

Actuators- Linear, rotary & oscillating. Types, Construction. Single-acting & double-acting. Speed control- of actuators. Selection of actuator size. Auxiliary devices accumulators, Intensifiers .Developing simple hydraulic circuits. Electro-hydraulic systems. Basics of automation. Sequencing through the ladder diagrams. Truth table & Boolean Algebra. PLCs.

Proportional Valves & their applications. Introduction to servo Control.Hydraulic & Electro-hydraulic Servo Systems</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">1. Oil Hydraulic Systems-Principles & Maintenance. S.R. Majumdar, Tata McGraw Hill, New Delhi.
2. Industrial Hydraulic Technology. Parker Hannifin Corporation Training Modules.
3. Industrial Hydraulics - Pippenjer Industrial press
4. Fluid Power and Control Systems. Fitch E C McGraw Hill Book Co.</td></tr>
</table>

Mechanical Engineering Department

Semester : VII

I	Course Code	**ME 4501**			
II	Course Title	**B.Tech Project - I**			
III	Credit Structure	L	T	P	C
		0	0	3	4
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Students are required to carry out project under the supervision of faculty members for the defined objectives. The project includes the thesis submission and viva-voice.			
VI	Text/References				

Mechanical Engineering Department
Semester : VII

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 4002</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Open Elective I Computational Heat Transfer</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Fluid Mechanics and Heat Transfer Fortran, Matlab or C Programming</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Mathematical Description of the Physical Phenomena

-Governing equationsmass, momentum, energy, species, General form of the scalar transport equation, Elliptic, parabolic and hyperbolic equations, Behavior of the scalar transport equation with respect to these equation type Discretization Methods
- Methods for deriving discretization equations-finite difference, finite volume and finite element method,
Method for solving discretization equations, Consistency, stability and convergence
Diffusion Equation
- 1D-2D steady diffusion, Source terms, non-linearity, Boundary conditions, interface diffusion coefficient, Under- relaxation, Solution of linear equations (preliminary), Unsteady diffusion, Explicit, Implicit and Crank-Nicolson scheme, Two dimensional conduction, Accuracy, stability and convergence revisited
Convection and Diffusion
- Steady one-dimensional convection and diffusion, Upwind, exponential, hybrid, power, QUICK scheme, Two-dimensional convection-diffusion, Accuracy of Upwind scheme; false diffusion and dispersion, Boundary conditions Flow Field Calculation
- Incompressibility issues and pressure-velocity coupling, Primitive variable versus other methods, Vorticity-stream function formulation, Staggered grid, SIMPLE family of algorithms
Multiphase problems
Modelling of multiphase problems: enthalpy method, volume of fluid (VOF) and Level Set Methods.
Introduction to turbulence modeling
Projects/Exercises
Solving simplified problems: formulation, discretization with coarse grids, applying appropriate boundary and initial conditions. Solving practical problems through software: writing user sub-routines; post-processing and interpretation of results.</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">1. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow," Hemisphere Publishing Corporation, 1980.

2. D. A. Anderson, J. C. Tannehill, and R. H. Pletcher, "Computational Fluid Mechanics and Heat Transfer," Hemisphere Publishing Corporation, 1984.

3. J. H. Ferziger and M. Peric, "Computational Methods for Fluid Dynamics", Second Edition, Springer, Berlin, 1999.

4. H. K. Versteeg and W. Malalasekera, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method",</td></tr>
</table>

Mechanical Engineering Department

Semester : VII

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 4003</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Open Elective II Power Plant Engineering</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Basic thermodynamics, Fluid Mechanics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Basics of Turbo-machines, Analysis of Steam Turbines, Gas Turbines, Hydraulic Turbine, Pumps. Elements of Power Plant: General Sources of power, Importance of Central Power Stations, types of power stations steam, nuclear, diesel and hydro Elements of modern power stations.

Steam Power Plant: Steam power plants, selection of working medium, Heat Balance in steam cycles, Heat rates, comparison of efficiencies gas loop, fuels and combustion. Boilers and their analysis, Supercritical boilers, mounting and accessories, Condenser-Cooling tower.

Hydro Electric power station Classification of Hydro-electric power plants and their applications-Selection of prime movers-Potential power with reference to rainfall and catchments area, Water storage, equipment used in hydroelectric power stations. Characteristics of hydraulic Turbines. Comparison of the factors governing the cost of hydro steam and diesel power stations.

Diesel power station Suitability of diesel engines for bulk power, advantages and limitations of diesel, power stations, efficiency and heat balance.

Nuclear Power Plant: Evolution of nuclear energy from atoms by fission and fusion. Chain reactions, fission materials, types of reactors, gas cooled, boiling water liquid, metal cooled and fast reactor, arrangements of various elements in a nuclear power station.

Gas turbine power plant: Open and closed cycles, Inter-cooling, Reheating and Regenerating-Combined cycle power plant.

Idealized and realized load curves, effect of variable load on plant design and Operation variable load operation and load dispatch. Combustion and Firing Methods. Coal handling and preparation-Combustion equipment and firing methods. Power Plant Economics, Indian Energy Scenario, Elements of Electric power systems primary and secondary distribution substations.</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">1. Nag P.K. 2014. Power Plant Engineering 4 edition Tata McGraw-Hill Pub. Com., New Delhi. (Text Book).

2. R. Yadav, 2000, Steam and Gas Turbines and Power Plant Engineering, 7th Edition, Central Publishing House. (Text Book).

Reference Books:

1. Arora S.C., Domkundwar S. A Course in Power Plant Engineering, Dhanpat Rai & Co. New Delhi.</td></tr>
</table>

BACHELOR OF TECHNOLOGY

Mechanical Engineering Department

Semester - VIII

Course Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
ME 4004	Safety Engineering and Management	3	0	0	4
ME 4502	B.Tech Project-II	0	0	3	8
ME 195001	Open Elective-III Advanced Industrial Tribology	3	0	0	4
ME 195002	Open Elective-IV Mechanical Metallurgy	3	0	0	4
	Total	**9**	**0**	**3**	**20**

BACHELOR OF TECHNOLOGY

Mechanical Engineering Department

Semester-VIII

I	Course Code	**ME 4004**			
II	Course Title	**Safety Engineering and Management**			
III	Credit Structure	L	T	P	C
		3	0	0	4
IV	Prerequisite(If any for the student)				
V	Course Content	Introduction: Background, Benefits of safety in Industry, Safety Terms and Definitions. Safety Mathematics and Reliability Basics: Basic Statistics, Set Algebra, Probability, Reliability. Workplace Accidents and Safety: Accident Causation Theories (Dmino Theory, Human Factor Theory), Accident Investigation and Reporting. Legal Aspects of Safety: Factories Act 1948, Other International Codes (OSHA Laws & Regulations). Hazards Related to Various Industries: Chemical, Electrical, Mining, and Construction. Safety and Risk Management: Safety Management Principles, Safety Program Plan, Safety Committees, Safety Performance Measures, Risk Assessment, Risk Management. Safety Analysis Methods: Failure Mode Effects Analysis (FMEA), Fault Tree analysis (FTA), Markov Method, Hazard and operability study (HAZOP), Job Hazard Analysis (JHA). Human Factors in Safety: Job Stress, Ergonomics, Human behaviour, Human Reliability Prediction Models, Personal Protective Equipments; Safety Costing; Safety Cost Estimation Methods, Safety Cost Estimation Models, Safety Cost Performance Measurement Indices.			
VI	Text/References	1. B. S. Dhillon, Engineering Safety: Fundamentals, Techniques, Applications, World Scientific, 2003. 2. H.E. Roland, B. Moriarty, System Safety Engineering and Management, John Wiley & Sons, 1990.			

BACHELOR OF TECHNOLOGY

Mechanical Engineering Department

Semester-VIII

I	Course Code	**ME 4502**			
II	Course Title	**B.Tech Project-II**			
III	Credit Structure	L	T	P	C
		0	0	3	8
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Students are required to carry out project under the supervision of faculty members for the defined objectives. The project includes the thesis submission and viva-voice.			
VI	Textbooks/References				

BACHELOR OF TECHNOLOGY
Mechanical Engineering Department
Semester-VIII

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 195001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Open Elective-III Advanced Industrial Tribology</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">Subject: Introduction to tribology</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Unit-I:
Introduction to tribology, Friction, Wear, Bearings and lubrication, Theories of Wear, Approaches to Friction Control and Wear Prevention, Wear classification, Introduction to Bearings and Lubrication of Bearings,

Unit-II:
Basic principles of lubrication, lubrication theories, Various type of lubricant, additive Importance of lubrication in GDP, Hydrostatic, boundary, hydrodynamic and elasto-hydrodynamic lubrication. Generalized Reynolds equation, Finite Element Modeling of Reynold equation, Elastohydrodynamic lubrication, Thermohydrodyamic lubrication, Mixed lubrication, flow and shear stress. Cavitation in fluid film lubrication, Surface texture,

Unit-III:
Mechanism of hydrodynamic instability. Dynamic characteristics of hydrodynamic journal bearings. Plain bearing lubrication and performance. Hydrostatic thrust bearing, Design, application and selection of various types of bearings – sliding and rolling element bearings. Vibration analysis of rotordynamics system, Chaos in bearing, Concept of air and magnetic bearings.

Unit-IV:
Materials for Tribological Applications, An overview of engineering materials having potential for tribological application, Characterization and evaluation of Ferrous materials for tribological requirements/applications, Selection of ferrous materials for rolling element bearings, gears, crank shafts, piston rings, cylinder liners, etc. Non-ferrous materials and their applications such as sliding bearings, piston rings, cylinder liners, etc., materials for dry friction materials.Composite materials (PM, CMC and MMC) for tribological applications, Surface treatment and Surface coating techniques.

Unit-V:
Industrial visits, Industrial case studies, Industrial oriented mini projects, Friction-Wear-Bearings and lubrication oriented studies.</td></tr>
<tr><td>VI</td><td>Textbooks</td><td colspan="4">1. Introduction to tribology of bearings - B.C.Majumdar
2. Principles of Tribology - J. Halling
3. Engineering Tribology - Prasanth Sahoo
4. Friction & Wear - B. Pugh
5. Applied Tribology: Bearing Design and Lubrication - Michael M. Khonsari
6. Fundamentals of Tribology - Basu, Sengupta, Ahjua
7. Friction, wear, lubrication - K. C. Ludema</td></tr>
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BACHELOR OF TECHNOLOGY

Mechanical Engineering Department

Semester-VIII

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 195002</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Open Elective-IV Mechanical Metallurgy</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Course Content</td><td colspan="4">Introduction – Ductile vs brittle materials, Stress at a point, description of strain, strain energy.

Macroscopic Plastic deformation
The flow curve, engineering and true stress-strain, yielding criteria in ductile materials, maximum shear stress criterion

Microscopic Plastic deformation
Crystal structures and lattice defects - vacancies, dislocations and grain boundries, cold working, recovery and recrystallization, deformation by slip, Critical resolved shear stress for slip, deformation of single crystals, deformation by twinning, stacking faults.

Dislocation theory
Dislocation types- line, screw and mixed, burgers vector and burgers circuit, dislocations in FCC, BCC and HCP lattices, stress fields and energetics of dislocations, forces between dislocation, motion of dislocations, dislocations-point defect interactions.

Strengthening Mechanisms
Strengthening by grain boundries, yield point phenomenon, strain aging, solid solution strengthening, Strain hardening, Precipitation hardening, Martensite strengthening, Hall-Petch effect.</td></tr>
<tr><td>V</td><td>Text/Referencesbooks</td><td colspan="4">1. George. E. Dieter, ‘Mechanical Metallurgy,’ McGraw Hill series in Materials Science, McGraw book company UK, SI metric edition, 1988.
2. W. T. Read, ‘Dislocations in Crystals,’ McGraw Hill book company, New York, 1953.
3. D. Hull and D. J. Bacon, ‘Introduction to Dislocations,’ Pergamon press, Oxford, 1984.</td></tr>
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