MANAV RACHNA UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAM STRUCTURE

&

DETAILED SYLLABUS

B.Tech. Mechanical Engineering

BATCH: 2019-2023

MANAV RACHNA UNIVERSITY									
PROGRAM STRUCTURE									
SEMESTER-1									
				COURSE TYPE (CORE/ELECTIVE/				No. of Contact Hours per week	
SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE	UNIVERSITY COMPULSORY	L	T	P		Credits
			(HARD/SOFT/						
			WORKSHOP/NTCC						
CHH144B-T	CHEMISTRY	CH	HARD	CORE	3	1	0	4	4
CHH144B-P	CHEMISTRY LAB	CH	HARD	CORE	0	0	2	2	1
MAH102B	MATHEMATICS-I	MA	HARD	CORE	3	1	0	4	4
MEH101B	ENGINEERING MECHANICS	ME	HARD	CORE	3	1	0	4	4
ECH103B-T	BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING	ECE	HARD	CORE	3	1	0	4	4
ECH103B-P	BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING LAB	ECE	HARD	CORE	0	0	2	2	1
MEH105B	THERMODYNAMICS	ME	HARD	CORE	3	1	0	4	4
MEW106B	COMPUTER AIDED DRAFTING	ME	WORKSHOP	CORE	0	0	2	2	1
LWS324	INDIAN CONSTITUTION	LW	AUDIT	CORE	1	0	2	3	0
TOTAL (L/T/P/CONTACT HOURS/CREDITS					13	4	9	29	23

SEMESTER-2

				COURSE TYPE (CORE/ELECTIVE/				No. of Contact Hours per week	
SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE	UNIVERSITY COMPULSORY	L	T	P		Credits
			(HARD/SOFT/						
			WORKSHOP/NTCC						
MAH105B-T	MATHEMATICS-II	MA	HARD	CORE	3	1	0	4	4
MAH105B-P	MATHEMATICS-II LAB	MA	HARD	CORE	0	0	2	2	1
PHH110B-T	OPTICS & WAVE OSCILLATIONS	PHY	HARD	CORE	3	1	0	4	4
PHH110B-P	OPTICS & WAVE OSCILLATIONS LAB	PHY	HARD	CORE	0	0	2	2	1
CSH101B-T	PROGRAMMING FOR PROBLEM SOLVING USING C	CSE	HARD	CORE	3	1	0	4	4
CSH101B-P	PROGRAMMING FOR PROBLEM SOLVING USING C LAB	CSE	HARD	CORE	0	0	2	2	1
MEH103B-T	MANUFACTURING PROCESSES	ME	HARD	CORE	3	0	0	3	3
MEH103B-P	MANUFACTURING PROCESSES LAB	ME	HARD	CORE	0	0	2	2	1
HLS103/HLS104B	PROFESSIONAL ENGLISH-ADVANCED/BASIC	EDU	WORKSHOP	CORE	2	0	2	2	3
CHH137	ENVIRONMENTAL SCIENCE	CH	AUDIT	CORE	2	0	0	4	0

TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**16**	**3**	**10**	**29**	**22**
SEMESTER 3									
		OFFERING DEPARTMENT	**COURSE NATURE**	**COURSE TYPE (CORE/ELECTIVE/**				**No. of Contact Hours per week**	
SUBJECT CODE			**(HARD/SOFT/**	**UNIVERSITY COMPULSORY**					
	SUBJECT NAME		**WORKSHOP/NTCC**		**L**	**T**	**P**		**Credits**
MEH207B-T	**FLUID MECHANICS & MACHINES**	**ME**	**HARD**	**CORE**	**3**	**1**	**0**	**4**	**4**
MEH207B-P	**FLUID MECHANICS & MACHINES LAB**	**ME**	**HARD**	**CORE**	**0**	**0**	**2**	**2**	**1**
MAH203B	**MATHEMATICS-III (PROBABILITY & STATISTICS)**	**MA**	**HARD**	**CORE**	**3**	**1**	**0**	**4**	**4**
MOOC COURSES									**3**
MEH204B-T	**APPLIED THERMODYNAMICS**	**ME**	**HARD**	**CORE**	**3**	**1**	**0**	**4**	**4**
MEH204B-P	**APPLIED THERMODYNAMICS LAB**	**ME**	**HARD**	**CORE**	**0**	**0**	**2**	**2**	**1**
MEH301B-T/P	**MANUFACTURING TECHNOLOGY**	**ME**	**HARD**	**CORE**	**3**	**0**	**0**	**3**	**3**
					0	**0**	**2**	**2**	**1**
CDO201	**PROFESSIONAL COMPETENCY ENHANCEMENT-I**	**CDC**	**OUTCOME BASED**	**CORE**	**0**	**0**	**1**	**1**	**0.5**
FLS101/FLS102/FLS103	**FOREIGN LANGUAGES-I**	**FL**	**AUDIT**	**ELECTIVE**	**2**	**0**	**0**	**2**	**0**

RDO501	**INTRODUCTION TO RESEARCH**	**RESEARCH**	**OUTCOME BASED**	**CORE**	**0**	**0**	**1**	**1**	**0.5**
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**14**	**3**	**8**	**25**	**22**
SEMESTER 4									
SUBJECT CODE	**SUBJECT NAME**	**OFFERING DEPARTMENT**	**COURSE NATURE (HARD/SOFT/ WORKSHOP/NTCC**	**COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY**	**L**	**T**	**P**	**No. of Contact Hours per week**	**Credits**
MEH205B-T	**STRENGTH OF MATERIALS-I**	**ME**	**SOFT**	**CORE**	**3**	**1**	**0**	**4**	**4**
MEH205B-P	**STRENGTH OF MATERIALS-I LAB**	**ME**	**SOFT**	**CORE**	**0**	**0**	**2**	**2**	**1**
MEH305B-T	**ROBOTICS**	**ME**	**HARD**	**CORE**	**3**	**1**	**0**	**4**	**4**
MEH305B-P	**ROBOTICS LAB**	**ME**	**HARD**	**CORE**	**0**	**0**	**2**	**2**	**1**
MOOC COURSE									**3**
MEH206B-T	**THEORY OF MACHINES**	**ME**	**HARD**	**CORE**	**3**	**1**	**0**	**4**	**4**
MEH206B-P	**THEORY OF MACHINES LAB**	**ME**	**HARD**	**CORE**	**0**	**0**	**2**	**2**	**1**
MEH202B-T	**MATERIALS SCIENCE**	**ME**	**HARD**	**CORE**	**3**	**0**	**0**	**3**	**3**
MEH202B-P	**MATERIALS SCIENCE LAB**	**ME**	**HARD**	**CORE**	**0**	**0**	**2**	**2**	**1**

CSH327B-T	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	CS	HARD	CORE	3	0	0	3	3
CSH327B-P	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING LAB	CS	HARD	CORE	0	0	2	2	1
LWS323/LWS325	CYBER LAW/LAW RELATING TO INTELLECTUAL PROPERTY RIGHTS	LW	HARD	CORE	2	0	0	2	2
RDO502	RESEARCH INNOVATION-I	RESEARCH	OUTCOME BASED	CORE	0	0	1	1	0.5
FLS105/FLS106/FLS 107	FOREIGN LANGUAGES-II	FL	AUDIT	ELECTIVE	2	0	0	2	0
CDO202	PROFESSIONAL COMPETENCY ENHANCEMENT-II	CDC	OUTCOME BASED	CORE	0	0	0	1	0.5
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					19	2	10	33	28

SEMESTER 5

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	No. of Contact Hours per week	Credits
MEH318B-T	COMPUTER AIDED DESIGN & MANUFACTURING	ME	HARD	CORE	3	0	0	3	3
MEH318B-P	COMPUTER AIDED DESIGN & MANUFACTURING LAB	ME	HARD	CORE	0	0	2	2	1
MEH302B	MACHINE DESIGN-I	ME	HARD	CORE	3	1	0	4	4
CSH217B-T	DATA STRUCTURES	CS	HARD	CORE	3	0	0	3	3

CSH217B-P	DATA STRUCTURES LAB	CS	HARD	CORE	0	0	2	2	1
ECH305B-T	INTERNET OF THINGS	EC	HARD	CORE	3	0	0	3	3
ECH305B-P	INTERNET OF THINGS LAB	EC	HARD	CORE	0	0	2	2	1
MEH319B-T	MECHATRONICS	ME	HARD	CORE	3	0	0	3	3
MEH319B-P	MECHATRONICS LAB	ME	HARD	CORE	0	0	2	2	1
MEH303B-T	HEAT TRANSFER	ME	HARD	CORE	3	1	0	4	4
MEH303B-P	HEAT TRANSFER LAB	ME	HARD	CORE	0	0	2	2	1
CHS234/CSS325/ECS306B	ENVIRONMENTAL ETHICS & SUSTAINABLE DEVELOPMENT/GREEN COMPUTING/E-WASTE	CH/CS/ECE	SOFT	ELECTIVE	1	0	2	3	2
EDS240	ESSENCE OF TRADITIONAL KNOWLEDGE	ED	AUDIT	CORE	1	0	2	3	0
CDO301	PROFESSIONAL COMPETENCY ENHANCEMENT-III	CDC	OUTCOME BASED	CORE	0	0	1	1	0.5
RDO601	RESEARCH INNOVATION-II	RESEARCH	OUTCOME BASED	CORE	0	0	1	1	0.5
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					19	2	13	38	28
SEMESTER 6									

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	No. of Contact Hours per week	Credits
MEH304B-T	INTERNAL COMBUSTION ENGINE & GAS TURBINES	ME	SOFT	CORE	3	1	0	4	4
MEH304B-P	INTERNAL COMBUSTION ENGINE & GAS TURBINES LAB	ME	SOFT	CORE	0	0	2	2	1
MEH310B	OPERATIONS RESEARCH	ME	HARD	CORE	3	0	0	3	3
MEH311B-T	REFRIGERATION & AIR CONDITIONING	ME	HARD	CORE	3	1	0	4	4
MEH311B-P	REFRIGERATION & AIR CONDITIONING LAB	ME	HARD	CORE	0	0	2	2	1
MEH307B/MEH308B/MEH321B-T	TOOL ENGINEERING DESIGN/PRODUCT DESIGN & DEVELOPMENT/FUNDAMENTALS OF NANOSCIENCE &	ME	HARD	ELECTIVE	3	0	0	3	3
MEH307B/MEH308B/MEH321B-P	TOOL ENGINEERING DESIGN/PRODUCT DESIGN & DEVELOPMENT LAB/FUNDAMENTALS OF	ME	HARD	ELECTIVE	0	0	2	2	1
MEH312/MEH313B/MEH314B-T	MECHANICAL VIBRATIONS/AUTOMOBILE ENGINEERING/COMPOSITE MATERIALS	ME	HARD	ELECTIVE	3	0	0	3	3
MEH312/MEH313B/MEH314B-P	MECHANICAL VIBRATIONS LAB/AUTOMOBILE ENGINEERING LAB/COMPOSITE MATERIALS LAB	ME	HARD	ELECTIVE	0	0	2	2	1
ECH403B/CSH414B-T	WIRELESS SENSOR NETWORK/INFORMATION RETRIEVAL	EC/CS	HARD	ELECTIVE	3	0	0	3	3
ECH403B/CSH414B-P	WIRELESS SENSOR NETWORK LAB/INFORMATION RETRIEVAL LAB	EC/CS	HARD	ELECTIVE	0	0	2	2	1
CDO302	PROFESSIONAL COMPETENCY ENHANCEMENT-IV	CDC	OUTCOME BASED	CORE	0	0	1	1	0.5

TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					18	2	11	28	22.5
SEMESTER 7									
		OFFERING DEPARTMENT	COURSE NATURE	COURSE TYPE (CORE/ELECTIVE/				No. of Contact Hours per week	
SUBJECT CODE			(HARD/SOFT/	UNIVERSITY COMPULSORY					
	SUBJECT NAME		WORKSHOP/NTCC		L	T	P		Credits
MEH306B/MEH401B/MEH402B/MEH403B/MEH404B	STRENGTH OF MATERIALS-II/RENEWABLE ENERGY SOURCES/MACHINE DESIGN-II/POWER PLANT	ME	HARD	ELECTIVE	4	0	0	4	4
MEH405/MEH406/MEH409/MEH408B-T	COMPUTATIONAL FLUID DYNAMICS/OPTIMIZATION TECHNIQUES/HEATING, VENTILATION & AIR	ME	HARD	ELECTIVE	3	0	0	3	3
MEH405/MEH406/MEH409/MEH408B-P	COMPUTATIONAL FLUID DYNAMICS LAB/OPTIMIZATION TECHNIQUES LAB/HEATING, VENTILATION & AIR	ME	HARD	ELECTIVE	0	0	2	2	1
EDS288/	HUMANITIES-I	EDU	SOFT	ELECTIVE	1	0	2	3	2
EDS289/	(APPLIED PHILOSOPHY/ APPLIED PSYCHOLOGY/ APPLIED SOCIOLOGY)								
EDS290									
ECW204B/CSW317B	ELECTRONIC DESIGN WORKSHOP/AGILE TECHNOLOGY	ME	ALLIED	ELECTIVE	0	0	2	2	1
ECW310B/CSW318B	SENSOR & IoT/R PROGRAMMING	ME	HARD	ELECTIVE	0	0	2	2	1
MCH321B	INTRODUCTION TO FINANCE	MGMT	SOFT	CORE	3	0	0	3	3
MCS368B	ENTREPRENEURSHIP	ME	SOFT	CORE	2	0	0	2	2

TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**13**	**0**	**8**	**21**	**17**
SEMESTER 8									
		OFFERING DEPARTMENT	**COURSE NATURE**	**COURSE TYPE (CORE/ELECTIVE/**				**No. of Contact Hours per week**	
SUBJECT CODE			**(HARD/SOFT/**	**UNIVERSITY COMPULSORY**					
	SUBJECT NAME		**WORKSHOP/NTCC**		**L**	**T**	**P**		**Credits**
MEN411B	**PROJECT/INDUSTRIAL TRAINING**	**ME**	**NTCC**	**CORE**	**0**	**0**	**0**	**16**	**8**
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**0**	**0**	**0**	**16**	**8**

DEPARTMENT OF MECHANICAL ENGINEERING
B.TECH (ME) – MEU01B

MANAV RACHNA UNIVERSITY

Department of Mechanical Engineering

SEMESTER-1

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	No. of Contact Hours per week	Credits
CHH144B-T/P	CHEMISTRY	CH	HARD	CORE	3	1	2	6	5
MAH102B	MATHEMATICS-I	MA	HARD	CORE	3	1	0	4	4
MEH101B	ENGINEERING MECHANICS	ME	HARD	CORE	3	1	0	4	4
ECH103B-T/P	BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING	ECE	HARD	CORE	3	1	2	6	5
MEH105B	THERMODYNAMICS	ME	HARD	CORE	3	1	0	4	4
MEW106B	COMPUTER AIDED DRAFTING	ME	WORKSHOP	CORE	0	0	2	2	1
LWH324B	CONSTITUTION OF INDIA	LW	AUDIT	CORE	1	0	2	3	0
TOTAL (L/T/P/CONTACT HOURS/CREDITS					13	4	9	29	23

Course Title/Code	CHEMISTRY
Course Type	CORE
Course Nature	Hard
L-T-P-O structure	3-1-2-0
Prerequisite	NIL

SECTION-A

Atomic Structure: Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties.

Periodic properties: Electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital, energies of atoms in the periodic table, polarizability and Polarization, Fajan's Rule, oxidation states and their stabilities.

SECTION-B

Intermolecular forces and potential energy surfaces: Ionic, dipolar and van der waals interaction, equations of state of real and gases and critical phenomenon.

Use of free energy in chemical equilibrium: Thermodynamic functions: entropy and gibbs free energy; estimations of entropy and free energies. Relationship between Free energy and emf Cell potentials.Nernst equation and application. Acid base, oxidation reduction and solubility equilibria,Water chemistry : Introduction - Use of water for Industrial and domestic purposes, sources of water supply, Hardness of water, degree of hardness and its estimation by EDTA methods). PH-value of water, disinfection of water Softening of hard water (Lime-Soda method, calgon methods.corrosion:introduction,cause and theories:Dry and wet theory and prevention methods,use of free energy consideration in metallurgy through Ellingham Diagram.

SECTION-C

Stereochemistry: Representations of three dimensional structures, introduction to the terms: achirality, chirality, enantiomers, diastereomers, optical activity, structural isomers and stereoisomers, relative and absolute configurations, conformational analysis of ethane and n-butane. Structural isomerism in transitional metal compounds.

Organic reactions and synthesis using conventional and green approach: Introduction to Green Chemistry, its 12 principles, Synthesis of a commonly used molecules: Aspirin, Ibuprofen, bio-diesel and bio-ethanol.

SECTION-D

Spectroscopic techniques and applications: Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging.

Suggested Text Books

(i) University chemistry, by B. H. Mahan
(ii) Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
(iii)Fundamentals of Molecular Spectroscopy, by C. N. Banwell
(iv) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
(v) Physical Chemistry, by P. W. Atkins
(vi) Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition
http://bcs.whfreeman.com/vollhardtschore5e/default.asp

LIST OF EXPERIMENTS:

1. Determination of chloride content of water
2. Colligative properties using freezing point depression
3. Determination of the rate constant of a reaction
4. Synthesis of a polymer (UF, Resol, PMMA).
5. Determination of surface tension and viscosity.
6. Determination of cell constant and conductance of solutions.
7. Saponification/acid value of oil.
8. Adsorption of acetic acid by charcoal.
9. Determination of the partition coefficient of a substance between two immiscible liquids.

Course Title/ Code	**MATHEMATICS-I**

Course Type:	**CORE**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-0-0)**
Prerequisite	**NIL**

SECTION –A

Calculus: Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Calculus: Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

SECTION –B

Sequences and series: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

SECTION –C

Multivariable Calculus (Differentiation): Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

SECTION –D

Matrices Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Suggested Text/Reference Books

(i) G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
(ii) N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

(iii) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Title/ Code	**ENGINEERING MECHANICS**
Course Type:	**CORE**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-0-0)**
Prerequisite	**NIL**

SECTION-A

Basics and Statics of Particles : Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces — Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

SECTION-B

Equilibrium of Rigid Bodies: Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

SECTION-C

Properties of Surfaces And Solids: Centroids and center of mass– Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula – 28 Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

SECTION-D

Dynamics of Particles: Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

Friction and Elements of Rigid Body Dynamics: Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

Course Title/ Code	**BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING**
Course Type:	**CORE**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION A

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion. MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractor, Serial and Parallel Adders, BCD Adder.

SECTION B

Sequential Logic Design: Building blocks like S-R, J-K and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation.

SECTION C

VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modeling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits. Concept of Programmable logic devices like FPGA. Logic implementation using Programmable Devices.

SECTION D

8- bit Microprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. 8051 Architecture Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles**.** Addressing mode, 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs.

Text/Reference Books:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.
2. Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.
3. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd edition ,2006.
4. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
5. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd edition 2012.
6. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, "The8051Microcontroller and Embedded Systems: Using Assembly and C",Pearson Education, 2007.
7. K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning,2004.

LIST OF EXPERIMENTS:

1. Familiarization with the components, breadboard, resistor coding and various types of meters and implementation of a circuit on breadboard.
2. Verification of Kirchhoff's law: (a) Kirchhoff's voltage law (b) Kirchhoff's current law.
3. Measurement of power in single phase AC circuits.
4. Calculation of efficiency and regulation of a single phase transformer OC and SC test on single phase transformer
5.To plot OCC for a DC separately excited shunt generator.
6. To perform direct load test on a DC separately excited shunt generator and plot load voltage vs load current 7. Armature voltage control and field current control of speed of DC shunt motor
8. Familiarization with the working knowledge of the CRO & Function generator, calculation of form factor, peak factor.
9. To plot V-I characteristics of PN junction diode, Zener diode and calculate cut-in voltage and break down voltage
10. Frequency response of CE configuration
11. Integrator and differentiator using op-amp.

Course Title/ Code	THERMODYNAMICS
Course Type	Core
Course Nature	Hard
L-T-P-O Structure	3-1-0-0
Prerequisites	NIL

SECTION A

Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.

Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

SECTION B

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.

SECTION C

First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.

SECTION D

Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for

systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.
Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.

Text Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

Course Title/ Code	**COMPUTER AIDED DRAFTING**
Course Type:	**Core**
Course Nature:	**Workshop**
L-T-P-O Structure	**(0-0-2-0)**
Prerequisite	**NIL**

SECTION-A

Introduction to Engineering Drawing :Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Orthographic Projections: Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

SECTION-B

Projections of Regular Solids: Inclined to both the Planes- Auxiliary Views; Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Sections and Sectional Views of Right Angular Solids : Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

SECTION-C

Isometric Projections: Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Overview of Computer Graphics covering, listing the computer technologies that impact on graphical communication, demonstrating knowledge of the theory of CAD software, Customization & CAD Drawing

SECTION-D

Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models.

Demonstration of a simple team design project that illustrates Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; introduction to Building Information Modeling (BIM).

Suggested Text/Reference Books:

(i) Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
(ii) Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
(iii) Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
(iv) Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
(v) Corresponding set of) CAD Software Theory and User Manual.

Course Title	**CONSTITUTION OF INDIA**
Course Type	**CORE**
Course Nature	**AUDIT**
L-T-P-O structure	**1-0-2-0**
Prerequisites	**NIL**

SECTION-A

Meaning of the constitution law and constitutionalism, Historical perspective of the Constitution of India, Salient features and characteristics of the Constitution of India

SECTION-B

Scheme of the fundamental rights, The scheme of the Fundamental Duties and its legal status, The Directive Principles of State Policy – Its importance and implementation

SECTION-C

Federal structure and distribution of legislative and financial powers between the Union and the States, Parliamentary Form of Government in India – The constitution powers and status of the President of India, Local Self Government – Constitutional Scheme in India

SECTION-D

Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency.

SEMESTER-2

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/ NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	No. of Contact Hours per week	Credits
MAH105B-T/P	MATHEMATICS-II	CH	HARD	CORE	3	1	2	6	5
PHH110B-T/P	OPTICS & WAVE OSCILLATIONS	MA	HARD	CORE	3	1	2	6	5

CSH101B-T/P	**PROGRAMMING FOR PROBLEM SOLVING USING C**	**ME**	**HARD**	**CORE**	**3**	**1**	**2**	**6**	**5**
MEH103B-T/P	**MANUFACTURING PROCESSES**	**ECE**	**HARD**	**CORE**	**3**	**0**	**2**	**5**	**4**
HLS103/HLS104B-T/P	**PROFESSIONAL ENGLISH-ADVANCED/BASIC**	**ME**	**WORKSHOP**	**CORE**	**2**	**0**	**2**	**2**	**3**
CHH137B	**ENVIRONMENTAL SCIENCE**	**LW**	**AUDIT**	**CORE**	**2**	**0**	**0**	**4**	**0**
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**16**	**3**	**10**	**29**	**22**

Course Title/ Code	**MATHEMATICS-II**
Course Type:	**CORE**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION –A

Multivariable Calculus (Integration):Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals

(Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

SECTION –B

First order ordinary differential equations: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Ordinary differential equations of higher orders: Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

SECTION –C

Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

SECTION –D

Complex Variable – Integration Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Suggested Text/Reference Books

(i) G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
(ii) Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
(iii) W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
(iv) S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
(v) E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
(vi) E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
(vii) J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.
(viii) N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
(ix) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Title/ Code	**OPTICS & WAVE OSCILLATIONS**
Course	**CORE**

Type:	
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION A

Interference: Interference of light, Young's Double Slit Experiment, analytical treatment of interference, Conditions for Sustained Interference, Coherent Sources and coherence, Interference based on the Division of Wave Front, Interference based upon Division of Amplitude, Fresnel Bi-Prism and its Applications, Interference in Thin Films, Newton's Ring and its Applications, Michelson Interferometer and its Applications. (10L)

SECTION B

Diffraction and Polarization: Difference between interference and diffraction; Fraunhoffer and Fresnel diffraction; Fraunhoffer diffraction through a single slit; plane transmission diffraction grating (N-slits); absent spectra; Resolving power-Rayleigh's criterion of resolution; Dispersive power; Resolving power of a grating.

Polarized and Un-Polarized Light; Brewster's law, Malus Law; Uniaxial crystals, Double Refraction; Nicol Prism; Quarter and Half Wave Plates; Laurent's Half Shade Polarimeter (10L)

SECTION C

Laser: Stimulated absorption, Spontaneous and stimulated emission, Population inversion, Conditions for laser action, Types of laser: He-Ne laser, Ruby Laser, Semiconductor laser, Laser properties and applications;

Fiber Optics: Introduction; Propagation of light through a fiber; Numerical aperture; Types of fiber; Modes of propagation (simple idea); V-number, applications of optical fibers; (10L)

SECTION D

Wave Oscillations: Simple concepts of harmonic oscillator, resonance, damped harmonic oscillator-heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator. (10L)

References/ Text Books:

1. Textbook of Optics, Brijlal and Subramaniam
2. Optics- A K Ghatak
3. Fundamentals of Optics- Jenkins and White
4. Optics- Eugene Hecht
5. Fundamentals of Optics- Khanna and Gulati
6. Engineering Physics- Satya Parkash
7. Modern Physics for Engineers- S P Taneja
8. Principals of Lasers-O. Svelto
9. Oscillations and waves in Physics-Ian G. Main
10. The Physics of vibrations and waves- H. J. Pain

List of Experiments:

1. To determine the Refractive index of the Material of a given Prism using sodium light.
2. To determine the wavelength of sodium light by Newton's rings experiment.
3. To determine the wavelength of sodium light by Fresnel's biprism experiment.
4. To determine the wavelength of various colors of white light with the help of a plane transmission diffraction grating.
5. Determination of dispersive power of the given grating.
6. To determine the refractive index and Cauchy's constants of a prism by using spectrometer.
7. To determine the wavelength of sodium light by Michelson interferometer.
8. To determine the resolving power of a telescope.
9. To determine the wavelength laser light using diffraction.

10. To determine the specific rotation of optically active solution by using Laurent's half shade polarimeter.
11. To determine the numerical aperture of an optical fiber using laser light.

References:

1. Advanced Practical Physics- B. L. Worsnop and Flint.
2. Practical Physics- S. L. Gupta and V. Kumar
3. B. Sc. Practical Physics- Harnam Singh and P. S. Hemine
4. Advanced Practical Physics- Chauhan and Singh

Course Title/ Code	**PROGRAMING FOR PROBLEM SOLVING USING C**
Course Type:	**CORE**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION-A

Programming and UNIX: Students will learn the basics of programming using Scratch, they will learn to use statements, expressions, conditions, selection, iteration, variables, functions, arrays, threads and events. In addition, they will be introduced to basic UNIX commands under Bash.
Introduction to Programming, test driven development
Scratch: Introduction, statements, expressions, conditions, selection, iteration, variables, functions, arrays.
UNIX: Basic commands- pwd, ls, cd, rm, cat, less, mkdir, rmdir; permissions, root
C language: statements, expressions, conditions, selection iteration, variables, functions, arrays.

SECTION-B

Applying programming constructs: Students will learn how to write programs that satisfy unit tests. The instructor will build the unit tests, demonstrating how to break a problem down into smaller components. In the labs and homework, students will construct programs that satisfy the unit tests. Students become familiar with the constructs of the C programming language.
Moving to C: Data Types, constants, and variables, Statements, Expressions, Conditions, Selection, iteration, Functions and recursion
Decision making within a program, Conditions, Relational Operators, Logical Connectives, if statement, if-else statement, Loops: while loop, do while, for loop, Nested loops, Infinite loops, Switch statement, structured Programming
Arrays; One dimensional arrays: Array manipulation; Searching, Insertion, Deletion of an element from an array; Finding the largest/smallest element in an array; Null terminated strings as array of characters, Standard library string functions
Introduction to Top-down approach of problem solving, Modular programming and functions, Standard Library of C functions, Prototype of a function: Formal parameter list, Return Type, Function call, Block structure, Passing arguments to a Function: call by reference, call by value, Recursive Functions, arrays as function arguments .

SECTION-C

Practical programming: During the third quarter of the class, students will begin building their own programs by decomposing problems into smaller tasks and writing unit tests that will check to see that the program accurately accomplishes the task using Test Driven Development. They will then write the program that satisfies their own unit tests. Students will learn to apply the constructs of the C programming language to create programs.
Students will learn to apply these programming techniques: Structure variables, initialization, structure assignment, nested structure, structures and functions, structures and arrays: arrays of structures, structures containing arrays, unions, Break, Continue and Goto, Type Conversion; Enumerations; Macros. Students will be able to use these techniques to develop programs

SECTION-D

Memory Management and Abstraction: During the final quarter, students will be introduced to dynamic memory allocation and dynamic data structures including: dynamic arrays. They will consolidate their ability to use the C programming techniques they have learned in the earlier sections.

Address operators, pointer type declaration, pointer assignment, pointer initialization, pointer arithmetic, functions and pointers, Arrays and Pointers, pointer arrays, pointers and structures, dynamic memory allocation,

Software Configuration Management, Modules, CUnit, GIT, SCRUM, MAKE. Dynamic Memory Allocation.

LIST OF EXPERIMENTS:

- Scratch : Covering Concepts of
  - Sequential Statements
  - Variables
  - Blocks
- Unix Commands : pwd, mkdir, cd, ls, less, touch, cp,move, cat, rm, rmdir –r etc.
- Moving to C Using nano and gcc.
- Project on Calculator Using Agile Methodology, Nano, Cunit, Git, Scrum , Agile Methodology, Nano, Gcc, Make. Covering Conepts :
  - Statements
  - Functions
  - Arrays
  - Structures
  - Pointers
  - File Handling.

Books

1. *The C Programming Language*, Brian Kernighan and Dennis Ritchie
2. *The Unix Programming Environment*
3. *Pro Git*,

Help Pages

1. Eclipse C/C++ Development Guide

Wikipedia Pages

1. Test-driven development, http://en.wikipedia.org/wiki/Test-driven_development
2. Unit testing, http://en.wikipedia.org/wiki/Unit_testing

Tool Web Sites

1. Eclipse, https://eclipse.org/users/
2. Git, http://git-scm.com/
3. GCC, https://gcc.gnu.org/onlinedocs/gcc-4.9.3/gcc/
4. Make
5. Unix

Web tutorials

1. Harvard's CS50, https://courses.edx.org/courses/HarvardX/CS50x3/2015/info

Course Title/ Code	**MANUFACTURING PROCESSES**
Course Type:	**CORE**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-0-2-0)**
Prerequisite	**NIL**

SECTION A

Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions

SECTION B

Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.

SECTION C

Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems.

SECTION D

Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems.
Solutions using potentials. Energy methods. Introduction to plasticity.

Text Books:

[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.
[2] Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
[3] Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.

Course Title	**PROFESSIONAL ENGLISH-BASIC**
Course Type	**CORE**
Course Nature	**SOFT**
L-T-P-O structure	**2-0-2-0**
Prerequisites	**NIL**

SECTION-A

Communication: What is communication? Introduction to Business Communication, Basic forms of communication – Verbal & Non-Verbal Communication, Process of Communication, Principles of Effective Communication, 7 Cs of Communication, Media of Communication, Types of Communication, Barriers of Communication, Formal and Informal Communication Network, Grapevine Communication, Miscommunication, Steps for improving communication.

SECTION-B

Grammar and Semantics: Parts of Speech, Modifiers, Subject-Verb Agreement, Tenses, Sentence: Kinds & Parts, The Phrase, The Clause; Simple, Complex and Compound Sentences, Synthesis of Simple Sentence, Active & Passive Voices, Direct & Indirect Narration, Spotting the Errors.

SECTION-C

Technical Writing-I: ABC of Writing, 7 Cs of Writing Skills, Précis Writing, Report Writing, Email Writing & Email Etiquettes, Paraphrasing, Comprehension, Punctuation, Essay Writing. Agenda & Minutes of Meeting.

SECTION-D

Literature: Scientists and Engineers Need Literature- Troy Camplin**,** Some Hints on Public Speaking by James Bryce**,** Ozymandias by John Keats**,** Macbeth by William Shakespeare**.**

Lab Exercises/Activities:

1. Exercises based on Grammar
2. Exercises based on Sentence
3. Exercise on Communication
4. Spotting the Errors
5. Reading/Listening Comprehension
6. Essay Writing Session
7. Report Writing and Email Writing
8. Direct & Indirect Narration
9. Active & Passive Voices
10. Tense
11. Paraphrasing
12. Movie/Book review

Suggested Text Book Reading:

(i) Camplin, Troy. 'Why Scientists and Engineers Need Literature'. www.popecenter.org. Web.

(ii) A Practical Course for Developing Writing Skills in English. J K Gangal: PHI Learning Pvt.

(iii) High School English Grammar and Composition. Wren and Martin: S.Chand and Co.

(iv) A Textbook of English Phonetics for Indian Students. T.Bala Subhrmaniam: Macmillan

Course Title/ Code	**PROFESSIONAL ENGLISH-ADVANCED**
Course Type:	**CORE**
Course Nature:	**SOFT**
L-T-P-O Structure	**(2-0-2-0)**
Prerequisite	**NIL**

SECTION-A

Lexis: The Concept of Word Formation, Homonym, Homophones, Root Words of Foreign Languages & their use in English, Foreign Words, Phrasal Verbs & Idioms and Phrases.

SECTION-B

Oral Communication: Importance of Speech Sounds, Organs of Speech, Vowel Sounds, Consonant Sounds, IPA Symbols, Phonetic Transcription, Phoneme and Syllables, Intonation, Word Stress, Sentence Stress, Connected Speech, Indianism, Question Tags.

SECTION-C

Presentation Skills: Body Language and Paralanguage, Gestures and Postures, Kinesics, Proxemics, Importance of Body Language in Presentation, Etiquette of the Telephone Handling and Business Meetings, Professional Presentation, Hearing and Listening, Essentials of Effective Listening, Importance of Effective Listening, Visual Presentation – How to prepare slide presentation.

SECTION-D

Technical Writing-II: Business Letters, Job Application and Resume Writing, Paraphrasing, Developing Outlines, Circular, Memos, Essay Writing. Blog Writing and Comments on Social Media.

Lab Exercises/Activities

1. Exercise on Lexis-I.
2. Exercise on Lexis-II
3. One- Man Task
4. Exercise on Business Quiz
5. Role-Play Activities
6. Organs of Speech
7. IPA Symbols
8. Intonation
9. Phonetic Transcription
10. Hearing vs Listening
11. Telephonic and Face-to-Face Communication
12. Presentation

Suggested Text Reading:

(i) A Practical Course for Developing Writing Skills in English. J K Gangal: PHI Learning Pvt.

(ii) A Textbook of English Phonetics for Indian Students. T.Bala Subhrmaniam: Macmillan

(iii) English Vocabulary in Use. MaCarthy: Foundation Books, OUP. Print.

(iv) English Grammar, Competition and Correspondenc. M.A. Pink and A.C. Thomas: S. Chand and Co. Print.

(v) Reading Between the Line: Students Book. MacRae: Foundation Books. CUP, New Delhi.

Course Tittle/Code	**ENVIRONMENTAL SCIENCE**
Course Type	**University Compulsory**
Course Nature	**AUDIT**
L-T-P-O Structure	**2-0-2-0**
Prerequisite	**NIL**

SECTION-A

Multidisciplinary nature of environmental studies: Definition, scope and importance**,** Need for public awareness (OC)
Renewable and Non-Renewable Resources: Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

SECTION-B

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies (OC). Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
Role of an individual in conservation of natural resources. (OC) Equitable use of resources for sustainable lifestyle

Ecosystems: Concept of an ecosystem. Structure and function of an ecosystem., Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem :- Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) (OC)

Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity, Biogeographical classification of India.

Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values (OC), Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity (OC).

SECTION-C

Environmental Pollution: Definition**,** Cause, effects and control measures of :- Air pollution**,** Water pollution**,** Soil pollution**,** Marine pollution**,** Noise pollution**,** Thermal pollution**,** Nuclear hazards**,** Solid waste Management : Causes, effects and control measures of urban and
Industrial wastes. (OC), Role of an individual in prevention of pollution. (OC), Pollution case studies. (OC), Disaster management: floods, earthquake, cyclone and landslides.

Social Issues and the Environment: From Unsustainable to Sustainable development**,** Urban problems related to energy**,** Water conservation, rain water harvesting, watershed management**,** Resettlement and rehabilitation of people; its problems and concerns. Case
Studies, Environmental ethics: Issues and possible solutions.

SECTION-D

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies (OC): Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act (OC)**,** Water (Prevention and control of Pollution) Act (OC)**,** Wildlife Protection Act**,** Forest Conservation Act**,** Issues involved in enforcement of environmental legislation (OC), Public awareness (OC).
Human Population and the Environment: Population growth, variation among nations, Population explosion – Family Welfare Programme, Environment and human health, Human Rights (OC)**,** Value Education (OC), HIV/AIDS (OC), Women and Child Welfare (OC), Role of Information Technology in Environment and human health, Case Studies (OC).
*OC = Outcome component

Field work
• Visit to a local area to document environmental assets river/ forest/grassland/hill/mountain
• Visit to a local polluted site-Urban/Rural/Industrial/Agricultural

- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.
- Any socially relevant problem identification and proposing its possible solution

NOTE: Manav Rachna has adopted five villages, where students would be visiting, will identify the socially relevant issues and work on to provide possible solution.

SEMESTER 3

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/ NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	O	No. of Contact Hours per week	Credits
MEH207B-T/P	**FLUID MECHANICS & MACHINES**	ME	HARD	CORE	3	1	2	0	6	5
MAH203B	**MATHEMATICS-III (PROBABILITY & STATISTICS)**	MA	HARD	CORE	3	1	0	0	4	4
MOOC COURSES										3
MEH204B-T/P	**APPLIED THERMODYNAMICS**	ME	HARD	CORE	3	1	2	0	6	5
MEH301B-T/P	**MANUFACTURING TECHNOLOGY**	ME	HARD	CORE	3	0	2	0	5	4
CDO201	**PROFESSIONAL COMPETENCY ENHANCEMENT**	CDC	OUTCOME BASED	CORE	0	0	1	0	1	0.5
FLS101/FLS102/FLS103	**FOREIGN LANGUAGES-I**	FL	AUDIT	ELECTIVE	2	0	0	0	2	0
RDO201	**INTRODUCTION TO RESEARCH**	RESEARCH	OUTCOME BASED	CORE	0	0	1	0	1	0.5
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**14**	**3**	**8**	**0**	**25**	**22**

Course Title/Code	FLUID MECHANICS & MACHINES
Course Type	Core
Course Nature	Hard
L-T-P-O structure	3-1-2-0
Prerequisite	NIL

SECTION A

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

SECTION B

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.

SECTION C

Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis.

Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps Reciprocating pump – working principle.

SECTION D

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of Turbines.

Course	MATHEMATICS-III

Title/Code	
Course Type	**CORE**
Course Nature	**Hard**
L-T-P-O structure	**3-1-0-0**
Prerequisites	**NIL**

SECTION –A

Partial Differential Equations: Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and integral method. Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables.

SECTION –B

Probability Theory: Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables. Continuous random variables and their properties, distribution functions and densities, normal distribution.

SECTION –C

Numerical Methods – 1: Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsi method. Finite differences, Relation between operators. Interpolation using Newton’s forward and backward difference formulae. Interpolation with unequal intervals: Newton’s divided difference and Lagrange’s formulae

Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson’s 1/3rd and 3/8 rules. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves.

SECTION –D

Numerical Methods – 2: Ordinary differential equations: Taylor’s series, Euler and modified Euler’s methods. Runge- Kutta method of fourth order for solving first and second order equations. Milne’s and Adam’s predicator-corrector methods.

Textbooks/References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
3. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
5. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand & Company, 2nd Edition, Reprint 2012.
6. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005.
7. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,
2006.
8. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.

Course Title / Code	**APPLIED THERMODYNAMICS**
Course Type	**CORE**
Course Nature	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION-A

Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.

SECTION-B

Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.

SECTION-C

Properties of dry and wet air, use of psychrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.

Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, supersaturation- compressible flow in diffusers, efficiency of nozzle and diffuser.

SECTION-D

Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

Analysis of steam turbines, velocity and pressure compounding of steam turbines

Text Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

Course Title/ Code	**MANUFACTURING TECHNOLOGY**
Course Type	**CORE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

Section-A

Metal Casting Process: Introduction, Foundry: Introduction to Casting Processes, Basic Steps in Casting Processes. Pattern: Types of Pattern and Allowances. Sand Casting: Sand Properties, Constituents and Preparation. Mould & Core making with assembly and its Types. Gating System. Melting of Metal, Furnaces and Cupola, Metal Pouring, Fettling. Casting Treatment, Inspection and Quality Control, Sand Casting Defects & Remedies.

Section-B

Welding: Introduction to Welding, Classification of Welding Processes, Gas Welding: Oxy-Acetylene Welding, Resistance Welding; Spot and Seam Welding, Arc Welding: Metal Arc, TIG & MIG Welding, Submerged arc welding (SAW), resistance welding principles, electrode types and selection, thermit welding, electro slag welding, electron beam welding, laser beam welding, forge welding, friction welding, Welding Defects and remedies, brazing & soldering.

Section-C

Forming Processes: Basic Principle of Hot & Cold Working, Hot & Cold Working Processes, Rolling, Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, Impact extrusion, Hydrostatic extrusion.
Sheet metal forming: Spring back effect, Stamping, Blanking, Bending, Drawing, Piercing, Coining, Embossing, Stretch forming, Hot and cold spinning. Special forming: Hydro forming, High energy rate forming, Drawing, Wire Drawing and Spinning.
Forging: Principles of forging, Tools and dies, Types: Smith forging, Drop Forging, Forging hammers, Rotary forging, forging defects.

Section-D

Unconventional Machining Processes: Abrasive jet machining: Principles, applications, process parameters. Ultrasonic machining: Principles, applications, analysis of process parameters. Electro-chemical machining and grinding: Principles, classifications, choice of electrolytes, applications. Electric discharge machining: Principles, selection of tools materials and dielectric fluid. Electron beam machining: Generation of electron beam, relative merits and demerits. Laser beam machining: Principles and applications.

Introduction to 3D Printing & its applications.

LIST OF EXPERIMENTS:

1. Analysis of flat rolling for an aluminum sheet

2. To study the effects of material properties (ductility, types, strength) on the bend radius, spring-back and bending force.
3. To study Heat flow in Welding (Equipment for use-Gas Welding equipment)

4. To study Bead Geometry, Hardness of Bead, Micro structure of welding Bead in case of:

   i). MIG Welding
   ii). SAW Welding
   iii). FCAW Welding (By changing electrode diameter & carriage speed)

5. Prepare mould and measure of mould hardness by mould hardness tester and Measure fluidity of casting metals
6. Part Programming and Proving for Milling a Rectangular Slot
7. Electrical Discharge Machining (EDM): Measurement of MRR, TWR and surface finish
8. Ultrasonic Machining (USM): Measurement of MRR, TWR and surface finish

Text Books

1. Manufacturing Technology – Vol. - 2, P.N. Rao, T.M.H, New Delhi

2. Computer Aided Manufacturing: S Kumar & B Kant Khan, SatyaPrakashan, New Delhi

Reference Books

1. Principles of Machine Tools – G.C. Sen& A. Bhattacharya, Tata McGraw Hill, New Delhi

2. Manufacturing Engg.& Tech, Kalpakian, Serope Addison -Wisly Publishing Co. New York.

3. Modern Machining Processes: P.C. Pandey& H.S. Shan, T.M.H. Company, New Delhi

4. Text Book of Production Engineering: P.C. Sharma, S.Chand& Sons.

5. Production Engineering by KC Jain & AK Chilate, PHI, New Delhi

Course Tittle/Code	**FRENCH-I**
Course Type	**University Compulsory**
Course Nature	**NTCC**
L-T-P-O Structure	**1-1-0-0**

Prerequisite	**NIL**

SECTION-A

Les Salutations & forms of politeness, Alphabets, Taking leave expression

SECTION-B

Les pronoms sujets, Les verbes ER, Self introduction

SECTION-C

Les noms, Verbes Avoir, Etre, Aller & Faire, Les articles define et indefini

SECTION-D

Les moin de l'annee, les jours de la semain, Repondez aux questions

Course Tittle/Code	**SPANISH-I**
Course Type	**University Compulsory**
Course Nature	**NTCC**
L-T-P-O Structure	**1-1-0-0**
Prerequisite	**NIL**

SECTION-A

Presentation on Spanish language, Greetings and goodbye's

SECTION-B

Introduction cntd, Alphabets, Numbers 1-20

SECTION-C

Personal pronouns, Hobbies and Professions

SECTION-D

Café related vocabulary and dialogues, Revision personal pronouns, Common verbs and their conjugations, Introduction of VerboSER

Course Tittle/Code	**GERMAN-I**
Course Type	**University Compulsory**
Course Nature	**NTCC**
L-T-P-O Structure	**1-1-0-0**
Prerequisite	**NIL**

SECTION-A

Salutations/Greetings, Introduction

SECTION-B

Uses of Verbo SER, Introduction of Nationality, Professions and vocabulary related to professions, Adjectives related to Verbo SER, Counting till number 20.

SECTION-C

Introduction of Articles and Indefinite articles, Interrogatives, Adjectives to describe things and place and Counting till number 90

SECTION-D

Introduction of Verbo ESTAR, Uses of Verbo ESTAR with respect to positioning of objects, Prepositions related to the positioning of an object.

SEMESTER 4

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	O	No. of Contact Hours per week	Credits
MEH205B-T/P	STRENGTH OF MATERIALS-I	ME	SOFT	CORE	3	1	2	0	6	5
MEH305B-T/P	ROBOTICS	ME	HARD	CORE	3	0	2	0	5	4
MOOC COURSE										3
MEH206B-T/P	KINEMATICS & THEORY OF MACHINES	ME	HARD	CORE	3	1	2	0	6	5
MEH202B-T/P	MATERIALS SCIENCE	ME	HARD	CORE	3	0	2	0	5	4
CSH321B-T/P	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	CS	HARD	CORE	3	0	2	0	5	4
LWS322/LWS321B-T/P	CYBER LAW/LAW OF PATENT	LW	HARD	CORE	2	0	0	0	2	2
RDO202	INTRODUCTION TO RESEARCH	RESEARCH	OUTCOME BASED	CORE	0	0	1	0	1	0.5
FLS105/FLS106/FLS107	FOREIGN LANGUAGE	FL	AUDIT	ELECTIVE	2	0	0	0	2	0
CDO202	PROFESSIONAL COMPETENCY ENHANCEMENT	CDC	OUTCOME BASED	CORE	0	0	0	1	1	0.5
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					19	2	10	1	33	28

Course Title / Code	STRENGTH OF MATERIALS –I
Course Type	CORE
Course Nature	Hard
L-T-P-O Structure	(3-1-2-0)
Prerequisite	NIL

SECTION A

Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

SECTION B

Beams and types transverse loading on beams- shear force and bend moment diagrams Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

SECTION C

Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.

SECTION D

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.

Text Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.

Course Title/ Code	**ROBOTICS**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION-A

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

SECTION-B

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, and Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks.

SECTION-C

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, Computed torque control, force control, hybrid control.

SECTION-D

Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals With effect from 2015 - 16 for robotic applications, image acquisition and preprocessing. Segmentation and region characterization object recognition by image matching and based on features

Text Books:

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, 2003.

2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
4.Harry Asada & Slottine “Robot Analysis& Control” , Wiley Publications, 2014
5. S K Saha, “introduction to Robotics “, 2 nd edition, TMH, 2013

Course Title / Code	**KINEMATICS & THEORY OF MACHINES**
Course Type	**CORE**
Course Nature	**Hard**
L-T-P-O Structure	**(3-1-2-0)**
Prerequisite	**NIL**

SECTION A

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof’s law, Kinematic inversions of four bar chain and slider crank chains, Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms

SECTION B

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamicsCoincident points- Coriolis component of acceleration- introduction to linkage synthesisthree position graphical synthesis for motion and path generation

SECTION C

Classification of cams and followers- Terminology and definitions- Displacement diagramsUniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers

SECTION D

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics
Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication friction clutches- belt and rope drives- friction in brakes.

Text Books:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. CleghornW.L. , Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East West Pvt. Ltd, New Delhi, 1988.

Course Title/Code	**MATERIALS SCIENCE**
Course Type	**CORE**
Course Nature	**Hard**
L-T-P-O structure	**3-0-2-0**
Prerequisites	**NIL**

SECTION A

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.
Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

SECTION B

Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics:

Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to nondestructive testing (NDT).

SECTION C

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.

SECTION D

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys.

Text Books:

1. W. D. Callister, 2006, “Materials Science and Engineering-An Introduction”, 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, “Material Science and Engineering’, Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, “Engineering Materials and Metallurgy”, Pearson, 2011.

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Course Title/ Code	**Artificial Intelligence and Machine Learning** **(CSH321B) T & P**
Course Type:	**Elective**
Course Nature:	**Hard**
L-T-P-O Structure	**(3-0-2-0)**
Prerequisite	**NIL**

Section-A

Introduction: Overview and Historical Perspective, Turing Test, Physical Symbol Systems and the scope of symbolic AI, Agents. **State Space Search**: Depth First Seach, Breadth First Search. **Heuristic Search**: Best First Search, Hill Climbing. **Randomized Search**: Simulated Annealing, Genetic Algorithms, Ant Colony Optimization.

Section-B

Finding Optimal Paths: Branch and Bound, A*, IDA*, Divide and Conquer approaches. **Problem Decomposition**: Goal Trees, AO***. Game Playing**: Minimax Algorithm, Alpha Beta Algorithm, SSS*.

Planning and Constraint Satisfaction: Domains, Forward and Backward Search, Goal Stack Planning, Plan Space Planning, Graphplan, Constraint Propagation.

Logic and Inferences: Propositional Logic, First Order Logic, Soundness and Completeness, Forward and Backward chaining.

Section-C

Overview of Machine Learning: Introduction to Machine Learning, Elements of machine learning, Logistic Regression : Naive Bayes - the big picture, Logistic Regression: Maximizing conditional likelihood, Gradient ascent as a general learning/Optimization method , Generative versus Discriminative model, Linear regression, Instance Based Learning, Bias, Variance, Decision Tree Learning: The big picture , Overfitting, Random variables, Probabilities.

Section-D

Model Selection, Clustering and EM, mixture model and Hidden Markov Models(HMM),Graphical Model, Inference and Learning in GM, Active learning, Boosting, Reinforcement Learning, Neural Networks: Non-linear regression , Back-propagation and Gradient descent, Learning hidden layer representations, Introduction to Deep learning.

LIST OF EXPERIMENTS:

1. Basic operations & algebra of machine learning
2. Analyzing and plotting data
3. Linear Regression
4. Machine learning algorithms (logic regression, k-mean clustering, k-nearest neighbor classification, decision tree)
5. Implement searching algorithms
6. Implementation of Game Playing
7. Solving real-life problems using AI techniques.

a) Implement and solve the problem of creating a map using rules.

b) Implement and solve the problem of Towers of Hanoi.

Text Books:

1. Tom. M. Mitcheli. Machine Learning, McGraw-Hill Publishing Company Ltd
2. Ethern ALPAYDIN. Introduction to Machine Learning, The MIT Press.
3. Deepak Khemani.A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.

Reference Book:

1. Jaime GuillernoCarbonell and Tom Michael Mitchell, “Machine Learning”, Morgan Kaufmann, 1994.
2. Bishop, Christopher “Pattern Recognition and Machine Learning” ,Springer.
3. John Haugeland,Artificial Intelligence: The Very Idea,A Bradford Book, The MIT Press, 1985.
4. Elaine Rich and Kevin Knight.Artificial Intelligence, Tata McGraw Hill, 1991

Course Title/ Code	LAW OF PATENT
Course Type	ELECTIVE
Course Nature	SOFT
L-T-P-O Structure	1-0-2-0
Prerequisite	NIL

SECTION A

The Concept of patents: objective of patents, theories of patent protection: economic and moral justifications for patent, Historical development of patent law in India, International instruments dealing with patent protection: Paris Convention for Protection of Industrial Property, Patent Cooperation Treaty (PCT) , TRIPS Agreement Budapest Treaty for Microorganisms.

SECTION B

Patentable Subject matter, Patentability of Computer Programs, Algorithms and Mathematical Formulae, Pharmaceutical Patent, Patentability of diagnostic method, Patentability of Traditional Knowledge

Cases: Novartis A.G. v. Union Of India & Others, AIR 2012, Diamond V. Chakrabarty (447 U.S. 303 (1980). Criteria for patent: novelty, inventive step, and industrial application.

SECTION C

Procedure for filing of patents: national filing , International filing of patents: PCT ,Revocation of patents , Opposition to patents

SECTION D

Infringement of patents, Remedies for infringement of patents, Exceptions/defenses to infringement of patents, Licensing of patents: basics, and statutory provisions, Traditional Knowledge: Meaning and basics, Traditional Knowledge Digital Library (TKDL), interaction with patent law, case studies on TK: patenting of turmeric, neem, and basmati rice.

Tutorial Exercises (2 hours per week)

1. Drafting exercises on patent drafting and filing 2. Drafting exercises on licensing of patents.

TEXT BOOKS & REFERENCES:

1. B.L. Wadhera, B.L. Wadhera, Law Relating to Intellectual Property, Universal Publishing Company, 5th Edition.
2. Narayanan, P., Patent Law (Kolkata: Eastern Law House, 1998.

Course Title/ Code	CYBER LAWS
Course Type	ELECTIVE
Course Nature	SOFT
L-T-P-O Structure	1-0-2-0
Prerequisite	NIL

SECTION A

Introduction: Overview of Computer and Web Technology, Need for Cyber Law, Cyber Jurisprudence at International and Indian Level

SECTION B

Cyber Crimes & Legal Framework: Cyber Crimes against Individuals, Institution and State, Hacking: Digital Forgery, Cyber Stalking/Harassment, Cyber Pornography, Identity Theft & Fraud Cyber Terrorism, Different offences under IT Act, 2000

SECTION C

Digital signature and Electronic Signature and Data Protection **,** Concept of public key and private key, Certification authorities and their role**,** Creation and authentication of digital signature, Concept of electronic signature certificates, electronic records and electronic signatures.

SECTION D

E Contracting: Salient features of E-contract, Formation of E-contract and types: E-mail Contracting**,** Indian Approach on E-contracts**,** E-commerce: Salient Features and advantages, Models of E-commerce.

TEXT BOOKS & REFERENCES:

1. Vishwanathan Suresh T., "The Indian Cyber Law" Second Edition 2001:- Bharat Law House.
2. Prasad T.V.R. Satya, : "Law Relating to Information Technology (Cyber Laws)" 1st edition 2001:- Asia Law House.
3. Syed Shakil Ahmed and Reheja Rajiv, " A Guide to Information Technology" (Cyber Laws & Ecommerce) Edition 2001:- Capital Law House.

SEMESTER 5

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/ NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	O	No. of Contact Hours per week	Credits
MEH318B-T/P	COMPUTER AIDED DESIGN & MANUFACTURING	ME	HARD	CORE	3	0	2	0	5	4
CSH210B-T/P	DATA STRUCTURES	CS	HARD	CORE	3	0	2	0	5	4
	INTERNET OF THINGS	EC	HARD	CORE	3	0	2	0	5	4
MEH319B-T/P	MECHATRONICS	ME	HARD	CORE	3	0	2	0	5	4
MEH303B-T/P	HEAT TRANSFER	ME	HARD	CORE	3	1	2	0	6	5
CHS234/CSS 325/ECS306 B-T/P	ENVIRONMENTAL ETHICS & SUSTAINABLE DEVELOPMENT/GREEN COMPUTING/E-WASTE MANAGEMENT	CH/CS/ECE	SOFT	ELECTIVE	1	0	2	0	3	2
MES325B-T/P	ESSENCE OF TRADITIONAL KNOWLEDGE	ED	AUDIT	CORE	1	0	2	0	3	0
CDO301	PROFESSIONAL COMPETENCY ENHANCEMENT	CDC	OUTCOME BASED	CORE	0	0	1	0	1	0.5

RDO301	**RESEARCH METHODOLOGY**	**RESEARCH**	**OUTCOME BASED**	**CORE**	**0**	**0**	**1**	**0**	**1**	**0.5**
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**16**	**1**	**13**	**2**	**31**	**24**

Course Title/ Code	**COMPUTER AIDED DESIGN & MANUFACTURING**
Course Type	**CORE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION-A

Introduction: Definition and scope of CAD/CAM, Introduction to design process and role of computers in the design process. Transformations: 2D and 3D transformations. Curves and Surfaces: Analytical, Synthetic curves with advantages, Disadvantages, Comparison with parametric curves, Geometric modeling curves and surfaces, Representation, Wire frame models, Parametric representations, Parametric curves and surfaces, Manipulations of curves and surfaces, DDA, Bresenham's /Mid point line, circle, ellipse algorithms.

SECTION-B

Solid modeling: Solid models, Fundamentals of solid modeling, Different solid representation schemes, Half -spaces, Boundary representation (B-rep), Constructive solid geometry (CSG), Sweep representation, Analytic solid modeling, Perspective, Parallel projection, Hidden line removal algorithms. CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards.

SECTION-C

Introduction: Need of NC technology, Fundamental concepts in numeric control: structure and functions of NC System, advantages of NC technology over conventional manufacturing. NC Machine Tools: Types, Definition and designation of control axes,Special constructional and design characteristics of NC machine tools, Standard tooling used for NC turning and milling centres. NC Part Programming: Work holding and tool setting procedure for NC turning and milling centres, Tool zero presetting, Block formats and introduction to ISO based G & M codes for NC part programming, Concepts of tool length and radius compensation, Standard canned cycles used in CNC turning and milling centres, Introduction to automatic

SECTION-D

NC part program generation from CAD models using standard CAD/CAM software for machining of surfaces, moulds and dies etc. Computer Numerical Control of Machine Tools: Types and functions of computer numeric control (CNC), Types and functions of direct numeric control (DNC), Need of adaptive control types, functions and types of adaptive control, its uses & benefits, Advantages of combined CNC/DNC systems.

System Devices: Drives, Feedback devices, Interpolator systems, Control loop circuit elements in point to point (PTP) and contouring system, Interpolation schemes for linear and circular interpolations.

Laboratory Work: Graphics programming in C++/MATLAB for geometric modeling of different Curves, Surfaces and Solid primitives. The generated geometric models will have the capability to be modified as per the user's requirements.

Laboratory Work: Exercises in tool presetting and workpiece referencing on CNC machine tools, manual part programming for CNC turning and milling centres, Use of software for simulation of turned and milled parts and simple surfaces, Automatic Cutter location data generation from CAD Models in APT format and post-processing for machining on CNC machines using standard CAD/CAM software.

Recommended Books

1. Zeid, I., CAD/CAM, McGraw Hill (2008).

2. Rogers, D. F. and Adams, J. A., Mathematical Elements for Computer Graphics, McGraw Hill (1989).

3. Rogers, D. F., Procedural Elements for Computer Graphics, McGraw Hill (2008).

4.Groover, M. P. and Zimmers, E. W., CAD/CAM:Computer Aided Design & Manufacturing, 2006, Pearson Education India

5. Hood-Daniel P., and Kelly J.F., Build Your Own CNC Machine, 2009, Springer-Verlag New York

Course Title/ Code	**Data Structures (CSH210 B) T & P**
Course Type:	**Core**
Course Nature:	**Hard**
L-T-P-O Structure	**(2-0-2-0)**
Prerequisite	**NIL**

SECTION-A

Data structures and Algorithms: Introduction to Data structure: Concept of data structure, choice of right data structures, types of data structures, Introduction to algorithms, how to design and develop an algorithm: stepwise refinement, algorithm analysis, complexity of algorithms

Arrays: Introduction, One Dimensional Arrays, two dimensional array, address calculation of a location in arrays operations defined: traversal, selection, searching, insertion, deletion, Searching: linear search, binary search, Sorting: selection sort, bubble sort, insertion sort

SECTION-B

Pointers: Introduction to pointers, Pointer variables, Pointer and arrays, array of pointers, pointers and structures, Dynamic allocation. Linked Lists: Concept of a linked list, operations on Singly linked lists: traversal, selection, searching, insertion, deletion, and sorting, overview of circular and doubly linked list. Applications of linked lists.

SECTION-C

Stacks: Introduction to Stacks, array representation of stack, operations on stack: PUSH, POP, Evaluation of Expression: Concept of precedence and associatively in expressions, Resolving precedence of operators and association of operands, postfix & prefix expressions, conversion of expression from one form to other form using stack (with & without parenthesis),Recursion, Linked list representation of stack, Applications of stacks. Queues: Queues, array representation of Queues, operations on queue: insertion and deletion, Linked list representation of queue, Overview of priority queue, circular and dequeue. Applications of Queues.

SECTION-D

Non-Linear Structures: Trees definition, characteristics concept of child, sibling, parent child relationship etc, binary tree: different types of binary trees based on distribution of nodes, operation on binary tree: insertion, deletion, searching and traversal, traversing: Preorder, Postorder and Inorder, Introduction to binary search tree, operations on BST: insertion, deletion, searching, Application of trees. Graphs: Definition, Relation between tree & graph, directed and undirected graph, connected and disconnected graph, Depth first and breadth first traversal of graphs, Applications of Graph.

List of Experiments:

1. Programs on C language

2. Write a program on Linear search and Binary search Using C

3. Write a program to implement bubble sort, insertion sort, selection sort

4. Programs on Link list

5. Programs on stack

6. Programs on queues

7. Programs on binary trees

• Traversal

• Insertion

• Deletion

Text Books:

1. Data Structures with C by Seymour Lipschutz ,McGraw Hill Education(India) Private Limited.

2. Data Structures using C by A. K. Sharma, Pearson Publication.

3. Data Structures using C-YashwantKanetkar Publication.

Reference Books:

1.Data Structures using C by A. M. Tenenbaum, Langsam, Moshe J. Augentem, PHI Pub.
2. Data Structures and Algorithms by A.V. Aho, J.E. Hopcroft and T.D. Ullman Publisher.

Course Title/ Code	**INTERNET OF THINGS**
Course Type	**CORE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION A

Introduction to IoT : Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.

SECTION B

Elements of IoT Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces.
Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

SECTION C

IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

SECTION D

IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

LIST OF EXPERIMENTS:

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries. 12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.

Course Title/ Code	**MECHATRONICS**
Course Type	**HARD**

Course Nature	**CORE**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION-A

Introduction: Integration of mechanical, electronics, control and computer science engineering, Elements of mechatronics system, Open-loop and closed-loop system. Physical and Mathematical

SECTION-B

Modeling of Dynamic Systems: Equations of motion of mechanical, electrical, pneumatic and hydraulic systems, Transforming physical model to mathematical model, Linearization, Frequency response. Modeling of different motors and generators.

Control Systems: Laplace transformations, Block diagram reduction, Signal flow graph, Performance specifications, Transfer functions, Stability, Sensitivity of the open -loop and closed -loop systems, Types of controller, Controller design using frequency domain and Laplace domain methods. Sensors: Displacement, Position and Proximity sensors, Flow sensors, Pressure and force sensors, Motion sensors, Optical, Mechanical and Thermal sensors.

Actuators in Mechatronics System: Electric actuators, Stepper motors, DC motors, and AC motors.
Electronic Elements in Mechatronic System: Analog to digital and digital to analog converters, Operational amplifiers, Introduction to Microcontrollers and Microprocessors.

Recommended Books:

1. Bolton, W., Mechatronics, Pearson Education Asia (2004). 6
2. Anslander, D. M. and Kampf, C. J., Mechatronics: Mechanical System Interfacing, Prantice Hall (1995).
3. Kamm, L. J., Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics, Prantice Hall of India (2000).
4. Alciatore, D. G. and Histand, M. B., Introduction to Mechatronics and Measurement System, McGraw Hill (1999).
5. Doebelin, E.O., Measurement Systems, Application & Design, McGraw Hill (2004).
6. Nagrath, I. J. and Gopal, M., Control System Engineering, New Age International (2008).

LIST OF EXPERIMENTS:

Each team of 4-5 students will submit a case study of a mechatronics device. The research assignment will constitute collection of literature, CAD model of the device, development of the mathematical model and its controller design for different control tasks. Finally, each team has to submit a detailed report along with a presentation. The team can demonstrate the case study by developing a working model of the mechatronic device using the LEGO or Tetrix kits.

Course Title/ Code	**HEAT TRANSFER**
Course Type	**CORE**
Course Nature	**HARD**
L-T-P-O Structure	**3-1-2-0**
Prerequisite	**NIL**

SECTION A

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer- approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

SECTION B

Heat convection,basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

SECTION C

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann’s law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

SECTION D

Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-

NTU methods. Boiling and Condensation heat transfer, Pool boiling curve
Introduction mass transfer, Similarity between heat and mass transfer

Text Books:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. Massoud Kaviany, Principles of Heat Transfer, John Wiley, 2002
5. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002

LIST OF EXPERIMENTS:

1. To analyze the Heat Transfer from a Pin-Fin Apparatus
2. To analyze the Heat Transfer through Composite Wall.
3. To determine the Critical Heat Flux
4. To measure the emissivity using Emissivity Measurement Apparatus.
5. To analyze the Heat Transfer through the Lagged Pipe.
6. To determine the Thermal Conductivity of Insulating Powder.
7. To determine the Thermal Conductivity of Metal Rod
8. To analyze the Heat Transfer in Natural Convection.
9. To explain the Parallel Flow / Counter Flow Heat Exchanger
10. To determine the Heat Transfer in Forced Convection.

Course Title/ Code	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**
Course Type	**CORE**
Course Nature	**AUDIT**
L-T-P-O Structure	**1-0-2-0**
Prerequisite	**NIL**

SECTION-A

Basic Structure of Indian Knowledge System (i) वेद, (ii) उऩवेद (आयुवेद, धनुवेद, गन्धवेद, स्थाऩत्य आदद) (iii) वेदा◌ांग (शिक्षा, कल्ऩ, ननरुत, व्याकरण, ज्योनतष छांद), (iv) उऩाइग (धर्म ि◌ास्र, र्◌ीर्◌ा◌ांसा, नुराण, तकमिास्र) •

SECTION-B

Modern Science and Indian Knowledge System

SECTION-C

Yoga and Holistic Health care

SECTION-D

Case Studies.

Reference Books

1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014
2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan
3. Fritzof Capra, Tao of Physics
4. Fritzof Capra, The wave of Life
5. V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation, Velliarnad, Amaku,am
6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta
7. GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi, 2016
8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakasham, Delhi, 2016
9. P R Sharma (English translation), Shodashang Hridayam.

SEMESTER 6

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/ NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	O	No. of Contact Hours per week	Credits
MEH320B-T/P	**INTERNAL COMBUSTION ENGINE & GAS TURBINES**	ME	SOFT	CORE	3	1	2	0	6	5
MEH310B-T/P	**OPERATIONS RESEARCH**	ME	HARD	CORE	3	0	2	0	5	4
MEH311B-T/P	**REFRIGERATION & AIR CONDITIONING**	ME	HARD	CORE	3	1	2	0	6	5
MEH306B/MEH307B/MEH308B/MEH318B/	**STRENGTH OF MATERIALS-II/TOOL ENGINEERING DESIGN/PRODUCT DESIGN & DEVELOPMENT/FUNDAMENTALS OF NANOSCIENCE & NANOTECHNOLOGY**	ME	HARD	ELECTIVE	3	0	2	0	5	4
MEH312/MEH313B/MEH314B-T/P	**MECHANICAL VINRATIONS/AUTOMOBILE ENGINEERING/COMPOSITE MATERIALS/DESIGN OF HEAT EXCHANGER**	ME	HARD	ELECTIVE	3	0	2	0	2	1

ECH403B/CSH414 B-T/P	**WIRELESS SENSOR NETWORK/INFORMATION RETRIVAL**	EC/CS	HARD	ELECTIVE	3	0	2	0	5	4
CDO302	**PROFESSIONAL COMPETENCY ENHANCEMENT**	CDC	OUTCOME BASED	CORE	0	0	1	0	1	0.5
RDO302	**RESEARCH METHODOLOGY**	RESEARCH	OUTCOME BASED	CORE	0	0	1	0	4	0.5
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**18**	**2**	**14**	**0**	**34**	**27**

Course Title/ Code	**INTERNAL COMBUSTION ENGINES & GAS TURBINES**
Course Type	**CORE**
Course Nature	**HARD**
L-T-P-O Structure	**3-1-2-0**
Prerequisite	**NIL**

SECTION-A

Air Standard Cycles: Internal and external combustion engines; classification of I.C. Engines, Cycles of operation in four stroke and two stroke I.C. Engines, Wankel Engines, Assumptions made in air standard cycle; Otto cycle; diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles; sterling and Ericsson cycles; air standard efficiency, specific work output, specific weight; work ratio; mean effective pressure; deviation of actual engine cycle from ideal cycle. Problems.

SECTION-B

Carburetion, fuel Injection and Ignition systems: Mixture requirements for various operating conditions in S.I. Engines; elementary carburetor, Requirements of a diesel injection system; types of inject systems; petrol injection, Requirements of ignition system; types of ignition systems ignition timing; spark plugs. Problems.

Combustion in I.C. Engines: S.I. engines; Ignition limits; stages of combustion in S.I. Engines; Ignition lag; velocity of flame propagation; detonation; effects of engine variables on detonation; theories of detonation; octane rating of fuels; pre-ignition; S.I. engine combustion chambers, Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.

SECTION-C

Lubrication and Cooling Systems: Functions of a lubricating system, Types of lubrication system; mist, wet sump and dry sump systems; properties of lubricating oil; SAE rating of lubricants, engine performance and lubrication, Necessity of engine cooling; disadvantages of overcooling; cooling systems; air-cooling, water cooling; radiators.

Engine Testing and Performance: Performance parameters: BHP, IHP, mechanical efficiency, brake mean effective pressure and indicative mean effective pressure, torque, volumetric efficiency; specific fuel consumption (BSFC, ISFC), thermal efficiency; heat balance; Basic engine measurements; fuel and air consumption, brake power, indicated power and friction power, heat lost to coolant and exhaust gases; performance curves. Problems.

SECTION-D

Gas Turbines: Brayton cycle; Components of a gas turbine plant; open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; multi stage compression with inter-cooling; multi stage expansion with reheating between stages; exhaust gas heat exchanger, Applications of gas turbines. Problems.

Text Books:

1. Obert E. F, "Internal Combustion Engines and Air Pollution", Harper and Row Publication Inc. NY, 1973.
2. Heisler H, "Advanced Engine Technology", Edward Arnold, 1995.
3. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989
4. Heldt P. M, "High Speed Combustion Engines", Oxford & IBH publishing Co. India, 1985.
5. Stockel M W, Stockel T S and Johanson C, "Auto Fundamentals", The Goodheart, Wilcox Co. Inc., Illinois, 1996.

Course Title/ Code	**OPERATIONS RESEARCH**
Course Type	**CORE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION A

Introduction: Definition, role of operations research in decision-making, applications in industry. Concept on O.R. model building –Types & methods. Linear Programming (LP): Programming definition, formulation, solution- graphical, simplex Gauss-Jordan reduction process in simplex methods, BIG-M methods computational, problems.

SECTION B

Deterministic Model: Transportation model-balanced & unbalanced, north west rule, Vogel's Method, least cost or matrix minimal, Stepperg stone method, MODI methods, degeneracy, assignment, traveling salesman, problems. Advanced Topic Of LP: Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems.

SECTION C

Waiting Line Models: Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications in industries, problems. Project Line Models: Network diagram, event, activity, defects in network, PERT & CPM, float in network, variance and probability of completion time, project cost- direct, indirect, total, optimal project cost by crashing of network, resources leveling in project, problems.

SECTION D

Simulation: Introduction, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, problems. Decision Theory: Decision process, SIMON model types of decision making environment-certainty, risk, uncertainty, decision making with utilities, problems.

Text Books:

1. Operation Research – TAHA, PHI, New Delhi.
2. Principle of Operations Research – Ackoff, Churchaman, arnoff, Oxford IBH, Delhi.

Reference Books:

1. Operation Research- Gupta & Sharma, National Publishers, New Delhi.
2. Quantitative Techniques- Vohra, TMH, New Delhi
3. Principles of operation Research (with Applications to Managerial Decisions) by H.M.Wagher, Prentice Hall of India, New Delhi.
4. Operation Research – Sharma, Gupta, Wiley Eastern, New Delhi.
5. Operation Research – Philips, Revindran, Solgeberg, Wiley ISE.

Course Title/ Code	REFRIGERATION & AIR CONDITIONING
Course Type	CORE
Course Nature	HARD
L-T-P-O Structure	3-1-2-0
Prerequisite	NIL

SECTION-A

Classification of refrigeration systems, advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics - Ozone depletion and global warming issues

SECTION B

System components: Compressors, Condensers, Expansion devices and Evaporators -Performance matching of components of refrigeration systems

SECTION C

Advanced sorption refrigeration systems and their components. Review of Psychometry and Air-conditioning processes - Comfort air conditioning and Cooling load calculations

SECTION-D

Applications of AC systems - Concept of enthalpy potential - Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils.

Text Books:

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.

Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998

Course Title/ Code	**STRENGTH OF MATERIALS-II**
Course Type	**Elective**
Course Nature	**Hard**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION A

Theories of Elastic Failure: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2-dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading, Numerical.

SECTION B

Unsymmetrical Bending: Properties of beam cross section, product of inertia, ellipse of inertia, slope of the neutral axis, stresses & deflections, shear center and the flexural axis Numerical. Thin Walled Vessels: Hoop & Longitudinal stresses & strains in cylindrical & spherical vessels & their derivations under internal pressure, wire would cylinders, Numerical.

SECTION C

Bending of Curved Bars : Stresses in bars of initial large radius of curvature, bars of initial small radius of curvature, stresses in crane hooks, rings of circular & trapezoidal sections, deflection of curved bars & rings, deflection of rings by Castiglione's theorem stresses in simple chain link, deflection of simple chain links, Theories of Failures. Numerical

SECTION D

Thick Cylinders & Spheres: Derivation of Lame's equations, radial & hoop stresses and strains in thick, and compound cylinders and spherical shells subjected to internal fluid pressure only, wire wound cylinders, hub shrunk on solid shaft, Numerical.
Rotating Rims & Discs: Stresses in uniform rotating rings & discs, rotating discs of uniform strength
Stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders, hollow cylinders & solids cylinders

TEXT BOOKS & REFERENCES:

1. Strength of Materials- GH Ryder
2. Vibration and Control- SS Rao.

Course Title/ Code	**TOOL ENGINEERING DESIGN**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION-A

Introduction: Tool design practice, procedure of tool design, process planning and tool design
Mechanics of Machining: Place of machine in production , classification of material removal processes, orthogonal and oblique cutting, merchant's circle diagram-force and velocity relationship, types of cutting tool mechanics, their characteristics and selection criteria, mechanics of metal cutting- effect of tool-geometry and other cutting parameters, mechanisms of formation of chips-types of chips formed, concept of specific cutting pressure , types of tool wear, Factors causing wear, tool life, variables affecting tool life, economical cutting speed, machinability of metals, economics of machining

SECTION-B

Thermal Aspects in Machining: Sources of heat generation in machining and its effects, temperature measurement techniques in machining, types of cutting fluids, Functions of cutting fluid, Characteristics of cutting fluid, Application of cutting fluids.

Design of Single Point Cutting Tools: Tool geometry for single point cutting tool, tool signature , Design of single point cutting tools such as solid tools , tipped tools, coated tipped tools, throw away type tools and diamond tools.

SECTION-C

Design of Multipoint Tools: Design of milling cutters, gear milling cutters, hobs gear shaping tools, broaches, drills, reamers, taps & dies for thread cutting, boring tools, flat form tools, circular form tools. Standard tool holders & standard tooling and their design for turrets and automates.

Cutting Tool Materials: Types of cutting tool materials, their selection and Applications.

SECTION-D

Design of Press Tools: Introduction to press tools and related terminology, effect of clearances, theory of deformation, stages of cutting operation, center of pressure, strap strip layout , die and punch design, design of simple, compound and progressive dies, methods of mounting punches and dies, design of drawing dies, bend allowances, bending and forming dies, Dies for diecasting and forging operations.

Jigs and Fixture: Essential requirements of jigs & fixtures, economics of jigs and fixtures, principles of location and clamping, location and clamping devices, types of drill bushes, types of jigs and fixtures- such as fixtures for milling, welding, heat treatment, grinding, assembly and inspection processes; standardization in jigs and fixtures, principle of work holders, common work holders for production like vises, chucks, arbors, mandrels & collets.

Course Title/ Code	**PRODUCT DESIGN & DEVELOPMENT**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION-A

Introduction to course, Product life-cycle, Product policy of an organization. Selection of a profitable product, Product design process, Product analysis, Value engineering in product design; Advantages, Applications in product design, Problem identification and selection, Analysis of functions, Anatomy of function.

SECTION-B

Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST), Case studies, Introduction to product design tools, QFD, Computer Aided Design, Robust design, DFX, DFM, DFA, Ergonomics in product design.

SECTION-C

DFMA guidelines, Product design for manual assembly, Design guidelines for metallic and non-metallic products to be manufactured by different processes such as casting, machining, injection molding etc.

SECTION-D

Rapid prototyping, needs, advantages, working principle of SLA, LOM and SLS.

Course Title/ Code	**FUNDAMENTALS OF NANOSCIENCE & NANOTECHNOLOGY**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION A

Introduction to Nanoscience and Nanotechnology - Characteristic length scales. Definition of nanotechnology. Concepts of nanomaterials and nanostructures. Low-dimensional systems. Quantum effect. Physical properties of nanocrystalline solids. Concepts of micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems (NEMS). Perspective of nanotechnology.

SECTION B

Fundamentals of Nanoscience - Crystal structures. Nanocrystals. Molecules and bio-systems. Top-down and bottom-up nano-fabrications. Principles of electron microscopy. Principles of scanning probe microscopy. Principles of lithography technology. Mechanical behaviours of nanocrystalline metals, alloys and carbon nanotubes. Electro-magneto-mechanical coupling in nano-scales. Nano-fluidic flows.

SECTION C

Nanotechnology in Mechanical Engineering - Elasticity and plastic deformation of nanostructures. Processing and manufacturing of nanomaterials and nanostructures. Devices constructed with nanometer-scale and micrometer-scale systems. Nano-scale resonators. Nanosensors and actuators. Industrial applications of nanocrystalline solids and nanodevices.

SECTION D

Current Progresses in Nanoscience and Nanotechnology - Nano-biotechnology. Nanotechnology in energy and environmental engineering. Functional nanomaterials. Nanoelectronics.

List of Experiment:

1. Preparation of nanocrystalline metals
2. Mechanical properties of nanocrystalline metals

TEXT BOOKS & REFERENCES:

1. Gabor L. Hornyak, H. F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to nanoscience and nanotechnology, CRC Press, latest edition.
2. Carl C. Koch, Edited, Nanostructured materials: processing, properties, and applications, William Andrew Publishing, latest edition.
3. W.A. Goddard, D.W. Brenner, S.E. Lyshevski, and G.J. Iafrate, Edited, Handbook of Nanoscience, Engineering and Technology, CRC Press, latest edition.

Course Title/ Code	**MECHANICAL VIBRATIONS**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION A

Vibration: Scope of vibration, important terminology and classification, Degrees of freedom one dimensional longitudinal, transverse and torsional vibrations with and without damping using Newton's second law, D' Alembert's principle and Principle of conservation of energy.

Free and Damped Force Vibration Damped vibrations of single degree of freedom systems. Viscous damping; under damped, critically damped and over damped systems, Logarithmic decrement. Vibration characteristics of Coulomb damped and Hysteretic damped systems.

SECTION B

Undamped Force Vibration**:** System with two degrees of freedom; principle mode of vibration. Undamped forced vibrations of two degrees of freedom system with harmonic excitation. Vibration Absorber; Undamped dynamic vibration absorber and centrifugal pendulum absorber.
Forced Vibration**:** Forced vibrations of single degree of freedom systems. Forced vibration with constant harmonic excitation. Frequency response curves and phase angle plot. Forced vibration due to excitation of support. Vibration Isolation and transmissibility; Force transmissibility, Motion transmissibility. Forced vibration with rotating and reciprocating unbalance. Materials used in vibration isolation.

SECTION C

Two Degrees of Freedom Systems **:** Introduction to Multi-Degree of Freedom Systems, Normal Mode Vibrations, Coordinate Coupling, Principal Coordinates, Free Vibrations in Terms of Initial Conditions, Forced Harmonic Vibrations, Vibration Absorber, Centrifugal Vibration Absorber, Vibration Damper.
Multi degrees of Freedom Systems and Numerical Methods Introduction**:** Influence Coefficients, Stiffness Matrix, Flexibility Matrix, Natural Frequencies and Normal Modes, Orthogonality of Normal Modes, Many degrees of freedom systems: approximate methods; Rayleigh's, Dunkerley's, Stodola's and Holzer's methods. Geared and Branched Systems, Beams, computer programs for solutions.

SECTION D

Normal Mode Vibration of Continuous System (Closed form solutions): Vibrating String, Longitudinal and Torsional Vibrations of Rod, Transverse vibration of beams: equations of motion and boundary conditions, Transverse vibration of beams: natural frequencies and mode shapes
Normal Mode Vibration of Continuous System (Approximate solutions): Rayleigh's energy method, Rayleigh-Ritz method, Assumed modes and Galerkin's method.

TEXT BOOKS & REFERENCES:

1. Mechanical Vibration : G.K. Grover and S.P. Nigam, Nem Chand and Sons
2. Mechanical Vibration: V.P.Singh, Dhanpat Rai Publishers

Course Title/ Code	**COMPOSITE MATERIALS**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**

Prerequisite	**NIL**

SECTION-A

Definition and applications of composite materials, Fibers- glass, carbon, ceramic and aramid fibers; Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices. Lamina- assumptions, macroscopic viewpoint, generalized Hooke;s law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.

SECTION-B

Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes

SECTION-C

Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, TsaiHill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates

SECTION-D

Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies

Text Books:

1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
2. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998.

3. **Course Title/ Code**	**AUTOMOBILE ENGINEERING**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

Section A

Introduction to Automobiles : Classification, Components, Requirements of Automobile Body; Vehicle Frame, Separate Body & Frame, Unitised Body, Car Body Styles, Bus Body & Commercial Vehicle Body Types; Front Engine Rear Drive & Front Engine Front Drive Vehicles, Four Wheel Drive Vehicles, Safety considerations; Safety features of latest vehicle; Future trends in automobiles. Clutches : Requirement of Clutches – Principle of Friction Clutch – Wet Type & Dry Types; Cone Clutch, Single Plate Clutch, Diaphragm Spring Clutch, Multi plate Clutch, Centrifugal Clutches, Electromagnetic Clutch, Over Running Clutch; Clutch Linkages.

Section B

Power Transmission: Requirements of transmission system; General Arrangement of Power Transmission system; Object of the Gear Box; Different types of Gear Boxes; Sliding Mesh, Constant Mesh, Synchro- mesh Gear Boxes; Epi-cyclic Gear Box, Freewheel Unit. Overdrive unit- Principle of Overdrive, Advantage of Overdrive, Transaxle, Transfer cases. Drive Lines, Universal Joint, Differential and Drive Axles: Effect of driving thrust and torque reactions; Hotchkiss Drive, Torque Tube Drive and radius Rods; Propeller Shaft, Universal Joints, Slip Joint; Constant Velocity Universal Joints; Front Wheel Drive; Principle, Function, Construction & Operation of Differential; Rear Axles, Types of load coming on Rear Axles, Full Floating, Three quarter Floating and Semi Floating Rear Axles.

Section C

Suspension Systems: Need of Suspension System, Types of Suspension; factors influencing ride comfort, Suspension Spring; Constructional details and characteristics of leaf springs. Steering System : Front Wheel geometry & Wheel alignment viz. Caster, Camber, King pin Inclination, Toein/Toe-out; Conditions for true rolling motions of Wheels during steering; Different types of Steering Gear Boxes; Steering linkages and layout; Power steering – Rack & Pinion Power Steering Gear, Electronics steering.

Section D

Automotive Brakes, Tyres & Wheels : Classification of Brakes; Principle and constructional details of Drum Brakes, Disc Brakes; Brake actuating systems; Mechanical, Hydraulic, Pneumatic Brakes; Factors affecting Brake performance, Power & Power Assisted Brakes; Tyres of Wheels; Types of Tyre & their constructional details, Wheel Balancing, Tyre Rotation; Types of Tyre wear & their causes. Emission Control System & Automotive Electrical : Sources of Atmospheric Pollution from the automobile, Emission Control Systems – Construction and Operation of Positive Crank Case Ventilation (PVC) Systems, Evaporative Emission Control, Heated Air Intake System, Exhaust Gas Recirculation (ECR) Systems, Air Injection System and Catalytic Converters; Purpose construction & operation of lead acid Battery, Capacity Rating & Maintenance of Batteries; Purpose and Operation of Charging Systems, Purpose and Operations of the Starting System; Vehicle Lighting System.

Text Books:

1. Automobile Engineering by Anil Chhikara, Satya Prakashan, New Delhi.
2. Automobile Engineering by Dr. Kirpal Singh, standard Publishers Distributors.

Reference Books:

1. Automotive Mechanics – Crouse / Anglin, TMH.
2. Automotive Technology – H.M. Sethi, TMH, New Delhi.
3. Automotive Mechanics – S.Srinivasan, TMH, New Delhi.
4. Automotive Mechanics – Joseph Heitner, EWP.

5. Motor Automotive Technology by Anthony E. Schwaller – Delmer Publishers, Inc.
6. The Motor Vehicle – Newton steeds Garrett, Butter Worths. ME- 304 F MECHANICAL MACHI

LIST OF EXPERIMENTS:

1. To study and prepare report on the constructional details, working principles and operation of the following Automotive Engine Systems & Sub Systems. (a) Multi-cylinder: Diesel and Petrol Engines. (b) Engine cooling & lubricating Systems. (c) Engine starting Systems. (d) Contact Point & Electronic Ignition Systems.
2. To study and prepare report on the constructional details, working principles and operation of the following Fuels supply systems: (a) Carburetors (b) Diesel Fuel Injection Systems (c) Gasoline Fuel Injection Systems.
3. To study and prepare report on the constructional details, working principles and operation of the following Automotive Clutches. (a) Coil-Spring Clutch (b) Diaphragm – Spring Clutch. (c) Double Disk Clutch.
4. To study and prepare report on the constructional details, working principles and operation of the following Automotive Transmission systems. (a) Synchromesh – Four speed Range. (b) Transaxle with Dual Speed Range. (c) Four Wheel Drive and Transfer Case. (d) Steering Column and Floor – Shift levers.
5. To study and prepare report on the constructional details, working principles and operation of the following Automotive Drive Lines & Differentials. (a) Rear Wheel Drive Line. (b) Front Wheel Drive Line. (c) Differentials, Drive Axles and Four Wheel Drive Line.
6. To study and prepare report on the constructional details, working principles and operation of the following Automotive Suspension Systems. (a) Front Suspension System. (b) Rear Suspension System.
7. To study and prepare report on the constructional details, working principles and operation of the following Automotive Steering Systems. (a) Manual Steering Systems, e.g. Pitman –arm steering, Rack & Pinion steering. (b) Power steering Systems, e.g. Rack and Pinion Power Steering System. (c) Steering Wheels and Columns e.g. Tilt & Telescopic steering Wheels, Collapsible Steering Columns.
8. To study and prepare report on the constructional details, working principles and operation of the following Automotive Tyres & wheels. (a) Various Types of Bias & Radial Tyres. (b) Various Types of wheels. 9. To study and prepare report on the constructional details, working principles and operation of the Automotive Brake systems. (a) Hydraulic & Pneumatic Brake systems. (b) Drum Brake System. (c) Disk Brake System. (d) Antilock Brake System. (e) System Packing & Other Brakes.
10. To study and prepare report on the constructional details, working principles and operation of Automotive Emission / Pollution control systems.
11. Modeling of any two automotive systems on 3D CAD using educational softwares (eg. 3D modeling package/Pro Engineering/I-Deas/ Solid edge etc.)

Course Title/ Code	**Information Retrieval(CSH412B) T & P**

Course Type	**Elective**
Course Nature	Hard
L-T-P-O Structure	(3-0-2-0)
Objectives	Student will be able to Model, Represent and Retrieve the information from web.

Section-A

Knowledge representation - Basics of Prepositional logic- Predicate logic-reasoning using first order logic-unification-forward chaining-backward chaining-resolution- -Production rules-frames-semantic networks- scripts.
Information retrieval problem, an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval, an inverted index, Bi-word indexes, Positional indexes, Combination schemes

Section-B

Information Retrieval Modeling - Information retrieval – taxonomy-formal characterization classic information retrieval-set theoretic model-algebraic model-probabilistic model structured text retrieval models-models for browsing-.retrieval performance evaluation keyword based querying-pattern matching-structural queries-Query operations.

Section-C

Index construction : Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Other types of indexes **Index compression:** Statistical properties of terms in information retrieval, Heaps' law: Estimating the number of terms, Zipf's law: Modeling the distribution of terms, Dictionary compression, Dictionary as a string, Blocked storage, Postings file compression.

Ontology Development - Description logic-taxonomies-Topic maps-Ontology-Definition expressing ontology logically-ontology representations-XML-RDF-RDFS-OWL-OIL ontology development for specific domain-ontology engineering-Semantic web services

Parallel and distributed IR- multimedia IR- data modeling-query languages-.Web Searching Basics-Characterizing the Web-Search Engines-Web crawling and in dexex-link analysis

Section-D

Language models, Finite automata and language models, Types of language models, Multinomial distributions over words, The query likelihood model, Using query likelihood language models in IR, Estimating the query generation probability, Language modelling versus other approaches in IR, Naïve bayes-vector space classification-support vector machines and machine learning on documents-flat clustering hirarchical clustering

List of Experiments:

1. Rapid Miner tool will be explorer in the lab.

Text Books:

1. Elain Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill, 3rd Edition, 2003.

Reference Books:

1. Stuart Russell-Peter Norvig, “Artificial Intelligence – A modern Approach”, Pearson Education, 2nd Edition, 2003. (Unit I)

2. Michael c.Daconta,leo J. Obart and Kevin J Smith,”Semantic Web – A guide to the future of XML,Web Services and Knowledge Management”,Wiley Publishers 2003.

Christopher D. Manning,PrabhakarRaghavan and HinrichSchutze, “Introduction to Information Retrieval”, Cambridge University press, 2008.

Course Title/ Code	ELECTRIC & HYBRID VEHICLES
Course Type	CORE
Course Nature	HARD
L-T-P-O Structure	3-0-2-0
Prerequisite	NIL

SECTION-A

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Hybrid Electric Drive-trains: Basic concept of hybrid traction,

SECTION-B

Introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles,

SECTION-C

Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system:

SECTION-D

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

SEMESTER-7

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/ NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	O	No. of Contact Hours per week	Credits
MEH401/MEH402/MEH403/MEH404 B-T/P	**RENEWABLE E ENERGY SOURCES/MACHINE DESIGN-II/POWER PLANT ENGINEERING/LEAN MANUFACTURING**	ME	HARD	ELECTIVE	4	0	0	0	4	4
MEH405/MEH406/MEH409/MEH408 B-T/P	**COMPUTATIONAL FLUID DYNAMICS/OPTIMIZATION TECHNIQUES/HEATING, VENTILATION & AIR CONDITIONING/ENERGY**	ME	HARD	ELECTIVE	3	0	2	0	5	4

	CONSERVATION & MANAGEMENT									
CHS234/CSS 325/ECS306 B-T/P	**ENVIRONMENTAL ETHICS & SUSTAINABLE DEVELOPMENT/GREEN COMPUTING/E-WASTE MANAGEMENT**	CH/CS/EC E	SOFT	ELECTIVE	1	0	2	0	3	2
ECH204/CS H317B-T/P	**ELECTRONIC DESIGN WORKSHOP/AGILE TECHNOLOGY**	ME	ALLIED	ELECTIVE	0	0	2	0	2	1
ECW310/CS W318B	**SENSOR & IoT/R PROGRAMMING**	ME	HARD	ELECTIVE	0	0	2	0	2	1
MCH321B	**FINANCIAL & HUMAN RESOURCE MANAGEMENT**	MGMT	SOFT	CORE	3	0	0	0	3	3
MCS368B	**ENTREPRENEURSHIP**	ME	SOFT	CORE	2	0	0	0	2	2
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**13**	**0**	**8**	**0**	**21**	**17**

Course Title/ Code	**RENEWABLE ENERGY SOURCES**
Course Type	**CORE**
Course Nature	**HARD**
L-T-P-O Structure	**4-0-0-0**
Prerequisite	**NIL**

SECTION A

Introduction to Energy Sources: Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources.

Solar Energy : Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers,

storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaics - solar cells & its applications.

SECTION B

Wind Energy : Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

Energy from Biomass: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.

SECTION-C

Geothermal Energy: Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India

Energy from the ocean: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

SECTION-D

Magneto Hydro Dynamic (MHD) Power Generation: Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects. 8. Fuel Cells: Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells.

Hydrogen Energy: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles. Energy Management: Energy economics, energy conservation, energy audit, general concept of total energy system, scope of alternative energy system in India. Term work is based on above mentioned syllabus

Reference Books:

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers
2. Solar Energy: Fundamentals and Applications by H.P. Garg & Jai Prakash, Tata McGraw Hill
3. Solar Energy: Principles of Thermal Collection and Storage by S,P Sukhatme, Tata McGraw Hill
4. Alternative Energy Sources by B.L. Singhal Tech Max Publication
5. Non Conventional Energy Resources by S.Hasan Saeed and D.K.Sharma
6. Fuel Cells by Bockris and Srinivasan; McGraw Hill
7. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison
8. Solar Engineering of Thermal Processes by Duffic and Beckman, John Wiley

Course Title/ Code	MACHINE DESIGN-II
Course Type	ELECTIVE
Course Nature	HARD
L-T-P-O Structure	4-0-0-0
Prerequisite	NIL

SECTION A

Introduction: Problems in Engineering Design, Division of Design Project, testing models, patents and agreements.
Modeling of concurrent engineering design, real time constraints checking in design process, life design cycle.
Introduction to creep, Mechanisms of Creep Deformation, Deformation Mechanism Maps Creep Fracture, Material Design Against Creep.

SECTION B

Bearings & Lubrication: Types and laws of friction, Types of Lubrication Hydrodynamic and Hydrostatic bearings, Ball and Roller bearings, Method of load estimation and Selection of bearings. Concept of Air bearing

SECTION C

Springs: Design of helical springs subjected to static and dynamic loads, design of torsion and leaf springs, elementary idea of rubber springs.
Pressure vessel classification, Design of thick, thin & compound cylindrical shell, and design of head covers.

SECTION D

Power Transmission with Toothed Gears: Selection of Gears and Gear Materials, Tooth Forces, Design of Spur Gear, Design of Helical, Bevel and Worm Gears.

TEXT BOOKS & REFERENCES:

1. Sharma & Aggarwal; Machine Design, Kataria Publications.

2. V. B Bhandari: Design of Machine Elements, McGraw Hill

Course Title/ Code	POWER PLANT ENGINEERING
Course Type	ELECTIVE
Course Nature	HARD
L-T-P-O Structure	4-0-0-0

Prerequisite	NIL

SECTION-A

Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants. Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.

SECTION-B

Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator. Combined Cycles: Constant pressure gas turbine power plants, Arrangements of combined plants steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermodynamic efficiency of combined cycles. Problems.

SECTION-C

Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal. Power Plant Economics: load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input output curves, efficiency, heat rate, economic load sharing, Problems.

SECTION-D

Non-Conventional Power Generation: Solar radiation estimation, solar energy collectors, low, medium & high temperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants. Direct Energy Conversion Systems: Fuel cell, MHD power generation-principle, open & closed cycles systems, thermoelectric power generation, thermionic power generation.

Text Books:

1. Power station Engineering and Economy by Bernhardt G.A. skrotzki and William A. Vopat – Tata Mc Graw Hill Publishing Campany Ltd., New Delhi

2. Power Plant Engineering: P.K. Nag Tata McGraw Hill second Edition 2001.

Reference Books:

1. Power Plant Engg. : M.M. El-Wakil McGraw Hill 1985.

Course Title / Code	LEAN MANUFACTURING
Course Type	Elective

Course Nature	**Hard**
L-T-P-O Structure	**(4-0-0-0)**
Prerequisite	**NIL**

SECTION A

Introduction to Lean Manufacturing: Objectives of Lean Manufacturing, Key Principles And Implications Of Lean Manufacturing, Traditional Vs Lean Manufacturing.

Lean Manufacturing Concepts: Value creation and waste elimination, Main kinds of waste, Pull Production, Different models of Pull Production, Continuous flow, Continuous improvement (Kaizen), Worker involvement, Cellular layout, Administrative lean.

SECTION B

Lean Manufacturing Tools And Methodologies: Standard work, Communication of standard work to employees, Standard work and flexibility, Visual controls, Quality at the source, 5S principles.

Preventive maintenance, Total quality management, Total productive maintenance, Changeover/setup time, Batch size reduction, Production leveling.

Value Stream Mapping: The current state diagram, the future state map, Application to the factory simulation scenario, Line Balancing, Poka-Yoke, Kanban, Overall equipment effectiveness.

SECTION C

Just In Time Manufacturing: Introduction, Elements of JIT, Uniform production rate, Pull versus push method, Kanban system, Small lot size, Quick & Inexpensive set-up, Continuous improvement, Optimized production technology.

One-Piece Flow: Process Razing Techniques, Cells for assembly line, Case studies

SECTION D

Implementing Lean: Roadmap, Senior Management Involvement, Best practices.

Reconciling Lean with Other Systems: Toyota production system, Lean & Six Sigma, Lean and ERP, Lean with ISO9001:2000.

TEXT BOOKS & REFERENCES

1. Lean Manufacturing by By Aza Badurdeen

Course Title/ Code	COMPUTATIONAL FLUID DYNAMICS
Course Type	ELECTIVE
Course Nature	HARD
L-T-P-O Structure	3-0-2-0
Prerequisite	NIL

SECTION-A

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS - Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD – Elliptic, Parabolic and Hyperbolic equations.

SECTION-B

FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION
Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

SECTION-C

FINITE VOLUME METHOD FOR CONVECTION DIFFUSION
Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

FLOW FIELD ANALYSIS:
Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

SECTION-D

TURBULENCE MODELS AND MESH GENERATION

Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

Course Title/ Code	**OPTIMIZATION TECHNIQUES**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION A

Engineering Economy and Costing**:** Elementary cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements.

Facility Design**:** Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; assembly line balancing; materials handling systems.

Production Planning and Inventory Control**:** Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; concept of JIT manufacturing system;

SECTION B

Inventory: functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems.

Linear programming: problem formulation, simplex method, duality and sensitivity analysis;

SECTION C

Transportation and assignment models; network flow models, simple queuing models; dynamic programming; simulation – manufacturing applications; PERT and CPM, time-cost trade-off, resource leveling.

SECTION D

Quality Management**:** Quality – concept and costs, quality circles, quality assurance; statistical quality control, acceptance sampling, zero defects, six sigma; total quality management; ISO 9000; design of experiments – Taguchi method.
Management Information System**:** Value of information; information storage and retrieval system database and data structures; knowledge based systems.

TEXT BOOK & REFERENCES:

1. Production Systems: Planning, Analysis and Control by J.L. Riggs
2. Production, Planning and Inventory Control by S. Narasimhan, D. W. McLeavey, and P. J. Billington
3. Operation Research by D.S.Heera, S. Chand Publication

LIST OF EXPERIMENTS:

1. To prepare a case study for producing a product on shop floor covering areas of PPC, design, Methods Engineering, Operations and Quality Control.
2. To prepare a project report for calculating the total cost (direct and indirect cost) of a product being developed for manufacturing.
3, To prepare a flow chart identifying main steps to be followed by methods engineering in manufacturing a product.
4. To prepare a bar chart for producing a generator/turbine identifying the main sub assemblies along with their completion schedule.
5. To prepare a document for quality policy, quality systems and procedures required to be followed in the manufacture of a turbine/generator.

Course Title/ Code	**ENERGY CONSERVATION & MANAGEMENT**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION-A

Energy conservation: Principles of energy conservation, Energy Conservation Act 2001 and its features, Electricity Act-2003 & its features, Energy consumption pattern, Resource availability, Energy pricing, Energy Security, Estimation of energy use in a building. Heat gain and thermal performance of building envelope -Steady and non-steady heat transfer through the glazed window and the wall -Standards for thermal performance of building envelope, Evaluation of the overall thermal transfer

SECTION-B

Energy efficiency in thermal & electrical utilities: Energy efficiency in boilers, furnaces, steam systems, cogeneration utilities, waste heat recovery, compressed air systems, HVAC&R systems, fans and blowers, pumps, cooling tower Energy efficiency for electric motors, lighting systems, Characteristics of Light, Types of Lighting, Incandescent Lighting, Fluorescent Lighting, Vapor Lighting, Street Lighting, LED Lighting, Lighting Design, Light Dimming, Tips for Energy Conservation, Products for Energy Conservation in lighting system

SECTION-C

Energy Audit: Definition, objective and principles of Energy Management, Need of Energy Audit and Management, types of energy audit, audit process, Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations and energy audit report, energy audit of building system, lighting system, HVAC system, Water heating system, heat recovery opportunities during energy audit, Industrial audit opportunities, Instruments for Audit and Monitoring Energy and Energy Savings

SECTION-D

Energy Economics: Simple Payback Period, Time Value of Money, Internal Rate of Return, Net Present Value, Life Cycle Costing, Equivalent uniform annual cost (EUAC), Life cycle cost, Discounting factor, Capital recovery, Depreciation, taxes and tax credit, Impact of fuel inflation on life cycle cost, Cost of saved energy, cost of energy generated, Energy performance contracts and role of Energy Service Companies (ESCOs).
Climate Policy: Kyoto protocol, Clean development mechanism (CDM), Geopolitics of GHG control; Carbon Market.

Course Title/ Code	**HEATING, VENTILATION & AIR-CONDITIONING**
Course Type	**OPEN ELECTIVE**
Course Nature	**Hard**
L-T-P-O Structure	**3-0-2-0**
Prerequisite	**NIL**

SECTION A

Introduction: Purpose, applications, definition and components of air conditioning - Need and methods of ventilation - Course outline. Psychometric: Evolution of air properties and psychometric chart - Basic processes such as sensible heating/cooling, humidification/dehumidification and their combinations, steam and adiabatic humidification, adiabatic mixing, etc. - Bypass factor and Sensible heat ratio. Method of heat load calculation.Summer and Winter AC: Simple summer AC process, Room sensible heat factor, Coil sensible heat factor, ADP - Precision AC - Winter AC.

SECTION B

Human Comfort: Heat transfer from body, convection, radiation, conduction, evaporation, clothing resistance, activity level - Concept of human comfort - Thermal response - comfort factors - Environmental indices - Indoor air quality.AC Equipment - Filters, types, efficiency - Fans basic equations, parallel and series configurations - Air washer, adiabatic, heated and cooled - Cooling tower, enthalpy potential, types, tower efficiency, NTU and characteristics, sizing and off design performance - Cooling and dehumidifying coil, dry and wet, sizing, performance.

Sound Control- Definitions of various terms like level, pitch, attenuation, frequency, sources of noise in air conditioning plants, design procedure for noise prevention, noise and vibration study and elimination techniques

SECTION C

Heat Transfer - Heat transfer in wall and roof, sol-air temperature, insulation, cooling load temperature difference - Fenestration, types of glass, sun shade, shading coefficient, maximum radiation, cooling load factor. Direct and Indirect Evaporative Cooling: Basic psychometric of evaporative cooling, types of evaporative coolers, design calculations, indirect evaporative cooling for tropical countries. Cooling Load Estimation: Design conditions, outdoor, indoor - External load, wall, roof, glass - Internal load, occupancy, lighting, equipment - Ventilation, air quantity, loads - Load estimation methods

SECTION D

Heating load estimation: Vapour transfer in wall, vapour barrier, load estimation basics Air Distribution - Ducts, types, fittings, air flow, friction chart, methods of sizing, balancing. Air Diffusion - Isothermal jet, throw, drop, types of outlets, ADPI, outlet/inlet selection. Basics of Ventilation- Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow round buildings. Methods of Ventilation - Natural, wind effect, stack effect, combined effect - Mechanical, forced, exhaust, combined - Displacement ventilation, Industrial Ventilation - Steel plants, car parks, plant rooms, mines, etc

Ventilation System Design - Exhaust ducts, filters, blowers, hoods, chimney, etc

TEXT BOOKS & REFERENCES:

1. Arora, C.P., Refrigeration and Air Conditioning, Tata-McGraw- Hill, New Delhi, 2003.

2.Hainer R. W., Control System for Heating, Ventilation and Air conditioning, Van Nastrand Reinhold Co., New York, 1984.

LIST OF EXPERIMENTS:

1. To use the Psychometrics chart and human comfort chart and calculation of air velocity/distribution to best conditions.
2. To do the energy audit of building and heat load calculations of non-insulated and insulated building.
3. To explain the chilling plant and its working cycle.
4. To calculate the performance factor of split A.C and commercial air conditioning units
5. To design of duct system for a load calculated building.
6. To calculate noise and study the elimination techniques in air conditioning system.
7. To explain different types of cooling system in air conditioning system.
8. To explain different insulating materials in buildings.

Course Title/ Code	**ENVIRONMENTAL ETHICS & SUSTAINABLE MANAGEMENT**
Course Type	**CORE**
Course Nature	**SOFT**
L-T-P-O Structure	**1-0-2-0**
Prerequisite	**NIL**

SECTION A

Introduction to Sustainable Development**:** Definition of Sustainable Development; Triple Bottom Line, Components of TBL, Changing Perspective & Debates in Sustainable Development - Need for Sustainable Development, Evolution of the concept of Sustainable Development: Stockholm Conference, The Brundtland Commission, Earth Summit, Agenda 21; Millennium Development Goals

SECTION B

Challenges to Sustainable Development and Sustainable Development Goals (SDGs): Challenges to Sustainable Development - Agriculture, Population & Food Security, Public Health and Nutrition, Education, Natural Resources (Forests, Energy, Water), Climate Change Sustainable Development Goals (SDGs) - Introduction, Challenges to SDGs, Indian Scenario.

SECTION C

Sustainability Strategies & Reporting: Sustainability Strategies & Reporting - Introduction, Rationale and Mechanisms, Key Principles, Sustainability Strategies Adopted by Different Enterprises – Case Studies

SECTION D

Sustainable Development and Contemporary Issues: Sustainable Consumption, Indigenous Knowledge, Gender Issues, Population & Sustainable Agriculture, Sustainable Tourism.

TEXT BOOKS & REFERENCES:

1. Environmental Management for Sustainable Development; C.J. Barrow; Routledge Publishers
Roberts, J.T., and Hite, A., 2000.
2. Modernization to Globalization - Perspectives on Development and Social Change, Blackwell Publishing.
3. Sachs, J., 2004, Stages of Development, Speech at the Chinese Academy of Arts and Sciences

LIST OF EXPERIMENTS:

1. Survey- Business and non-business students' perception towards TBL (based on the readings listed above); inferences on the basis of survey; http://www.aabri.com/manuscripts/121249.pdf 2.Workshop based - Sustainable agriculture- Mushroom farm
2. Workshop based - Back to nature - DIY composting bin
3. Review - Sustainable Consumption in India: Challenges and Opportunities; Divesh Kumar,Praveen Goyal, Zillur Rahman, Ishwar Kumar; IJMBs Vol. 1, Issue 3, September 2011; http; ://www.ijmbs.com/13/devesh.pdf
4. Calculate Carbon Footprint/Ecological footprint
5. Stimulus Activity (Piece of writing) - Sustainable Consumption
6. CSR - Workshop for Village school children
7. Simulation Activity - Challenges to Sustainable Development
8. Case Studies - Sustainability initiatives @ TATA Motors, CAIRN INDIA, Mahindra & Mahindra, Subaru Isuzu, Disney, Novo Nordisk, etc.

Course Title/ Code	**E-WASTE MANAGEMENT**
Course Type	**CORE**
Course Nature	**SOFT**
L-T-P-O Structure	**1-0-2-0**
Prerequisite	**NIL**

SECTION A

Introduction: E-Waste, Indian and global scenario of e-Waste, Growth of Electrical and Electronics industry in India, E-waste generation in India, Composition of e-waste, Possible hazardous substances present in e-waste, Environmental and Health implications.

SECTION B

E-Waste Legislation: Regulatory regime for e-waste in India, The hazardous waste (Management and Handling) rules 2003, E- waste management rules 2015, Regulatory compliance including roles and responsibility of different stakeholders – producer, manufacturer, consumer etc., Proposed reduction in the use of hazardous substances (RoHS) & REACH, Extended producer responsibility (EPR).

SECTION C

End Of Life Management Of E-Waste: Historic methods of waste disposal – dumping, burning, landfill; Recycling and recovery technologies – sorting, crushing, separation; Life cycle assessment of a product – introduction; Case study – optimal planning for electronic waste.

SECTION D

Environmentally Sound E-Waste Management: Emerging recycling and recovery technologies, Guidelines for environmentally sound management of e-waste, Environmentally sound treatment technology for e-waste, Guidelines for establishment of integrated e-waste recycling and treatment facility, Case studies and unique initiatives from around the world.

REFERENCE BOOKS:

1. Electronic Waste Management, R E Hester, R M Harrison, RSC publishing.
2. E Waste: Implications, Regulations and Management in India and current global practices, Rakesh Johri, TERI PRESS.

LAB EXPERIMENTS:

1. Identify the hazardous materials present in printed circuit boards.
2. Extraction of copper of printed circuit boards in etching solution.
3. Demo of recycling process through videos.
4. Extraction of precious metal from e Waste.
5. Invited guest lecture.
6. Field visit to a waste management initiative in NCR.
7. Activity based learning: survey of the household practice of e-waste disposal and awareness.
8. Case study – presentation and group discussion.

Course Title/ Code	**Green Computing**
Course Type:	**Elective**
Course Nature:	**Soft**
L-T-P-O	**(1-0-2-0)**

Structure	

Section A

Overview and Issues: Problems: Toxins, Power Consumption, Equipment Disposal; Company's Carbon Footprint: Measuring; Plan for the Future; Cost Savings: Hardware, Power.

Initiatives and Standards: Global Initiatives: United Nations, Basel Action Network, Basel Convention; WEEE Directive, Restriction on Hazardous Substances Directive, the Paris Climate Agreement.

Section B

Minimizing Power Usage: Power Problems, Monitoring Power Usage, Servers, Low-Cost Options, Reducing Power Use, Data De-Duplication, Virtualization, Management, Low Power Computers, PCs, Linux, Components, Servers, Computer Settings, Storage, Monitors, Power Supplies, Wireless Devices, Software.

Green Data Centers: The benefits of a green data center, Developing a strategy, Energy optimization with IT equipment.

Section C

Changing the Way of Work: Old Behaviours, starting at the Top, Process Reengineering with Green in Mind, Analysing the Global Impact of Local Actions, Recycling, Energy, Pollutants, Teleworkers, Telecommuting, Outsourcing, how to Outsource.

Recycling: Problems: China, Africa; Materials, Means of Disposal, Recycling, Refurbishing, Recycling Life Cycle, Life of a Product, Cost, Green Design, Recycling Companies, Certifications, Hard Drive Recycling, Consequences, cleaning a Hard Drive, Pros and cons of each method, CDs and DVDs, good and bad about CDs and DVDs disposal, Change the mind-set.

Section D

Greening Your Information Systems: Initial Improvement Calculations, Change Business Processes, Customer Interaction, Paper Reduction, Green Supply Chain, Improve Technology Infrastructure, Reduce PCs and Servers, Shared Services, Hardware Costs, Cooling.

Text books:

- Green IT, Toby Velte, Anthony Velte, Robert Elsenpeter, McGraw Hill, 2008.
- Green Data Center: Steps for the Journey Alvin Galea, Michael Schaefer, Mike Ebbers, Shroff Publishers and Distributers, 2011.

Reference Books:

- Green Computing and Green IT Best Practice, Jason Harris, Emereo.

Course Title/ Code	ERGONOMICS
Course Type	CORE
Course Nature	HARD
L-T-P-O Structure	1-0-2-0
Prerequisite	NIL

SECTION-A

Work Study: Historical background; Definition, objectives and areas of application of work study in industries; Role of work study in improving productivity; Ergonomics and work study.

Work Study Procedure: Selection of jobs; Information, collection and recording; Recording techniques-charts and diagrams; Critical analysis; Developing better method; Installation and follow up of standard method, Economic analysis, Profit and competitiveness, 3 S's, Break Even Analysis, Economics of a new design, Production aspects.

Method Study and Motion Study: Introduction to Method Study, Data collection, recording, examining, and improving work, Material flow and material handling study, Charts to record movements in shop operation – process charts, flow diagram, flow process charts, travel chart and multiple activity charts (With simple problems).

SECTION-B

Work Measurement: Introduction & definition, Objectives and basic procedure of work measurement; Benefits and Application of work measurement in industries.

Work Measurement Techniques: Work sampling, need, confidence levels, sample size determinations, random observation, and conducting study with the simple problems.

Stop Watch Time Study: Time study: Basic procedure, Equipment needed, Methods of measuring time, Selection of jobs, Breaking a job into elements; Numbers of cycles to be timed; Rating and methods of rating, Allowances, Concept of normal time, Calculation of standard time. Work sampling: Basic procedure, Design of work sampling, Study conducting work sampling study and establishment of standard-time.

Memo motion and Micro motion study: Charts to record movements at work place – principles of motion economy, Therbligs and classification of movements, Two Handed process chart, SIMO chart, Cycle graph and Chrono cycle graph, and micro motion study. Development, definition and

installation of the improved method, brief concept about synthetic motion studies. Design of work place layout. Pre-determined Motion Time System Method Time Measurement (MTM)

SECTION-C

Quality: Introduction and definitions of quality, Evolution of Quality: Inspection, Quality Control, And Customer-Orientation: Internal & External Customer Concept, Life cycle approach to quality costs- Prevention; Appraisal and Failure costs. Seven QC tools (Histogram, Check sheets, Ishikawa diagrams, Pareto, Scatter diagrams, Control charts). Process capability concepts.

Reliability: Introduction, Definitions, Reliability evaluation, Maintainability and Availability concepts.

Capacity Planning: Introduction, measures of capacity, capacity strategies, A systematic approach for capacity decisions, Capacity planning and control (Long range, Medium range, and Short range)

SECTION-D

CPM/PERT: Introduction, Project scheduling with CPM, Project scheduling with PERT.

Loading and Scheduling: General scheduling problem, Significance of loading and scheduling, Factors affecting scheduling, Scheduling system, Flow shop scheduling, Job shop scheduling, Sequencing, Line balancing.

TEXT BOOKS & REFERENCES:

1. Groover, Mikell 2007. Work Systems and the Methods, Measurement, and Management of Work.
2. Introduction to Work Study: International Labour Organization Geneva

LIST OF EXPERIMENTS:

1. Work study Lab Experiments
    1. To draw Outline Flow Process Chart of any Activity using Standard Chart Symbols.
    2. Left and Right Hand Process Chart for an assembly of Pin, Washer and Collar.
    3. To Calculate the Basic Time requires completing the assembly task using Stop watch.
    4. Particular task observations were taken. To verify these observations are sufficient for ±5% accuracy also indicates the minimum number of observation required.
    5. To calculate the basic Time, standard time from the given observations for a desire accuracy ±5% with confidence level 95% for activity.
2. Methods Engineering Lab

Experiments on

1. Method Analysis
2. Micro motion study

3. Facility layout design
4. Ergonomics

Course Tittle/Code	3D CAD SOFTWARE
Course Type	OPEN ELECTIVE
Course Nature	Workshop
L-T-P-O Structure	0-0-2-0
Prerequisite	NIL

SECTION A

Introduction to design software: a solid modeler, Feature-Based, Parametric, and Associative

The design software interface : screen layout, Main Window ,Pull-Down Menus Toolbar, Display Area , Message Area, working with models ,Using Dialog Boxes Retrieving Models, Retrieving Multiple ,Models ,Saving Changes, Closing Windows, Deleting Files ,pick and place features: Creating the Straight Hole Feature, Creating the Simple Round , Specifying Radius Values for a Simple Round, Creating an Edge Chamfer

Sketcher basics: The sketcher environment, he sketcher interface, intent manager ,pop-up menus sketcher mode functionality, sketcher menus , specifying references , creating geometry ,dimensioning, constraining ,additional sketcher tools, setting sketcher preferences

sketcher philosophy, rules of thumb ,laboratory practical.

SECTION B

Sketched features: Two sketched features, specifying extruded and revolved forms, sketching and reference planes, The Sketching Plane's Default Orientation

Datum planes: Using base features and datum planes,the base feature and its importance, datum plane, using default datums as the base feature, creating additional datum planes, defining a datum plane, internal datums.

SECTION C

Parent/child relationships: Parent/child relationships with pick-and-place features, parent/child relationships with a sketched feature, changing the parents of a feature , order of feature regeneration, using feature insert mode

Sweeps and blends: Swept features, defining a sweep, sweep sections and trajectories, blend features, creating parallel blends

Duplicating features: patterns and copy : Creating a pattern, benefits of patterning, types of patterns , pattern options , the copy feature, specifying location, choosing features , establishing dependence

SECTION D

Drawings and views: Drawing fundamentals, creating a drawing, adding drawing views, types of views, adding a cross section, manipulating views, laboratory practical

Creating assemblies Assembly creation: the surface normal vector, constraint options, packaging or under-constrained, components, assembly modification, changing design intent of the assembly, other assembly options, extracting a bill of materials, creating exploded views.

TEXT BOOKS & REFERENCES

Design Software: Tutorial and Multimedia CD

Course Title	**ELECTRONIC DESIGN WORKSHOP/ ECW204B**
Course Type	**OPEN ELECTIVE**
Course Nature	**Workshop**
L-T-P-O structure	**0-0-2-0**
Prerequisites	**NIL**

Experiment List: Using Eagle 8.3.2 version/ PCB Design Hardware Lab

1. Design & Analysis of low pass & high pass filter using Resistance & capacitance
2. Design & Analysis of band pass & band stop filter using Resistance & capacitance
3. Design & Analysis of half-wave rectifier with effects of variable capacitance
4. Design & Analysis of full-wave rectifier with effects of variable capacitance
5. Project: Design & Analysis of 5V power supply.
6. Project: Design & Analysis of Mobile Phone Charger.
7. Project: Design & Analysis of Water Level Indicator.

8. Project: Design of FM receiver for Radio Manav Rachna.

Course Title/ Code	**Agile Technologies (CSW317B)**
Course Type	**OPEN ELECTIVE**
Course Nature	**Workshop**
L-T-P-O Structure	(0-0-2-0)
Objectives	To introduce the practical applications of agile software development tools.

Section-A

Agile Programming Tools: UNIX, Eclipse, Git, jUnit,
Processes: Stories, End-to-end Testing, Unit Testing, TDD, Refactoring
Reading: Scrum, Extreme Programming, Features Driven Development, Lean Software Development

Section-B

Agile Architecture/Design and Continuous Integration Tools: Jenkins, Maven, Cucumber
Processes: Scrum, Architecture, Iterative Refinement, Agile Design.

Section-C

Agile DesignTools: Use Cases, PowerPoint Design, Requirements/Story Extraction, Test Case Management
Processes: Use cases to Design, Design to Backlog, Backlog to Tasks, End to End Testing, Estimation

Section-D

Agile Process ManagementTools: Agilefant
Processes: Agile Process Management, Estimation, Burn-down, Release Planning, Multi-team coordination, Distributed teams

List of Experiments

1. Test Driven Development on Eclipse using jUnit
2. Software Configuration Management using Git
3. Backlog development from use cases and user interface designs using Specification by Example
4. End-to-end/Acceptance tests using Cucumber
5. Continuous Integration using Jenkins
6. Agile Process Management using Agilefant.

Text Books:

1. Robert C. Martin, Clean Code: A Handbook of Agile Software Craftsmanship, available at http://www.it-ebooks.info/book/1441/.

Reference Links:

4. Agile software development, http://en.wikipedia.org/wiki/Agile_software_development
5. Scrum, http://en.wikipedia.org/wiki/Scrum_%28software_development%29
6. Extreme Programming, http://en.wikipedia.org/wiki/Extreme_programming
7. Feature-drive development, http://en.wikipedia.org/wiki/Feature-driven_development
8. Lean Software development, http://en.wikipedia.org/wiki/Lean_software_development
9. Test-driven development, http://en.wikipedia.org/wiki/Test-driven_development
10. Unit testing, http://en.wikipedia.org/wiki/Unit_testing
11. Specification by example, http://en.wikipedia.org/wiki/Specification_by_example
12. Behavior-driven development, http://en.wikipedia.org/wiki/Behavior-driven_development
13. Code refactoring, http://en.wikipedia.org/wiki/Code_refactoring
14. User Experience, http://en.wikipedia.org/wiki/User_experience

Tool Web Sites:

6. Ubuntu, http://www.ubuntu.com/desktop
7. Eclipse, https://eclipse.org/users/
8. jUnit, http://junit.org/
9. Git, http://git-scm.com/
10. Jenkins, https://jenkins-ci.org/
11. Ant, http://ant.apache.org/
12. Maven, https://maven.apache.org/

13. Cucumber, https://cukes.info/
14. Fitnesse, http://www.fitnesse.org/

Agilefant, http://agilefant.com/

Course Title/ Code	**R Programming (CSW318B)**
Course Type	**OPEN ELECTIVE**
Course Nature	**Workshop**
L-T-P-O Structure	**(0-0-2-0)**
PRE-REQUISITE	**NIL**

Section-A

Introduction to R, Understand the use of 'R' in the industry, Compare R with other software in analytics, Install R and the packages useful for Business Analytics,Using the R console, Getting help, Learning about the environment, Saving your work. R Vectors, Data Frames

Section-B

Variables: Variables and Assignment, Decision Making, Loops in R, Classes & Objects in R, Reading CSV, Excel and Text files. Writing and saving data objects to file, the various steps involved in Data Cleaning, Functions used in Data Inspection.

Section-C

Tackling the problems faced during Data Cleaning, Uses of the functions like grepl(), grep(), sub(),Packages installation used for database import, Connect to RDBMS from R using ODBC and basic SQL queries in R.

Section-D

Understanding Data Visualization, Graphical functions present in R, Plot various graphs like tableplot, Scatter Plot, Histogram, Box plot,Line graph,Bar charts,Pie charts. Customizing Graphical Parameters to improvise the plots, R Mean, Median, Mode, Linear Regression, Logistic

Regression,Poission Regression, Normal Distribution and Binomial Distribution.Time Series Analysis, Decision Tree, Random Forest, Dimensionality reduction of Data: PCA, SVD, Predictive Analysis. Time series Decomposition, Time series clustering and classification.

Course Title	**IOT & SENSORS WORKSHOP**
Course Type	**OPEN ELECTIVE**
Course Nature	**Workshop**
L-T-P-O structure	**0-0-2-0**
Prerequisites	**NIL**

LIST OF EXPERIMENTS

1. IOT and Acoustic and Sound Sensors.
2. IOT and Chemical Sensors
3. IOT and Optical Sensors
4. IOT and Mechanical Sensors
5. IOT and Electromechanical Sensors
6. IOT and Thermal Sensors
7. IOT and Proximity Sensors
8. IOT and Pressure Sensors
9. IOT and Magnetic Sensors
10. Mini Project.

Course Title/ Code	**3D PRINTING**
Course Type	**ELECTIVE**
Course Nature	**HARD**
L-T-P-O Structure	**0-0-2-0**
Prerequisite	**NIL**

SECTION-A

Introduction of 3D Printing, Evolution of 3D Printing, What is additive manufacturing, General procedure of 3D Printing

SECTION-B

3D CAD file formats, Stereo lithography (stl) files, Various Printing technologies (SLA, SLS, FDM, Poly jet printing,Color jet Printing, SHS, SLM, LOM, Multi jet Printing, DLP).

SECTION-C

FDM in detail, Operating Plasto 200 - Live demonstration, STL principles, Object placement.

SECTION-D

Object analysis, Slicing and printing, Print settings.

SEMESTER-8

SUBJECT CODE	SUBJECT NAME	OFFERING DEPARTMENT	COURSE NATURE (HARD/SOFT/ WORKSHOP/ NTCC	COURSE TYPE (CORE/ELECTIVE/ UNIVERSITY COMPULSORY	L	T	P	O	No. of Contact Hours per week	Credits
MEN412B	**PROJECT/INDUSTRIAL TRAINING**	ME	NTCC	CORE	0	0	0	16	16	8
TOTAL (L/T/P/O/CONTACT HOURS/CREDITS					**0**	**0**	**0**	**16**	**16**	**8**