SYLLABUS BTECH FIRST YEAR COMMON TO ALL DSCIPILINES

SEMESTER 1

BTECH 101 (APPLIED MATHEMATICS -I)

Module	Detailed Contents	Hrs.
01	**Complex Numbers** **Pre-requisite**: Review of Complex Numbers-Algebra of Complex Number, Different representations of a Complex number and other definitions, D'Moivre's Theorem. 1.1. Powers and Roots of Exponential and Trigonometric Functions. 1.2. Expansion of $\sin^n \theta$, $\cos^n \theta$ in terms of sines and cosines of multiples of θ and Expansion of $\sin n\theta$, $\cos n\theta$ in powers of $\sin\theta$, $\cos\theta$ 1.3. Circular functions of complex number and Hyperbolic functions. Inverse Circular and Inverse Hyperbolic functions. Separation of real and imaginary parts of all types of Functions.	3 2 4
02	**Logarithm of Complex Numbers , Successive Differentiation** 2.1 Logarithmic functions, Separation of real and Imaginary parts of Logarithmic Functions. 2.2 Successive differentiation: nth derivative of standard functions. Leibnitz's Theorem (without proof) and problems	4 4
03	**Matrices** **Pre-requisite**: Inverse of a matrix, addition, multiplication and transpose of a matrix Types of Matrices (symmetric, skew- symmetric, Hermitian, Skew Hermitian, Unitary, Orthogonal Matrices and properties of Matrices). Rank of a Matrix using Echelon forms, reduction to normal form, PAQ in normal form, system of homogeneous and non – homogeneous equations, their consistency and solutions. Linear dependent and independent vectors. Application of inverse of a matrix to coding theory.	9
04	**Partial Differentiation** 4.1 Partial Differentiation: Partial derivatives of first and higher order. Total differentials, differentiation of composite and implicit functions.	6

	4.2. Euler's Theorem on Homogeneous functions with two and three independent variables (with proof).Deductions from Euler's Theorem	3
05	**Applications of Partial Differentiation , Expansion of Functions** 5.1 Maxima and Minima of a function of two independent variables, Jacobian. 5.2 Taylor's Theorem (Statement only) and Taylor's series, Maclaurin's series (Statement only).Expansion of e^x , sin(x), cos(x), tan(x), sinh(x), cosh(x), tanh(x), log(1+x), $sin^{-1}(x), cos^{-1}(x), tan^{-1}(x)$, Binomial series.	4 4
06	**Indeterminate forms, Numerical Solutions of Transcendental Equations and System of Linear Equations** 6.1 Indeterminate forms, L- Hospital Rule, problems involving series. 6.2 Solution of Transcendental Equations: Solution by Newton Raphson method and Regula –Falsi Equation. 6.3 Solution of system of linear algebraic equations, by (1) Gauss Elimination Method, (2) Gauss Jacobi Iteration Method, (3) Gauss Seidal Iteration Method. (Scilab programming for above methods is to be taught during lecture hours)	2 4 3

References:

1. A text book of Applied Mathematics, P.N.Wartikar and J.N.Wartikar, Vol – I and –II by Pune VidyarthiGraha.
2. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
3. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
4. Matrices, Shanti Narayan.S. Chand publication
5. Numerical Methods,   Dr. P. Kandasamy , S. Chand Publication
6. Howard Anton and Christ Rorres. Elementary Linear Algebra Application Version. 6th edition. John Wiley & Sons,   INC.
7. Eisenberg, Murray. Hill Ciphers and Modular Linear Algebra. 3 Nov 1999 (accessed November - 2 December   2001)
8. <http://www.math.umass.edu/~murray/Hillciph.pdf>

BTECH 102 (APPLIED PHYSICS- I)

Module	Detailed Contents	Hrs.
01	**CRYSTAL STRUCTURE** Introduction to crystallography; Study of characteristics of unit cell of Diamond, ZnS, NaCl and HCP; Miller indices of crystallographic planes & directions; interplanar spacing; X-ray diffraction and Bragg's law; Determination of Crystal structure using Bragg's diffractometer; Frenkel and Schotkey crystal defects; Ionic crystal legacy (3,4,6,8); Liquid crystal phases.	07
02	**QUANTUM MECHANICS** Introduction, Wave particle duality; de Broglie wavelength; experimental verification of de Broglie theory; properties of matter waves; wave packet, phase velocity and group velocity; Wave function; Physical interpretation of wave function; Heisenberg's uncertainty principle; Electron diffraction experiment and Gama ray microscope experiment; Applications of uncertainty principle; Schrodinger's time dependent wave equation; time independent wave equation; Motion of free particle; Particle trapped in one dimensional infinite potential well.	09
03	**SEMICONDUCTOR PHYSICS** Splitting of energy levels for band formation; Classification of semiconductors(direct & indirect band gap, elemental and compound); Conductivity, mobility, current density (drift & diffusion) in semiconductors(n type and p type); Fermi Dirac distribution function; Fermi energy level in intrinsic & extrinsic semiconductors; effect of impurity concentration and temperature on fermi level; Fermi Level diagram for p-n junction(unbiased, forward bais, reverse bias); Breakdown mechanism (zener&avalanchy), Hall Effect	14

	Applications of semiconductors: Rectifier diode, LED, Zener diode, Photo diode, Photovoltaic cell, BJT, FET, SCR., MOSFET	
04	**SUPERCONDUCTIVITY** Introduction, Meissner Effect; Type I and Type II superconductors; BCS Theory (concept of Cooper pair); Josephson effect Applications of superconductors- SQUID, MAGLEV	03
05	**ACOUSTICS** Conditions of good acoustics; Reflection of sound(reverberation and echo); absorption of sound; absorption coefficient; Sabine's formula; Acoustic Design of a hall; Common Acoustic defects and acoustic materials	03
06	**ULTRASONICS** Ultrasonic Wave generation; Magnetostriction Oscillator; Piezoelectric Oscillator; Applications of ultrasonic: Eco sounding; NDT; ultrasonic cleaning(cavitation); ultrasonic sensors; Industrial applications of ultrasonic(soldering, welding, cutting, drilling)	03

Suggested Experiments: (Any five)

1. Study of Diamond, ZnS, NaCl crystal structure.
2. Study of HCP structure.
3. Study of Miller Indices, Plane and direction.
4. Study of Hall Effect.
5. Determination of energy band gap of semiconductor.
6. Study of Ultrasonic Distance Meter.
7. Study of I / V characteristics of Zener diode.
8. Determination of 'h' using Photo cell.
9. Study of I / V characteristics of semiconductor diode

References:

1. A text book of Engineering Physics-Avadhanulu&Kshirsagar, S.Chand
2. Applied Solid State Physics –Ranikant, Wiley India
3. Solid State Electronic Devices- B. G. Streetman, Prentice Hall Publisher
4. Physics of Semiconductor Devices- S. M. Sze, John Wiley & sons publisher
6. Modern Engineering Physics – Vasudeva, S.Chand
7. Concepts of Modern Physics- ArtherBeiser, Tata McGraw Hill
8. Engineering Physics- V. Rajendran, Tata McGraw Hill
9. Introduction to Solid State Physics- C. Kittle, John Wiley & Sons publisher
10. Engineering Physics-H. K. Malik, McGraw Hill

BTECH 103 (APPLIED CHEMISTRY- I)

Module	Detailed Contents	Hrs.
01	**Water** Impurities in water, Hardness of water, Determination of Hardness of water by EDTA method and problems, Softening of water by Hot and Cold lime Soda method and numerical problems. Zeolite process and numerical problems. Ion Exchange process and numerical problems. Potable water standard as per BIS w.r.t. i) pH, ii) Alkalinity, iii) TDS, iv) Hardness; Drinking water or Municipal water -Treatments removal of microorganisms by adding Bleaching powder, Chlorination (no breakpoint chlorination), Disinfection by Ozone, Electrodialysis, Reverse osmosis, and Ultra filtration. BOD, COD- definition & significance, sewage treatment (only activated sludge process), Numerical problems related to COD.	12
02	**Polymers** Introduction to polymers, Classification, Types of polymerization, Thermoplastic and Thermosetting plastic; Compounding of plastic, Fabrication of plastic by Compression, Injection, Transfer and Extrusion moulding. Preparation, properties and uses of Phenol formaldehyde, PMMA, Kevlar. Effect of heat on the polymers (Glass transition temperature), Viscoelasticity. Conducting polymers, Engineering Plastics, Polymers in medicine and surgery. Rubbers : Natural rubber- latex, Drawbacks of natural rubber, Vulcanization of rubber, Preparation, properties and uses of Buna-S, Silicone and Polyurethane rubber.	12
03	**Lubricants** Introduction, Definition, Mechanism of lubrication, Classification of lubricants, Solid lubricants (graphite & Molybdenum disulphide), Semisolid lubricants, Liquid lubricants, Additives in blended Oils. Important properties of lubricants - Definition and significance of - Viscosity, Viscosity index, Flash and fire points, Cloud and pour points, Oiliness,	07

	Emulsification, Acid value and numerical problems, Saponification value and numerical problems.	
04	**Phase Rule** Gibb's Phase Rule, Terms involved with examples, One Component System (Water), Reduced Phase Rule, Two Component System (Pb- Ag), Advantages and Limitations of Phase Rule.	04
05	**Important Engineering Materials** Cement – Manufacture of Portland Cement, Chemical Composition and Constitution of Portland Cement, Setting and Hardening of Portland Cement, Concrete, RCC and Decay. Nanomaterials, preparation (Laser and CVD) method, properties and uses of CNTS, Fullerene - properties and uses.	05

Suggested Experiments:

1) To determine total, temporary and permanent hardness of water sample.
2) Removal of hardness using ion exchange column.
3) To determine acid value of a lubricating oil.
4) To determine free acid pH of different solutions using pHmeter
5) To determine metal ion concentration using colorimeter.
6) To determine flash point and fire point of a lubricating oil
7) To determine Chloride content of water by Mohr's Method.
8) To determine melting point and /or glass transition temperature of a polymer
9) Molecular weight determination of polymers by Oswald Viscometer.
10) To determine the percentage of lime in cement.
11) Hardening and setting of cement using Vicat's apparatus
12) Determination of Viscosity of oil by Redwood Viscometer.

References:

1. Engineering Chemistry - Jain& Jain (DhanpatRai)
2. Engineering Chemistry – Dara&Dara (S Chand)
3. Engineering Chemistry - Wiley India (ISBN – 9788126519880)
4. A Text Book of Engineering Chemistry – Shashi Chawla (DhanpatRai)

BTECH 104 (ENGINEERING MECHANICS)

Module	Detailed Contents	Hrs.
01	**1.1 System of Coplanar Forces:** Resultant of concurrent forces, parallel forces, non-concurrent Non-parallel system of forces, Moment of force about a point, Couples, Varignon's Theorem. Force couple system. Distributed Forces in plane.	05
	1.2 Centroid for plane Laminas.	04
02	**2.1 Equilibrium of System of Coplanar Forces:** Condition of equilibrium for concurrent forces, parallel forces and non-concurrent non-parallel general forces and Couples.	06
	2.2 Types of support: Loads, Beams, Determination of reactions at supports for various types of loads on beams.(Excluding problems on internal hinges)	03
	2.3 Analysis of plane trusses: By using Method of joints and Method of sections. (Excluding pin jointed frames).	05
03	**3.1 Forces in space:** **Resultant of Non-coplanar Force Systems:** Resultant of concurrent force system, parallel force system and non-concurrent non-parallel force system. **Equilibrium of Non-coplanar Force Systems:** Equilibrium of Concurrent force system, parallel force system and non-concurrent non-parallel force system.	05
	3.2 Friction: Introduction to Laws of friction, Cone of friction, Equilibrium of bodies on inclined plane, Application to problems involving wedges, ladders.	07
	1.3 Principle of virtual work: Applications on equilibrium mechanisms, pin jointed frames.	04

04	**4.1 Kinematics of a Particle:** -Rectilinear motion, Velocity & acceleration in terms of rectangular co-ordinate system, Motion along plane curved path, Tangential& Normal component of acceleration, Motion curves (a-t, v-t, s-t curves), Projectile motion.	10
05	**5.1 Kinematics of a Rigid Body :-** Introduction to general plane motion, Instantaneous center of rotation for the velocity, velocity diagrams for bodies in plane motion.	06
06	**6.1 Kinetics of a Particle: Force and Acceleration:** -Introduction to basic concepts, D'Alemberts Principle, Equations of dynamic equilibrium, Newton's second law of motion.	04
	6.2 Kinetics of a Particle: Work and Energy: Principle of work and energy, Law of conservation of energy.	03
	6.3 Kinetics of a Particle: Impulse and Momentum: Principle of linear impulse and momentum. Law of conservation of momentum. Impact and collision.	03

List of Experiments:-

1. Polygon law of coplanar forces.
2. Non-concurrent non-parallel (General).
3. Bell crank lever.
4. Support reaction for beam.
5. Inclined plane (to determine coefficient of friction).
6. Collision of elastic bodies (Law of conservation of momentum).
7. Kinematics of particles
8. Kinetics of particles

References:

1. Engineering Mechanics by R. C. Hibbeler.2
2. Engineering Mechanics by Beer &Johnston, Tata McGraw Hill
3. Engineering Mechanics by F. L. Singer, Harper& Raw Publication
4. Engineering Mechanics by Macklin & Nelson, Tata McGraw Hill
5. Engineering Mechanics by Shaum Series,
6. Engineering Mechanics by A K Tayal, Umesh Publication.
7. Engineering Mechanics by Kumar, Tata McGraw Hill
8. Engineering Mechanics (Statics) by Meriam and Kraige, Wiley Bools
9. Engineering Mechanics (Dynamics) by Meriam and Kraige, Wiley Bools

BTECH 105 (BASIC ELECTRICAL ENGINEERING)

Module	Detailed Contents	Hrs.
01	**DC Circuits(Only Independent Sources):** Kirchhoff 's laws, Ideal and practical voltage and current source, Mesh and Nodal analysis, Super node and Super mesh analysis, Source transformation, Star-delta transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, (Source transformation not allowed for Superposition theorem, Mesh and Nodal analysis).	18
02	**AC Circuits:** Generation of alternating voltage and currents, RMS and Average value, form factor, crest factor, AC through resistance, inductance and capacitance, R-L, R-C and R-L-C series and parallel circuits, phasor diagrams, power and power factor, series and parallel resonance, Q factor and bandwidth.	12
03	**Three Phase Circuits:** Three phase voltage and current generation, star and delta connections(balanced load only), relationship between phase and line currents and voltages, Phasor diagrams, Basic principle of wattmeter, measurement of power by one and two wattmeter methods.	06
04	**Single Phase Transformer:** Construction, working principle, emf equation, ideal and practical transformer, transformer on no load and on load, phasor diagrams, equivalent circuit, OC and SC test, regulation and efficiency.	12
05	**DC Machines:** Principle of operation of DC motors and DC generators, construction and classification of DC machines, emf equation.	04

List of laboratory experiments (Minimum Six):
1. Mesh and Nodal analysis.
2. Verification of Superposition Theorem.
3. Verification Thevenin's Theorem.
4. Study of R-L series and R-C series circuit.
5. R-L-C series resonance circuit
6. R-L-C parallel resonance circuit.
7. Relationship between phase and line currents and voltages in three phase system (star & delta)
8. Power and phase measurement in three phase system by one wattmeter method.
9. Power and phase measurement in three phase system by two wattmeter method.
10. OC and SC test on single phase transformer

Reference Books:
1. B.L.Theraja "Electrical Engineering " Vol-I and II,
2. S.N.Singh, "Basic Electrical Engineering" PHI , 2011Book name and author

BTECH 106 (ENVIRONMENTAL STUDIES)

Module	Detailed Contents	Hrs.
01	**Overview of Environmental Aspects:** • Definition, Scope and Importance of Environmental Study • Need for Public awareness of environmental education • Introduction to depletion of natural resources: Soil, Water, Minerals and Forests. • Global crisis related to – Population, water, sanitation & Land. **Ecosystem:** • Study of ecosystems : Forest, desert and aquatic (in brief). • Energy flow in Ecosystem, overview of Food Chain, Food Web and Ecological Pyramid. • Concept of ecological succession and its impact on human beings (in brief). **Case Study on Chipko Movement (Uttarakhand, India), (began in 1973).**	4
02	**Aspects of Sustainable Development:** • Concept and Definition of Sustainable Development. • Social, Economical and Environmental aspects of sustainable development. • Control measures: 3R (Reuse, Recovery, Recycle), • Resource utilization as per the carrying capacity (in brief). **Case Study on Narmada BachaoAndolan (Gujarat, India, in the mid and late 1980s).**	2

03	**Types of Pollution:** • Water pollution: Sources of water pollution and Treatment of Domestic and industrial waste water (with flow-diagram of the treatment), • Land Pollution: Solid waste, Solid waste management by land filling, composting and incineration • Air pollution: Sources of air pollution, Consequences of air pollution :- Greenhouse effect (Explanation with schematic diagram), Photochemical Smog (Explanation with chemical reaction). Cleaning of gaseous effluents to reduce air contaminants namely dust particle or particulate matters by using:- (i) Electrostatic precipitators (ii) Venturi scrubber (Schematic diagram and working). • Noise pollution: Sources, effects, threshold limit for different areas and control methods. • E-Pollution: Definition, Sources and effects. • Nuclear pollution: Sources and effects. **Case study on Water Pollution of Ganga River.** **Case study on London smog (U. K.)(December, 1952).** **Case Study of Fukushima Disaster (March, 2011).**	8
04	**Pollution Control Legislation:** • Functions and powers of Central and State Pollution Control Board. • Environmental Clearance, Consent and Authorization Mechanism. **Case Study of Dombivali MIDC- Boiler Blast Tragedy (Thane, Maharashtra, India), (May, 2016).**	3
05	**Renewable Sources of Energy:** • Importance of renewable sources of energy. • Principle and working with schematic diagram of :- (i) Solar Energy: (a) Flat plate collector and (b) Photovoltaic cell. (ii) Wind Energy: Wind Turbines. (iii) Hydropower: Hydropower generation from water reservoir of the dam. (iv) Geothermal Energy: Utilisation of underground sources of steam for power generation.	4
06	**Technological Advances to overcome Environmental problems:** • Concept of Green Buildings, • Various indoor air pollutants and their effects on health. • Carbon Credit: Introduction and general concept. • Disaster Management: Techniques of Disaster Management to cope up with (i) Earthquake and (ii) Flood. **Case Study on Earthquake in Latur (Maharashtra, India), (September,1993).** **Case Study on Cloudburst and Landslides at Kedarnath (Uttarakhand, India), (June, 2013).**	5

References:

1. Environmental Studies by Benny Joseph, TataMcGraw Hill.
2. Environmental Studies by R.Rajagopalan, Oxford University Press.
3. Environmental Studies by. AnanditaBasak, Pearson Education.
4. Essentials of Environmental Studies by Kurian Joseph &Nagendran, Pearson Education.
5. Fundamentals of Environmental Studies by Varadbal G. Mhatre, Himalaya Publication House.
6. Perspective of Environmental Studies, by Kaushik and Kaushik,New Age International.
7. Renewable Energy by Godfrey Boyle, Oxford Publications.
8. Textbook of Environmental Studies by Dave and Katewa, Cengage Learning.
9. Textbook of Environmental studies by ErachBharucha, University Press.
10. Environmental pollution control engineering by C.S. Rao, New Age International (P) Limited Publishers.

BTECH 107 (BASIC WORKSHOP PRACTICE-I)

	Detailed Contents	Hrs.
Note:	The syllabus and the Term- work to be done during semester I and Semester II is given together. Individual Instructor for the course is to design the jobs for practice and demonstration and spread the work over entire two semesters. The objective is to impart training to help the students develop engineering skill sets. This exercise also aims in inculcating respect for physical work and hard labor in addition to some amount of value addition by getting exposed to interdisciplinary engineering domains. The two compulsory trades (Trade 1 – Fitting and Trade 2 – Carpentry) shall be offered in separate semesters. Select any four trade topics (two per semester) out of the topic at trade 3 to 11. Demonstrations and hands on experience to be provided during the periods allotted for the same. Report on the demonstration including suitable sketches is also to be included in the term – work	
Trade 1	**Fitting (compulsory)** • Use and setting of fitting tools for chipping, cutting, filing, marking, center punching, drilling, tapping. • Term work to include one job involving following operations : filing to size, one simple male- female joint, drilling and tapping	30
Trade 2	**Carpentry (compulsory)** • Use and setting of hand tools like hacksaws, jack planes, chisels and gauges for construction of various joints, wood tuning and modern wood turning methods. • Term work to include one carpentry job involving a joint and report on demonstration of a job involving wood turning	30
Trade 3	**Forging (Smithy)** • At least one workshop practice job (Lifting hook and handle) is to be demonstrated.	15
Trade 4	**Welding** • Edge preparation for welding jobs. Arc welding for different job like, Lap welding of two plates, butt welding of plates with simple cover, arc welding to join plates at right angles.	15
Trade 5	**Machine Shop** • At least one turning job is to be demonstrated.	15
Trade 6	**Electrical board wiring** • House wiring, staircase wiring, wiring diagram for fluorescent tube light, Godown wiring and three phase wiring for electrical motors.	15
Trade 7	**PCB Laboratory Exercises** Layout drawing, Positive and negative film making, PCB etching and drilling, Tinning and soldering technique.	15
Trade 8	**Sheet metal working and Brazing** • Use of sheet metal, working hand tools, cutting , bending , spot welding	15

	Plumbing	
Trade 9	• Use of plumbing tools, spanners, wrenches, threading dies, demonstration of preparation of a domestic line involving fixing of a water tap and use of coupling, elbow, tee, and union etc.	15
Trade 10	**Masonry** • Use of masons tools like trowels, hammer, spirit level, square, plumb line and pins etc. demonstration of mortar making, single and one and half brick masonry , English and Flemish bonds, block masonry, pointing and plastering.	15
Trade 11	**Hardware and Networking:** • Dismantling of a Personal Computer (PC), Identification of Components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives etc. • Assembling of PC, Installation of Operating System (Any one) and Device drivers, Boot-up sequence. Installation of application software (at least one) • Basic troubleshooting and maintenance • Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping. **NOTE**: Hands on experience to be given in a group of not more than four students.	15

SEMESTER- 2

BTECH 201 (APPLIED MATHEMATICS-II)

Module	Detailed Contents	Hrs.
01	**Differential Equations of First Order and First Degree** 1.1 Exact differential Equations, Equations reducible to exact form by using integrating factors. 1.2 Linear differential equations (Review), equation reducible to linear form, Bernoulli's equation. 1.3: Simple application of differential equation of first order and first degree to electrical and Mechanical Engineering problem (no formulation of differential equation)	4 3 2
02	**Linear Differential Equations With Constant Coefficients and Variable Coefficients Of Higher Order** 2.1. Linear Differential Equation with constant coefficient- complementary function, particular integrals of differential equation of the type f(D)y = X where X is e^{ax}, sin(ax+b), cos (ax+b), x^n, e^{ax}V, xV. 2.2. Cauchy's homogeneous linear differential equation and Legendre's differential equation, Method of variation of parameters.	6 3
03	**Numerical solution of ordinary differential equations of first order and first degree, Beta and Gamma Function** 3.1. (a)Taylor's series method (b)Euler's method (c) Modified Euler method (d) Runga-Kutta fourth order formula (SciLab programming is to be taught during lecture hours) 3.2 .Beta and Gamma functions and its properties.	4 4
04	**Differentiation under Integral sign, Numerical Integration and Rectification** 4.1. Differentiation under integral sign with constant limits of integration. 4.2. Numerical integration- by (a) Trapezoidal (b) Simpson's 1/3rd (c) Simpson's 3/8th rule (all with proof). (Scilab programming on (a) (b) (c) (d) is to be taught during lecture hours) 4.3. Rectification of plane curves.	2 3 3
05	**Double Integration** 5.1. Double integration-definition, Evaluation of Double Integrals. 5.2. Change the order of integration, Evaluation of double integrals by changing the order of integration and changing to polar form.	2 7
06	**Triple Integration and Applications of Multiple Integrals.** 6.1. Triple integration definition and evaluation (Cartesian, cylindrical and spherical polar coordinates). 6.2. Application of double integrals to compute Area, Mass, Volume. Application of triple integral to compute volume.	3 6

References:

1. A text book of Applied Mathematics, P.N.Wartikar and J.N.Wartikar, Vol – I and –II by Pune VidyarthiGraha.
2. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
3. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
4. Numerical methods by Dr. P. Kandasamy ,S.Chand Publications

BTECH 202 (APPLIED PHYSICS-II)

Module	Detailed Contents	Hrs.
01	**INTERFERENCE AND DIFFRACTION OF LIGHT** Interference by division of amplitude and by division of wave front; Interference in thin film of constant thickness due to reflected and transmitted light; origin of colours in thin film; Wedge shaped film(angle of wedge and thickness measurement); Newton's rings Applications of interference - Determination of thickness of very thin wire or foil; determination of refractive index of liquid; wavelength of incident light; radius of curvature of lens; testing of surface flatness; Anti-reflecting films and Highly reflecting film. Diffraction of Light –Fraunhoffer diffraction at single slit, Fraunhoffer diffraction at double slit, Diffraction Grating, Resolving power of a grating, dispersive power of a grating Application of Diffraction - Determination of wavelength of light with a plane transmission grating	14
02	**LASERS** Quantum processes as absorption, spontaneous emission and stimulated emission; metastable states, population inversion, pumping, resonance cavity, Einsteins's equations; Helium Neon laser; Nd:YAG laser; Semiconductor laser, Applications of laser- Holography (construction and reconstruction of holograms) and industrial applications(cutting, welding etc), Applications in medical field	04
03	**FIBRE OPTICS** Total internal reflection; Numerical Aperture; critical angle; angle of acceptance; Vnumber; number of modes of propagation; types of optical fiber; Losses in optical fibre(Attenuation and dispersion) Applications of optical fibre - Fibre optic communication system; sensors (Pressure, temperature, smoke, water level), applications in medical field	04

Module	Detailed Contents	Hrs.
04	**ELECTRODYNAMICS** Cartesian, Cylindrical and Spherical Coordinate system, Scaler and Vector field, Physical significance of gradient, curl and divergence, Determination of Maxwell's four equations. Applications-design of antenna, wave guide, satellite communication etc.	08
05	**CHARGE PARTICLE IN ELECTRIC AND MAGNETIC FIELDS** Fundamentals of Electromagnetism, Motion of electron in electric field (parallel ,perpendicular, with some angle); Motion of electron in magnetic field (Longitudinal and Transverse); Magnetic deflection; Motion of electron in crossed field; Velocity Selector; Velocity Filter, Electron refraction; Bethe's law; Electrostatic focusing; Magnetostatic focusing; Cathode ray tube (CRT);Cathod ray Oscilloscope (CRO) Application of CRO: Voltage (dc,ac), frequency, phase measurement.	05
06	**NANOSCIENCE AND NANOTECHNOLOGY** Introduction to nano-science and nanotechnology, Surface to volume ratio, Two main approaches in nanotechnology -Bottom up technique and top down technique; Important tools in nanotechnology such as Scanning Electron Microscope, Transmission Electron Microscope, Atomic Force Microscope. Nano materials: Methods to synthesize nanomaterials (Ball milling, Sputtering, Vapour deposition, solgel), properties and applications of nanomaterials.	04

Suggested Experiments: (Any five)

1. Determination of radius of curvature of a lens using Newton's ring set up
2. Determination of diameter of wire/hair or thickness of paper using Wedge shape film method.
3. Determination of wavelength using Diffracion grating. (Hg/ Ne source)
4. Determination of number of lines on the grating surface using LASER Sourse.
5. Determination of Numerical Aperture of an optical fibre.
6. Determination of wavelength using Diffracion grating. (Laser source)
7. Use of CRO for measurement of frequency and amplitude.
8. Use of CRO for measurement of phase angle.
9. Study of divergence of laser beam
10. Determination of width of a slit using single slit diffraction experiment (laser source)

References:

1. A text book of Engineering Physics-Avadhanulu&Kshirsagar, S.Chand
2. Fundamentals of Optics by Jenkins and White, McGraw-Hill
3. Optics - Ajay Ghatak, Tata McGraw Hill
4. Concepts of Modern Physics- ArtherBeiser, Tata Mcgraw Hill
5. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
6. Engineering Physics-D. K. Bhattacharya, Oxford
7. Concepts of Modern Physics- ArtherBeiser, Tata Mcgraw Hill
8. Classical Electodyamics – J. D. Jackson, Wiley
9. Introduction to Electrodynamics- D. J. Griffiths, Pearson publication
10. Intoduction to Nanotechnology- Charles P. Poole, Jr., Frank J. Owens, Wiley India edition
11. Nano: The Essential – T. Pradeep, Mcgraw-Hill Education

BTECH 203 (APPLIED CHEMISTRY-II)

Module	Detailed Contents	Hrs.
01	**Corrosion:** Introduction: Types of Corrosion- (I) Dry or Chemical Corrosion-i) Due to oxygen ii) Due to other gases (II) Wet or Electrochemical corrosion- Mechanism i) Evolution of hydrogen type ii) Absorption of oxygen. Types of Electrochemical Corrosion- Galvanic cell corrosion, Concentration cell corrosion (differential aeration), Pitting corrosion, Intergranular corrosion, Stress corrosion. Factors affecting the rate of corrosion- Nature of metal, position of metal in galvanic series, potential difference, overvoltage, relative area of anodic and cathodic parts, purity of metal, nature of the corrosion product, temperature, moisture, influence of pH, concentration of the electrolytes. Methods to decrease the rate of corrosion- Material selection, Proper designing, Use of inhibitors, Cathodic protection- i) Sacrificial anodic protection ii) Impressed current method, Anodic protection method, Metallic coatings- hot dipping- galvanizing and tinning, metal cladding, metal spraying, Electroplating, Cementation. Organic coatings – Paints (only constituents and their functions).	11
02	**Alloys** Introduction, purpose of making alloys, Ferrous alloys, plain carbon steel, heat resisting steels, stainless steels (corrosion resistant steels), effect of the alloying element- Ni, Cr, Co, Mn, Mo,W and V; Non-Ferrous alloys- Composition, properties and uses of- Alloys of Aluminium- i) Duralumin ii) Magnalium. Alloys of Cu- (I) Brasses-i) Commercial brass ii) German silver, (II) Bronzes- i) Gun metal ii) High phosphorous bronze. Alloys of Pb- i) Wood's metal ii)	07

	Tinmann's solder. Powder Metallurgy- Introduction, (1)Methods of powder metal formation- i) Mechanical pulverization ii) Atomization iii) Chemical reduction iv) Electrolytic process v) Decomposition (2) Mixing and blending. (3) Sintering (4) Compacting- i) Cold pressing ii) Powder injection moulding (iii) Hot compaction. Applications of powder metallurgy. Shape Memory Alloys- Definition, properties and Uses.	
03	**Fuels** Definition, classification of fuels-solid, liquid and gaseous. Calorific value- Definition, Gross or Higher calorific value & Net or lower calorific value, units of heat (no conversions), Dulong's formula & numerical for calculations of Gross and Net calorific values. Characteristics of a good fuel. Solid fuels- Analysis of coal- Proximate and Ultimate Analysis with Significance and numericals. Liquid fuels- Crude petroleum oil, its composition and classification and mining (in brief). Refining of crude oil- i) Separation of water ii) Separation of 'S' & iii) Fractional Distillation with diagram and composition and uses table. Cracking- Definition, Types of cracking- I) Thermal cracking – (i) Liquid phase thermal cracking (ii) Vapour phase thermal cracking. II) Catalytic cracking- (i) Fixed-bed catalytic cracking (ii) Moving-bed catalytic cracking. Advantages of Catalytic cracking. Petrol- Refining of petrol, unleaded petrol (use of MTBE), Catalytic converter, Power alcohol, Knocking, Octane number, Cetane number, Antiknocking agents. Combustion- Calculations for requirement of only oxygen and air (by weight and by volume only) for given solid & gaseous fuels. Biodiesel- Method to obtain Biodiesel from vegetable oils (Trans-esterification), advantage and disadvantages of biodiesel. Fuel cell- Definition, types and applications.	12
04	**Composite Materials** Introduction, Constitution- i) Matrix phase ii) Dispersed phase. Characteristic properties of composite materials. Classification- (A) Particle - reinforced composites- i) Large – particle reinforced composites ii) Dispersion – strengthened composites. (B) Fiber – reinforced composites- i) Continuous – aligned ii) Discontinuous – aligned (short)- (a) aligned (b) randomly oriented (C) Structural Composites- i) Laminates (ii) Sandwich Panels.	04
05	**Green Chemistry** Introduction, Twelve Principles of Green chemistry, numerical on atom economy, Conventional and green synthesis of Adipic acid, Indigo, Ibuprofen and Carbaryl. Green solvents (water,supercritical CO_2) and products from natural materials.	06

Suggested Experiments: (Any five)

1. Estimation of Zn- Complexometric titration.
2. Estimation of Ni- Complexometric titration.
3. Estimation of Al- Complexometic titration.
4. Flue gas analysis using Orsat's apparatus.
5. Estimation of Fe from plain carbon steel
6. Estimation of Ni by gravimetric method.
7. Estimation of Sniodometrically.
8. Preparation of Biodiesel from edible oil.
9. Estimation of Cu- Iodometrically.
10. Estimation of percentage moisture in coal.
11. Estimation of percentage ash in coal.
12. To estimate the emf of Cu-Zn system by potentiometry.
13. Demonstration of Electroplating.

References:

1. Engineering Chemistry - Jain &Jain (DhanpatRai)
2. Engineering Chemistry – Dara & Dara (S Chand)
3. Engineering Chemistry - Wiley India (ISBN – 9788126519880)
4. A Text Book of Engineering Chemistry - ShashiChawla (DhanpatRai)
5. A Text Book of Green Chemistry – V.K. Ahluwalia (Springer)

BTECH 204 (ENGINEERING DRAWING)

Module	Detailed Contents	Hrs.
01	**Introduction to Engineering Drawing:**- Types of Lines, Dimensioning Systems as per IS conventions. **Engineering Curves:**- Basic construction of Cycloid, Involutes and Helix (of cylinder) only. ** **Introduction to Auto CAD:**- Basic Drawing and Editing Commands. Knowledge of setting up layers, Dimensioning, Hatching, plotting and Printing.	3
02	**Projection of Points and Lines:**- Lines inclined to both the Reference Planes (Excluding Traces of lines) and **simple application based problems on Projection of lines.** @**Projection of Planes:**- Triangular, Square, Rectangular, Pentagonal, Hexagonal and Circular planes inclined to either HP or VP only. (Exclude composite planes)	6
03	**Projection of Solids:**- (Prism, Pyramid, Cylinder, Tetrahedron, Hexahedron and Cone only) Solid projection with the axis inclined to HP and VP. (Exclude Spheres, Composite, Hollow solids and frustum of solids). Use change of position or Auxiliary plane method **Section of Solids:**- Section of Prism, Pyramid, Cylinder, Tetrahedron, Hexahedron & Cone cut by plane perpendicular to at least one reference plane.(Exclude Curved Section Plane). Use change of position or Auxiliary plane method **Development of Lateral Surfaces of Sectioned Solids:**- Lateral surface development of Prism, Pyramid, Tetrahedron, Hexahedron, Cylinder, Cone **with section plane** inclined to HP or VP only. (Exclude DLS of a solid with a hole in it and Reverse Development). (Exclude Reverse Development)	14
04	**Orthographic and Sectional Orthographic Projections:**- • Different views of a simple machine part as per the first angle projection method recommended by I.S. • Full or Half Sectional views of the Simple Machine parts. • **Drawing of orthographic projections using Auto CAD.	12
05	**Isometric Views:**- Isometric View/Drawing of blocks of plain and cylindrical surfaces using plain/natural scale only. (Exclude Spherical surfaces). • **Drawing of Isometric views using Auto CAD. • @**Reading of Orthographic Projections. [Only for Practical Exam (AutoCAD)** and Term Work] • **Orthographic Reading using Auto CAD.** **Introduction to 3D in AutoCAD** Working in 3-dimensions, Viewing 3D Objects, Basic wireframe models, Extruding, simple revolved objects. Boolean operations.	10

References.

1. M.B Shah & B.C Rana, "Engineering Drawing", Pearson Publications.
2. P.J. Shah, "Engineering Graphics", S Chand Publications.
3. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.
4. Prof. Sham Tickoo (Purdue University) &GauravVerma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.

BTECH 204 (STRUCTURED PROGRAMMING APPROACH)

Module	Topic	Detailed Contents	Hrs.
01	Introduction to Computer, Algorithm And Flowchart	**1.1 Basics of Computer:** Turing Model, Von Neumann Model, Basics of Positional Number System, Introduction to Operating System and component of an Operating System. **1.2 Algorithm & Flowchart :** Three construct of Algorithm and flowchart: Sequence, Decision (Selection) and Repetition	06
02	Fundamentals of C-Programming	**2.1** Character Set, Identifiers and keywords, Data types, Constants, Variables. **2.2 Operators-**Arithmetic, Relational and logical, Assignment, Unary, Conditional, Bitwise, Comma, other operators. Expression, statements, Library Functions, Preprocessor. **2.3 Data Input and Output** – getchar( ), putchar( ), scanf( ), printf( ), gets( ), puts( ), Structure of C program .	06
03	Control Structures	**3.1 Branching -** If statement, If-else Statement, Multiway decision. **3.2 Looping** – while , do-while, for **3.3 Nested control structure-** Switch statement, Continue statement Break statement, Goto statement.	12
04	Functions and Parameter	**4.1Function -**Introduction of Function, Function Main, Defining a Function, Accessing a Function, Function Prototype, Passing Arguments to a Function, Recursion. **4.2 Storage Classes –**Auto , Extern , Static, Register	06
05	Arrays , String Structure and Union	**5.1 Array-**Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array. **5.2 String-** Basic of String, Array of String , Functions in String.h **5.3 Structure-** Declaration, Initialization, structure within structure, Operation on structures, Array of Structure. **5.4 Union -** Definition , Difference between structure and union , Operations on a union	14
06	Pointer and Files	**6.1 Pointer :**Introduction, Definition and uses of Pointers, Address Operator, Pointer Variables, Dereferencing Pointer, Void Pointer, Pointer Arithmetic, Pointers to Pointers, Pointers and Array, Passing Arrays to Function, Pointers and Function, Pointers and two dimensional Array, Array of Pointers, Dynamic Memory Allocation. **6.2 File**s: Types of File, File operation- Opening, Closing, Creating, Reading, Processing File.	08

Reference Books:

1 "Basics of Computer Science", by BehrouzForouzan , Cengage Learning .
2 "Programming Techniques through C", by M. G. Venkateshmurthy, Pearson Publication.
3 "Programming in ANSI C", by E. Balaguruswamy, Tata McGraw-Hill Education.
4 "Programming in C", by Pradeep Day and Manas Gosh, Oxford University Press.
5 "Let Us C", by YashwantKanetkar, BPB Publication.

BTECH 205 (COMMUNICATION SKILLS)

Module	Detailed Contents	Hrs.
01	Communication Theory: Concept and Meaning, Communication cycle, Objectives, Barriers to communication (linguistic and semantic, psychological, physical, mechanical, cultural), Methods of communication (verbal and non-verbal), Networks of communication (formal and informal), Language skills (listening, speaking, reading, writing), Corporate communication: Digital Content Creation.	13
02	Business Correspondence: Principles of Business Correspondence, Parts of a business letter, Formats (Complete block and Modified block), Types of letters: Enquiry, Reply to enquiry, Claim, Adjustment and Sales letter.	05
03	Grammar and Vocabulary: Common errors, Concord (subject- verb agreement), Pairs of confused words, Lexicon (Enriching vocabulary through one-word substitutes, synonyms, antonyms, etc.)	02

04	Summarization and Comprehension: Passages to test the analytical skills and expression	02
05	Technical writing : Techniques to define an object, writing instructions, language exercises based on types of expositions (description of an object, explanation of a process)	02
06	Information Communication Technology (ICT) enabled communication media: E-mail, Blog and Website.	02

References:
1. Communication in Organizations by Dalmar Fisher, Jaico Publishing House
2. Communication Skills by Meenakshi Raman & Sangeeta Sharma,
3. Oxford University Press.
4. Business Correspondence & Report-writing by R.C. Sharma& Krishna Mohan, Tata McGraw-Hill Education.
5. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.
6. Technical Writing & Professional Communication for non-native speakers of English by Thomas N. Huckin & Leslie A. Olsen, McGraw –Hill.
7. Mastering Communication by Nicky Stanton, Palgrave Master Series
8. www.buisnesscommunicationskills.com
9. www.kcitraing.com
10. www.mindtools.com
11. Journal of Business Communication

BTECH 205 (WORKSHOP PRACTICE-II)

Detailed Syllabus is given in Basic Workshop Practice-I

SEMESTER- 3

BTECHME- 301 (APPLIED MATHEMATICS-III)

Module	Detailed Contents	Hrs
1	**Laplace Transform** 1.1 Function of bounded variation, Laplace Transform of standard functions such as 1, t^n, e^{at}, $\sin at$, $\cos at$, $\sinh at$, $\cosh at$ 1.2 Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $L\{t^n f(t)\}, L\left\{\dfrac{f(t)}{t}\right\}, L\left\{\displaystyle\int_0^t f(u)du\right\}, L\left\{\dfrac{d^n f(t)}{dt^n}\right\}$ Laplace Transform. of Periodic functions 1.3 Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem(without proof). 1.4 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable	12
2	**Complex variables:** 2.1 Functions of complex variable, Analytic function, necessary and sufficient conditions fo $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates. 2.2 Milne- Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories **2.3** Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation	08
3	**Complex Integration:** 3.1 Line integral of a function of a complex variable, Cauchy's theorem for analytic functions(without proof)Cauchy's integral formula (without proof))Singularities and poles: 3.2 Taylor's and Laurent's series development (without proof) 3.3 Residue at isolated singularity and its evaluation 3.4 Residue theorem, application to evaluate real integral of type $\displaystyle\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x)\, dx$	08
4	**Fourier Series:** 4.1 Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period 2π and $2l$	10

	4.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series,Parsvel's identities (without proof) 4.3 Complex form of Fourier series	
5	**Partial Differential Equations:** 5.1. Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method). 5.2. Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series. 5.3. Heat equation, steady-state configuration for heat flow 5.4. Two and Three dimensional Laplace equations	09
6	**Correlation and curve fitting** 6.1. Correlation-Karl Pearson's coefficient of correlation- problems, Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems 6.2. Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$	05

References:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
3. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi
4. Complex Variables: Churchill, Mc-Graw Hill
5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
6. Numerical Methods, Kandasamy, S. Chand & CO
7. Fundamentals of mathematical Statistics by S.C.. Gupta and Kapoor

BTECHME- 302 (THERMODYNAMICS)

Module	Detailed Contents	Hrs
01	**Basic Concepts & definitions:** Thermodynamics and its importance, Macroscopic and Microscopic view point, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Control Volume approach and Systems approach, Equilibrium – Thermal ,Chemical, Mechanical and thermodynamic, Pure Substance, Property – Intensive and Extensive, State, Path, Process and Cycle. Point Function and Path Function, Quasi Static Process and processes like Isobaric, Isochoric, Isothermal, Polytropic Process, Temperature and different scales, Zeroth Law of Thermodynamics, Energy, sources of energy; forms of energy, Energy transfer by work and forms of work ; free Expansion, Energy transfer by heat ; Adiabatic Process, Equations of state, Ideal gas Equation-; Specific gas constant and Universal Gas Constant	08
02	**First Law of Thermodynamics:** Relation between Heat and Work- Joules Constant, First law of thermodynamics for a cyclic process, First law of thermodynamics for a closed system undergoing a process, Conservation principle, First Law of Thermodynamics applied to open system – Steady Flow Energy Equation, Perpetual motion Machine of First kind, Application of first law of thermodynamics to closed system or Non flow Process, Application of first law of thermodynamics to Open Systems like Steam Nozzle, Boiler, Steam Turbine, Pump, Heat Exchanger, Throttling Process – Joules Thompson Coefficient and its significance	07
03	**Second Law of Thermodynamics:** Limitation of first law of thermodynamics, Thermal Reservoir – Source and Sink, Concept of Heat Engine, Heat Pump and Refrigerator, Second law of thermodynamics – Kelvin Planck and Clausius Statements. Equivalence of Clausius and Kelvin Planck Statement, Reversible and Irreversible Process. Causes of Irreversibility, Perpetual Motion Machine of Second Kind, Need of Carnot theorem and its corollaries, Carnot cycle, Thermodynamic Temperature Scale and its equivalence with Ideal Gas Scale **Entropy:** Clausius Inequality, Clausius Theorem, Entropy is Property of a system, Isentropic Process, Temperature Entropy Plot and its relationship with heat interactions, Entropy Principle, Entropy change During a Process. Interpretation of concept of entropy	07
04	**Thermodynamic Relations:** Reciprocal Relation, Cyclic Relation Property relations, Maxwell Relations, TdS equations, Heat capacity relations, Volume Expansivity, Isothermal Compressibility, Clausius-Clapeyron Equation **Availability:**	10

	High grade and Low Grade Energy, Available and Unavailable Energy, Dead State, Available energy with respect to a process and a cycle, Decrease of Available Energy When heat is transferred through a finite temperature Difference, Second Law efficiency **Properties of Pure Substance:** Pure substance and Phase changes: Phase change processes of pure substance, Property diagrams for phase change process (T-v, T-s and p-h diagrams), Understanding of Steam Table and Mollier chart with suitable examples.	
05	**Compressors:** Reciprocating Air Compressor, Single stage compressor – computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram, Multistage compressors – Constructional details of multistage compressors, Need of multistage, Computation of work done, Volumetric efficiency, Condition for maximum efficiency, Inter cooling and after cooling (numerical), Theoretical and actual indicator diagram for multi stage compressors Rotary Air Compressors- Classification, Difference between compressors and blowers, Working and constructional details of roots blower, Screw type and vane type compressors	08
06	**Vapour Power cycle:** Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Methods to improve thermal efficiency of Rankine cycle – Reheat cycle and Regeneration Cycle. **Gas Power cycles:** Assumptions of Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Brayton Cycle, Sterling Cycle and Ericsson Cycle and Lenoir cycle and Atkinson cycle	10

Reference Books:
1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael ABoles,7[th]edition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, Longman Publishers Engineering
3. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India
4. Thermodynamics by P K Nag, 5th edition, TMH
5. Thermodynamics by Onkar Singh, New Age International
6. Thermodynamics by C P Arora, TMH
7. Engineering Thermodynamics through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
8. Fundamentals of Thermodynamics by Moran & Shapiro
9. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., JohnWiley & Sons
10. Thermodynamics by W.C. Reynolds, McGraw-Hill & Co
11. Thermodynamics by J P Holman, McGraw-Hill & Co

BTECHME- 303 (STRENGTH OF MATERIAL)

Module	Detailed Contents	Hrs
1	**Moment of Inertia:** Area moment of Inertia, Principal Axes and Principal Moment of Inertia, , Parallel Axis theorem, Polar moment of Inertia. **Stresses and Strains:** Definition – Stress, Strain, Hooke's law, elastic limit, uni-axial, bi-axial and tri-axial stresses, tensile & compressive stresses, shear stress, Principal stresses and strains, Mohr's circle. **Elastic Constants:** Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Bulk Modulus, yield stress, Ultimate stress. Factor of safety, state of simple shear, relation between elastic constants, volumetric strain, volumetric strain for tri-axial loading, deformation of tapering members, deformation due to self –weight, bars of varying sections, composite sections, thermal stress and strain.	12
2	**Shear Force and Bending Moment in Beams:** Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading, relationship between rates of loading, shear force and bending moment.	08
3	**Stresses in Beams:** Theory of pure bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, section modulus for different sections, beams for uniform strength, Flitched beams. **Direct and Bending Stresses:** Core of sections, Chimneys subjected to wind pressure. **Shear Stress in Beams:** Distribution of shear stress, across plane sections used commonly for structural purposes, shear connectors.	08
4	**Torsion:** Torsion of circular shafts- solid and hollow, stresses in shafts when transmitting power, shafts in series and parallel. **Strain Energy:** Resilience, Proof Resilience, strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to shear, bending and torsion.	08
5	**Deflection of Beams:** Deflection of Cantilever, simply supported and overhang beams using double integration and Macaulay's Method for different types of loadings **Thin Cylindrical and Spherical Shells:** Cylinders and Spheres due to internal pressure, Cylindrical shell with hemi spherical ends	08
6	**Columns and Struts:** Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine and Johnson formula	04

References:

1. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016
2. Strength of Materials by Ryder, Macmillan
3. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, 6thEd, 2009
4. Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
5. Strength of Materials by Basavrajaiah and Mahadevappa, Khanna Publishers,New Delhi
6. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
7. Mechanics of Materials byBeer, Jhonston, DEwolf and Mazurek, TMHPvt Ltd., New Delhi
8. Mechanics of Structures by S.B.Junnarkar, Charotar Publication
9. Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
10. Introduction to Solid Mechanics by Shames, PHI
11. Strength of Materials by Nag and Chandra, Wiley India
12. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
13. Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition

BTECHME- 304 (PRODUCTION PROCESS I)

Module	Detailed Contents	Hrs
1	1.1 **Metal casting:** Classification of Production Processes: Examples and field of applications Pattern materials and allowances, Types of pattern, Sand properties, Sand moulding, Machine moulding Gating system :Types of riser, types of gates, solidification Melting- cupola& induction furnaces 1.2 **Special casting processes** : CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	10
2	2.1 **Joining processes:** Welding: Classification of welding, Oxy-acetylene welding, types of flames, equipment used, welding methods & applications, Arc welding principle and working of metal arc welding, TIG & MIG welding, submerged arc welding, electro-slag welding & stud welding PAM welding. Applications merits & demerits of above welding processes, fluxes used, Thermit welding, Resistance welding, Friction welding, ultrasonic, explosive, LASER, electron beam welding, Welding defects and remedies Soldering and brazing techniques & applications Fastening processes	10
3	3.1 **Forming processes:** Principles and process characteristics, Rolling types, Rolling parameters: Draught, spread, elongation, roll pressure, torque, work and power in rolling. Effect of front and back tension on rolling load and capacities, Rolling defects, Thread rolling roll forging, production of seamless tubes, Forging, Extrusion and Wire Drawing processes	08
4	4.1 **Moulding with polymers:** Moulding with polymers: Basic concepts related to Injection Moulding, Compression moulding, Transfer moulding, Blow Moulding, Rotational Moulding, Thermoforming and Extrusion. Applications of plastics in Engineering field 4.2 **Moulding with ceramics**: Blow moulding and extrusion of glass.	06
5	**Classification, Selection and application of Machine Tools:** 5.1 Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines, Broaching machines, Lapping/Honing machines and shaping/slotting/planning Machines. 5.2 Gear Manufacturing -Gear milling, standard cutters and limitations, gear hobbing, gear shaping, gear shaving and gear grinding processes	10
6	5.1 **Modern Machine Tools:** CNC machines: Introduction, principles of operation, Types – Vertical machining centres and horizontal machining centres, major elements, functions, applications, controllers, open loop and closed loop systems 5.2 Types of automatic machines, Transfer machines	04

References

1. Workshop Technology By W. A. J. Chapman part I, II & III
2. A Textbook of Foundry Technology by M. Lal
3. Production Technology by R. C. Patel and C. G. Gupta Vol I, II.
4. Production Technology by Jain & Gupta
5. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R. Schmid, Prentice Hall
6. Production Technology by HMT
7. Elements of Workshop Technology Hazra Chaudhary Vol I, II.
8. Foundry technology by P.L. Jain
9. Production Technology by P.C. Sharma
10. Manufacturing processes by P. N. Rao, Vol. 1 and 2

BTECHME- 305 (MATERIAL TECHNOLOGY)

Module	Detailed Contents	Hrs
1	**1.1 Classification of Materials:** Metallic materials, Polymeric Materials, Ceramics and Composites: Definition, general properties, applications with examples **1.2 Lattice Imperfections:** Definition, classification and significance of Imperfections Point defects: vacancy, interstitial and impurity atom defects, Their formation and effects, Dislocation - Edge and screw dislocations Burger's vector, Motion of dislocations and their significance, Surface defects - Grain boundary, sub-angle grain boundary and stacking faults, their significance, Generation of dislocation, Frank Reed source, conditions of multiplication and significance. **1.3 Deformation:** Definition, elastic and plastic deformation, Mechanism of deformation and its significance in design and shaping, Critical Resolved shear stress, Deformation in single crystal and polycrystalline materials, Slip systems and deformability of FCC, BCC and HCP lattice systems. **1.4 Strain Hardening:** Definition importance of strain hardening, Dislocation theory of strain hardening, Effect of strain hardening on engineering behaviour of materials, Recrystallization Annealing: stages of recrystallization annealing and factors affecting it	08
2	**Failure mechanisms:** **1.1 Fracture:** Definition and types of facture, Brittle fracture: Griffith's theory of fracture, Orowan's modification, Dislocation theory of fracture, Critical stress and crack propagation velocity for brittle fracture, Ductile fracture: Notch effect on fracture, Fracture toughness, Ductility transition, Definition and significance **1.2 Fatigue Failure:** Definition of fatigue and significance of cyclic stress, Mechanism of fatigue and theories of fatigue failure, Fatigue testing, Test data presentation and statistical evolution, S-N Curve and its interpretation, Influence of important factors on fatigue, Notch effect, surface effect, Effect of pre-stressing, corrosion fatigue, Thermal fatigue. **1.3 Creep:** Definition and significance of creep, Effect of temperature and creep on mechanical behaviours of materials, Creep testing and data presentation and analysis, Mechanism and types of creep, Analysis of classical creep curve and use of creep rate in designing of products for load bearing applications, Creep Resistant materials	08
3	**3.1 Theory of Alloys& Alloys Diagrams :** Significance of alloying, Definition, Classification and properties of different types of alloys, Solidification of pure metal, Different types of phase diagrams (Isomorphous, Eutectic,	08

	Peritectic, Eutectoid, Peritectoid) and their analysis, Importance of Iron as engineering material, Allotropic forms of Iron, Influence of carbon in Iron- Carbon alloying Iron-Iron carbide diagram and its analysis, TTT diagram, CCT diagram Hardenability concepts and tests, Graphitization of Iron- Grey iron, white iron, Nodular and malleable irons, their microstructures, properties and applications	
4	**4.1 Heat treatment Process:** Technology of heat treatment, Classification of heat treatment process, Annealing- Principle process, properties and applications of full annealing, Diffusion annealing, process annealing and Cyclic annealing, Normalizing, Hardening heat treatment, Tempering, Subzero treatment, Austempering, Martempering, Maraging and Ausforming process, Surface hardening: Hardening and surface Hardening methods. Carburizing, Nitriding, Cyaniding, Carbonitriding, induction hardening and flame hardening processes	06
5	**5.1 Effect of Alloying Elements in Steels:** Limitation of plain carbon steels, Significance of alloying elements,Effects of major and minor constituents, Effect of alloying elements on phase transformation Classification of tool steels and metallurgy of tool steels and stainless steel	04
6	**Introduction to New materials:** **6.1** Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications **6.2** Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and Nano composites **6.3** An overview to Smart materials (e.g.: Rheological fluids)	04

References
1. Materials Science and Engineering by William D. Callister, Jr. – Adapted by R.Balasubramaniam, Wiley India (P) Ltd
2. Material Science and Metallurgy by V.D. Kodgire, Everest Publishing House
3. Mechanical Behaviour of Materials by Courtney, McGraw Hill International New Delhi
4. Introduction of Engineering Materials, by B.K. Agrawal, McGraw Hill Pub. Co. ltd
5. Mechanical Metallurgy by G.E. Dieter, McGraw Hill International New Delhi
6. A text book of Metallurgy by A.R.Bailey, Macmillan & Co. Ltd., London
7. The Structure and Properties of Engineering Alloys by W.F. Smith, McGraw hill Int.
8. Engineering Physical Metallurgy, by Y. Lakhtin, Mir Publishers, Moscow
9. Introduction to Physical Metallurgy by SydneyAvner, McGraw Hill
10. Metallurgy for Engineers by E.C. Rollason - ELBS SOC and Edward Arnold, London

BTECHME- 306 (COMPUTER AIDED MACHINE DRAWING)

Module	Detailed Contents	Theory	Practical
1	**1.1 Machine Elements:** Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc)	02	04
	1.2 Conventional representation of threaded parts, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components	01	--
	1.3 Solid Geometry: Intersection of surfaces and interpenetration of solids- Intersection of prism or cylinder with prism; cylinder or cone, both solids in simple position only. Primary auxiliary views	04	--
2	**2.1 Geometric Dimensioning and Tolerancing (GD&T) :** Dimensioning with tolerances indicating various types of fits,	02	--
	2.2 Details and assembly drawing: Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards,	02	--
	2.3 Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa,		
	2.4 Preparation of details and assembly drawings of *any three* from: Clapper block, Single tool post, Lathe and Milling tail stock, jigs and fixtures	02	08
	2.5 Cotter, Knuckle joint, Keys: keys-sunk, parallel woodruff, saddle, feather etc.	01	--
	2.6 Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling	02	06
3	**3.1 Preparation of details and assembly drawings of Bearings:** Simple, solid, Bushed bearing, I.S. conventional representation of ball and roller bearing, Pedestal bearing, footstep bearing	02	06
4	**4.1 Preparation of details and assembly drawings of pulleys, Pipe joints:** Classification of Pulleys, pipe joints	02	--
	4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys.	--	06
	4.3 Pipe joints*(any two)***:** Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint	--	06
5	**5.2 Preparation of details and assembly drawings of Valves, I.C. Engine parts:** Types of Valves, introduction to I.C. Engine	02	--
	5.3 Preparation of details and assembly drawings*(any three):* Air cock; Blow off cock, Steam stop valve, Gate valve, Globe valve, Non return Valve, I.C. Engine parts: Piston, Connecting rod, Cross head, Crankshaft, Carburettor, Fuel pump, injector, and Spark plug	--	08
6	**6.1 Reverse Engineering of a physical model:** disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions	02	06

References:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L. Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M. B. Shah
5. A text book of Machine Drawing by R. B. Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I.Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by ShamTickoo and SurinderRaina, Dreamtech Press
9. Engineering Drawing by P J Shah
10. Engineering Drawing by N D Bhatt

BTECHME- 351 (STRENGTH OF MATERIAL LAB)

Module	Detailed Contents
1	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)
2	Bending test on UTM
3	Torsion test on mild steel bar / cast iron bar
4	Impact test on metal specimen (Izod test)
5	Impact test on metal specimen (Charpy test)
6	Hardness test on metals - Brinell Hardness Number
7	Hardness test on metals - Rockwell Hardness Number
8	Flexural test on beam (central loading)
9	Flexural test on beam (three point loading)

BTECHME- 352 (MATERIAL TECHNOLOGY LAB)

Sr No	Details
1	Study of metallurgical microscope
2	Metallographic sample preparation and etching
3	Microstructures of plain carbon steels
4	Microstructures of cast irons
5	Annealing, Normalizing and Hardening of medium carbon steel and observation of microstructures
6	Study of tempering characteristics of hardened steel
7	Determination of hardenability of steel using Jominy end Quench Test
8	Fatigue test – to determine number of cycles to failure of a given material at a given stress

BTECHME- 353 (MACHINE SHOP-I PRACTICE LAB)

Module	Details
1	Introduction to Lathe Machine, demonstration of various machining processes performed on lathe machine. One Job on Plain and Taper Turning One job on Precision Turning, Taper Turning and Screw Cutting
2	Introduction to Shaping Machine and various machining processes performed on Shaping Machine One job on shaping machine to make horizontal and inclined surface
3	Introduction to various forging tools Two jobs on Forging of Cutting Tools used on Lathe Machine
4	One simple exercise on Welding, Preparation of a component using Compressive Welding Joint

SEMESTER-4

BTECHME- 401 (APPLIED MATHEMATICS IV)

Module	Details	Hrs
1	**Matrices:** 1.1 Brief revision of vectors over a real field, inner product, norm of a vector 1.2 Eigen values and Eigen vectors: Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix, Cayley Hamilton theorem (without proof) . Similarity of matrices. Functions of a square matrix	08
2	**Matrices:** 2.1 Minimal polynomial and Derogatory matrix 2.2 Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors **Vector calculus** 2.3 Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function 2.4 Line integrals, circulation of a vector, condition for independence of the path in the line integral	09
3	**Vector calculus:** 3.1 Green's theorem(without proof) for plane regions and properties of line integrals, Stokes theorem (without proof), Gauss divergence theorem (without proof) related identities and deductions.(No verification problems on Stoke's Theorem and Gauss Divergence Theorem) **Linear Programming problems** 3.2 Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P	09
4	**Linear Programming problems Probability Distributions:** 4.1 Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P. **Probability Distributions** 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. 4.3 Probability Distributions: Binomial, Poisson and Normal Distributions	09

5	**Sampling theory:** 5.1. Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical 5.2. region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples 5.3. Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples. **5.4.** Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test	09
6	**Sampling theory and ANOVA** 6.1. Chi-square test, Test for the Goodness of fit , Association of attributes and Yate's correction 6.2. Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method)	08

References:

1. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand & co
4. Vector Analysis by Murray R. Spiegel, Shaum Series
5. Operations Research, S.D. Sharma, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, S. Chand & Co
7. Elements of Applied mathematics, P N & J N Wartikar, Pune Vidyarthi Gruha Prakashan
8. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
9. Operations Research, Kantiswearup, Manmohan, P K Gupta, S. Chand & CO

BTECHME- 402 (FLUID MECHANICS)

Module	Detailed Contents	Hrs
1	1.1 Fluid Definition and properties, Newton's law of viscosity concept of continuum, Classification of fluids 1.2 Fluid Statics: Definition of body and surface forces, Pascal's law, Basic hydrostatic equation, Forces on surfaces due to hydrostatic pressure, Buoyancy and Archimedes' principle	06
2	**2 Fluid Kinematics:** 2.1 Eulerian and Lagrangian approach to solutions; Velocity and acceleration in an Eulerian flow field; Definition of streamlines, path lines and streak lines; Definition of steady/unsteady, uniform/non-uniform, one-two and three dimensional flows; Definition of control volume and control surface, Understanding of differential and integral methods of analysis 2.2 Definition and equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates, rotational and irrotational flows; Definition and equations for source, sink, irrotational vortex, circulation	06
3	**3 Fluid Dynamics:** 3.1 Integral equations for the control volume: Reynold's Transport theorem, equations for conservation of mass, energy and momentum, Bernoulli's equation and its application in flow measurement, pitot tube, venture, orifice and nozzle meters. 3.2 Differential equations for the control volume: Mass conservation in 2 and 3 dimension in rectangular, Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation; Navier-Stokes equations (without proof) in rectangular Cartesian co-ordinates; Exact solutions of Navier-Stokes Equations to viscous laminar flow between two parallel planes (Couette flow and plane Poiseuille flow)	12
4	**4 Real fluid flows:** 4.1 Definition of Reynold's number, Laminar flow through a pipe (Hagen-Poiseuille flow), velocity profile and head loss; Turbulent flows and theories of turbulence-Statistical theory, Eddy viscosity theory and Prandtl mixing length theory; velocity profiles for turbulent flows-universal velocity profile, $1/7^{th}$ power law; Velocity profiles for smooth and rough pipes 4.2 Darcy's equation for head loss in pipe (no derivation), Moody's diagram, pipes in series and parallel, major and minor losses in pipes	08
5	**5 Boundary Layer Flows:** 5.1 Concept of boundary layer and definition of boundary layer thickness, displacement, momentum and energy thickness; Growth of boundary layer,	08
	laminar and turbulent boundary layers, laminar sub-layer; Von Karman Momentum Integral equation for boundary layers (without proof), analysis of laminar and turbulent boundary layers, drag, boundary layer separation and methods to control it, streamlined and bluff bodies 5.2 Aerofoil theory: Definition of aerofoil, lift and drag, stalling of aerofoils, induced drag	
6	**6 Compressible Fluid flow:** 6.1 Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Application of continuity, momentum and energy equations for steady state conditions; steady flow through nozzle, isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio 6.2 Normal shocks, basic equations of normal shock, change of properties across normal shock	08

Reference Books:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, McGraw Hill Education, 3rd Edition
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press
3. Introduction to Fluid Mechanics by Fox and McDonald
4. Fluid Mechanics by R K Bansal
5. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9th Edition
6. Fluid Mechanics by K. L. Kumar
7. Introduction to Fluid Mechanics by James A. Fay
8. Fluid Mechanics by B. M. Massey
9. Mechanics of Fluids by Irving Shames
10. Fluid Mechanics and Hydraulics, S. K. Ukarande, Ane Books Pvt.Ltd

BTECHME- 403 (INDUSTRIAL ELECTRONICS)

Module	Detailed Contents	Hrs.
1	**Semiconductor Devices:** Diodes: Principles V-I characteristics and Application of: rectifier diode, zener diode, LED, photodiode, SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn-off thyristor (GTO). Structure and V-I characteristics of Triac (modes of operation not needed) and Diac, Applications of Triac-Diac circuit. Characteristics and principle of Power BJT, power MOSFET, IGBT, comparison of devices, MOSFET/IGBT Gate driver circuit Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT	08
2	**Phase controlled rectifiers and Bridge inverters:** Full wave controlled rectifier using SCR's(semi controlled, fully controlled) with R load only, Derivation of output voltage Block diagram of closed loop speed control of DC motors, Necessity of inner current control loop Basic principle of single phase and three phase bridge inverters , block diagrams including rectifier and inverter for speed control of AC motors (frequency control only)	07
3	**Operational amplifiers and 555 Timer:** Operational amplifier circuits, Ideal OPAMP behaviour, common OPAMP ICs; Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Instrumentation Amplifier, Active first order filter: Low pass and high pass filter; Power Op Amps, Optical Isolation amplifier; 555 timer-Operating modes: monostable, astable multivibrator	04
4	**Digital logic and logic families:** Digital signals, combinational and sequential logic circuits, clock signals, Boolean algebra and logic gates. Integrated circuits and logic families: Logic Levels, Noise Immunity, Fan Out, Propagation Delay, TTL logic family CMOS Logic family, comparison with TTL family Flip flops: Set Reset(SR),Trigger(T), clocked F/Fs; Registers, decoders and encoders, Multiplexer and Demultiplexer, applications	04
5	**Microprocessor and Microcontrollers:** Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller	08

	MSP430 architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output) Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor, Piezoelectric Actuator Drive	
6	**Motors:** Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor Basics of BLDC motor, Linear Actuator motor, Servo Motor Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor.	05

Reference Books:

1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics, Vedam Subramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall
6. Industrial Electronics and Control by S K Bhattacharya, S Chatterjee, TTTI Chandigarh
7. Modern Digitals Electronic, Jain R P, Tata McGraw Hill, 1984
8. Digital principal and Application, Malvino and Leach, Tata McGraw Hill, 1991
9. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM
10. MSP430 Microcontroller Basics, John H. Davies, Newnes; 1 edition 2008

BTECHME- 404 (PRODUCTION PROCESS II)

Module	Details	Hrs
1	**Metal Cutting:** 1.1 Features of machining processes, concept of speed and cutting, mechanism of chip formation, concept of shear plane, chip reduction coefficient force analysis, Merchants circle of cutting forces, expression for shear plane angle and coefficient of friction in terms of cutting forces and tool angles, Merchants theory-original and modified, effect of various parameters on cutting forces 1.2 Different types of dynamometers and their operations, Tool life definition, mechanism of tool wear and measurement, preliminary and ultimate feature, factors influencing tool life such as speed, feed, depth of cut, tool material, cutting fluids etc., Machinability, factors affecting surface finish	16
2.	**Tool Engineering:** 2.1 Cutting Tool geometry and definition of principles tool angles of single point cutting tools, Types of milling cutters and their geometry, Geometry of drill, broach 2.2 Specification & Selection of grinding wheel, dressing & truing and balancing of grinding wheels	06
3.	**Sheet Metal Forming:** 3.1 Sheet metal operations, Classification of presses, Types of Dies:, compound, combination, progressive, bending, forming and drawing dies, scrap strip layout, centre of pressure, selection of die sets, stock guides, strippers	06
4.	**Jigs and Fixtures:** 4.1 Elements of Jigs and fixtures, principles of location, types of locating and clamping elements, Drill bushes-their types and applications indexing devices, auxiliary elements, Types of jigs, Milling fixture and turning fixture	06
5.	**Non-traditional Machining:** 5.1 Ultrasonic Machining (USM), Abrasive Jet Machining (AJM),Water Jet Machining, Electrochemical Machining (ECM),Chemical Machining (CHM)Electrical Discharge Machining (EDM),Plasma Arc Machining (PAM),Laser Beam Machining (LBM),Electron Beam Machining (EBM)	06

6.	**Additive Manufacturing:** 6.1 Historical Development , Fundamentals of Rapid Prototyping, Advantages of Rapid Prototyping ,Additive Manufacturing (AM) Definition, Applications of AM parts, The Generic AM process, Why use the term Additive Manufacturing, The Benefits of AM, Distinction Between AM and CNC Machining, Other Related Technologies: Reverse Engineering, CAE, Haptic based CAD, Classifications of AM / RP System: Liquid polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems 6.2 New AM Classification Schemes as per ASTM F42 and ISO TC 261: Vat photo polymerization, Powder bed fusion, Material extrusion, Material jetting, Binder jetting, Sheet lamination and Directed energy deposition 6.3 Vat Photo Polymerization based AM / RP Systems: Principle of operation, Process, materials advantages, disadvantages, and applications of 3D Systems' stereo lithography (SLA), CMET'S Solid Object Ultraviolet-Laser Printer (SOUP).	08

References

1. Tool Design by Donaldson
2. Machining Process by H.L. Juneja
3. Production Technology - HMT
4. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R Schmid, Prentice Hall
5. Fundamentals of Tool Design by ASTME
6. Metal cutting Theory & Cutting Tool Designing by V. Arshinov, G Alekseev
7. Principle of Metal cutting by Sen & Bhattacharya
8. Manufacturing science by Ghosh and Mallick
9. Production Engg by P.C.Sharma
10. Additive Manufacturing Technologies, Ian Gibson, D.W. Rosen, and B. Stucker, , 2nd Edition, Springer 2015

BTECHME- 405 (KINEMATICS OF MACHINERY)

Module	Details	Hrs.
1	**1.1 Kinetics of Rigid Bodies:** Mass M.I. about centroidal axis and about any other axis, Radius of Gyration, D'Alembert's Principle of bodies under rotational motion about a fixed axis and plane motion, Application of motion of bars, cylinders and spheres only Kinetics of Rigid bodies: Work and Energy Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work Energy Principle and Conservation of energy **1.2 Basic Kinematics:** Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grübler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	10
2	**2.1 Special Mechanisms:** **Straight line generating mechanisms:** Introduction to Exact straight line generating mechanisms - Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms- Watt's,Grasshopper mechanism, Tchebicheff's mechanisms **Offset slider crank mechanisms** - Pantograph, Hook-joint (single and double). **Steering Gear Mechanism** - Ackerman, Davis steering gears	06
3	**3.1 Velocity Analysis of Mechanisms (mechanisms up to 6 links):** Velocity analysis by instantaneous center of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach) Analysis extended to find rubbing velocities at joints, mechanical advantage (Graphical approach) Velocity analysis of low degree complexity mechanism (Graphical approach), Auxiliary point method **3.2 Velocity and Acceleration Analysis of Mechanism:** Velocity and Acceleration- analysis by relative method (mechanism up to 6 link) including pairs involving Coriolis acceleration (Graphical Approach)	10
4	**4.1 Cam Mechanism:** Cam and its Classification, Followers and its Classification, Motion analysis and plotting of displacement - time, velocity-time, acceleration-time, jerk-time graphs for uniform velocity, UARM, SHM, and Cycloid motions (combined motions during one stroke excluded), Motion analysis of simple cams - R-R cam, D-R-R and D-R-D-R Cam operating radial translating follower, Pressure angle	06

Module	Details	Hrs.
5	**5.1 Belts, Chains and Brakes:** **Belts:** Introduction, types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission **Chains:** types of chains, chordal action, variation in velocity ratio, length of chain **Brakes:** Introduction, types and working principles, Introduction to braking of vehicles	06
6	**6.1 Gears and Gear Trains:** **Gears-** Introduction, types, Law of gearing, Construction of Involute and Cycloid gear tooth profile, Details of gear terminology, involutes and cycloidal tooth profile, Interference in involutes gears, Critical numbers of teeth for interference free motion Methods to control interference in involutes gears, Static force analysis in gears - spur, helical, bevel, worm & worm wheel **Gear Trains:** Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination	10

References:

1. Theory of Mechanisms and Machines by Amitabh Ghosh and A. Kumar Mallik
2. Theory of Machines and Mechanism by Uicker Jr, Garden Pennock & J.F. Shigley, OXFORD University Press
3. Theory of Machines by P L Ballaney
4. Theory of Machines by S S Ratan
5. Kinematics of Machines by R T Hinckle, Prentice Hall Inc
6. Kinematics by V M Fairs, McGraw Hill
7. Mechanism Design: Analysis and Synthesis Vol I by A. Erdman and G N Sander, Prentice Hall
8. Kinematics and Dynamics of Planer mechanisms by Jeremy Hirsihham, McGraw Hill
9. Theory of Machines by W. G. Green, Bluckie & Sons Ltd

BTECHME- 406 (DATABASE & INFORMATION RETRIEVAL)

Module	Detailed Contents	Hrs.
01	**Introduction to Database Concept:** What is a database?, Characteristics of database, Example of database, File system V/s Database system, What is DBMS?, Users of database system, Advantage of using an enterprise database, Concerns when using an enterprise database, Data independence, DBMS systems architecture, Database administrator	02
02	**Entity-Relationship Data Model:** Introduction, Benefits of Data Modelling, Types of Models, Phases of Database Modelling, The Entity-Relationship (ER) Model, Generalisation, Specialization and Aggregation, Extended Entity-Relationship (EER) Model	04
03	**Rational Model and Algebra:** Introduction, Mapping the ER and EER Model to the relational Model, Data Manipulation, Data Integrity, Advantages of Relational Model, Relational Algebra, Relational Algebra Queries, Relational Calculus	04
04	**Structured Query Language (SQL):** Overview of SQL, Data definition commands, set operations, aggregrate functions, null values, Data manipulation commands, Data control commands, Views- using virtual tables in SQL, Nested and complex queries	04
05	**Introduction to Transactions Management and Co-currency:** Transaction concept, transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, **Co-currency Control:** Lock-based, Timestamp-based, Validation-based protocols, Deadlock handling, Recovery system, Failure classification, Storage structure, Recovery and atomicity, Log based recovery, Shadow paging	04
06	**Graphical User Interface:** Murphy's law of GUI design, Features of GUI, Icons and graphics, Identifying visual cues, clear communication, colour selection, GUI standard, planning GUI Design Work **Visual Programming:** *Sharing Data and Code:* Working with projects, introduction to basic language, Using inbuilt controls and ActiveX controls, creating and using classes, introduction to collections, usinf and creating ActiveX components, dynamics data exchange, Object linking and embedding, *Creating visual software entities:* Working with text, graphics, working with files, file management, serial communication, multimedia control interfaces	06

Reference Books:
1. Database Management Systems, G K Gupta, McGraw – Hill
2. Database System Concepts, Korth, Slberchatz, Sudarshan, 6th Edition, McGraw – Hill
3. GUI Design for dummies, IDG books
4. Visual Basic 2005, How to program, Deitel and Deitel, 3rd Edition, Pearson Education
5. SQL and PL/SQL for Oracle 10g, Black Book, Dr P S Deshpande, Dreamtech Press
6. Introduction to Database Management, Mark L Gillenson, Paulraj Ponniah, Wiley
7. Oracle for Professional, Sharaman Shah, SPD.
8. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH
9. Fundamentals of Database Management System, Mark L Gillenson, Wiley India

BTECHME- 451 (FLUID MECHANICS LAB)

Expt no	Experiment
1	Calibration of Pressure Gauges
2	Measurement of Hydrostatic Pressures
3	Verification of Archimedes' Principle
4	Calibration of Venturimeter/ Orificemeter/Nozzlemeter/ Pitot tube
5	Determine the friction factor for Pipes
6	Determination of major and minor losses in Pipe systems
7	Verification of Bernoulli's Equation
8	Experiment on Laminar flow in pipes
9	Calculation of Lift and Drag over an aerofoil
10	Determine the pressure profile over an aerofoil

BTECHME- 452 (INDUSTRIAL ELECTRONICS LAB)

Sr No	Detailed Contents
1	MOSFET / IGBT as a switch
2	V-I characteristics of SCR
3	Triggering circuit of SCR (UJT)
4	Full wave Rectifier using SCR
5	Single phase Bridge inverter with rectifier load
6	OPAMP as integrator
7	555 timer as astable multivibrator
8	Implementing study of gates and Logic Operations like, NOT, AND, OR
9	Realization of basic gates using universal gates
10	Light dimmer circuit using Diac-Triac
11	Speed control of DC motor
12	Speed control of induction motor
13	Simple programs using microcontroller
14	Simple microcontroller based application like Temp Measurement/ Speed Measurement using Proximity Sensor/ Piezoelectric Actuator Drive
15	Microcontroller based speed control for Induction Motor

BTECHME- 452 (KINEMATICS OF MACHINERY LAB)

Sr No	Details
1	Analysis of velocity of mechanisms by Instantaneous Center of Rotation – 3 to 5 problems
2	Analysis of velocity of mechanism by Relative method – 3 to 5 problems
3	Analysis of Velocity & Acceleration of mechanism by Relative method – 3 to 5 problems
4	Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, jerk-time and layout of cam profiles - 2 to 3 problems
5	Mini project on design and fabrication of any one mechanism for a group of maximum 4 students

BTECHME- 453 (MACHINE SHOP- II PRACTICE LAB)

Module	Details
1	One composite job consisting minimum four parts employing operations on lathe like precision turning screw cutting, boring etc. This job shall involve use of shaping, milling and grinding operations

SEMESTER 5

BTECHME- 501 (INTERNAL COMBUSTION ENGINES)

Module	Detailed Contents	Hrs.
01	**Introduction** Classification of I.C. Engines; Parts of I.C. Engine and their materials, Cycle of operation in Four stroke and Two-stroke IC engines and their comparative study; Fuel air cycles and their analysis, Actual working cycle, Valve Timing Diagram. LHR Engines, Homogeneous charge compression Ignition, Rotary engine-Six stroke engine concept	06
02	**S.I. Engines** **Fuel Supply System:** Spark ignition Engine mixture requirements, Fuel-Air ratio, Simple carburettor and auxiliary circuits (excluding mathematical analysis of carburettors) Injection systems: Single-point and Multipoint injection, Gasoline Direct Injection **Ignition System:** Battery Ignition System, Magneto Ignition System, Functions and working of ignition coil, spark plug, contact breaker point, Requirements and working of Ignition advance mechanisms; mechanical and vacuum, Electronic Ignition Systems; Capacitor Discharge Ignition System, Transistorized Coil Assisted Ignition System, Transistor Ignition system with contactless breaker **Combustion :** Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Abnormal combustion, Auto ignition, Detonation and Knocking, Factors affecting combustion and detonation, Types of combustion chambers	12
03	**Compression Ignition Engines** **Fuel Injection Systems:** Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit systems. Injection pumps, Fuel injector, Types of nozzle, Electronically controlled unit fuel injection system **Combustion:** Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers	10
04	**Engine lubrication:** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems **Engine Cooling:** Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling **Supercharging/Turbo-charging:** Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers	06

05	**Engine Testing and Performance** Measurement of Brake Power, Indicated Power, Frictional Power, Fuel Consumption, Air flow, BMEP, Performance characteristic of SI and CI Engine Effect of load and speed on Mechanical, Indicated Thermal, Brake Thermal and Volumetric efficiencies, Heat balance sheet. **Engine Exhaust Emission and its control** Constituents of exhaust emission at its harmful effect on environment and human health, Formation of NOx, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms.	10
06	**Alternative Fuels** Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel- Biogas - Producer Gas - Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. **Basics of Electronic Engine Controls:** Electronic Control module (ECM), Inputs required and output signals from ECM, Sensors: Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow and Exhaust Gas Oxygen sensors, their construction and importance in ECM. Electronic Spark control, Air Management system, Idle speed control	04

References:

1. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education.
2. Internal Combustion Engines, Shyam Agrawal, New Age International
3. Internal Combustion Engine, Mathur and Sharma
4. Internal Combustion Engines, Mohanty, Standard Book House
5. Internal Combustion Engine, Gills and Smith
6. Internal Combustion Engines Fundamentals, John B. Heywood , TMH
7. Internal Combustion Engines, Gupta H N, 2nd ed, PHI
8. Internal Combustion Engine, V Ganesan, TMH
9. Introduction to Internal Combustion Engines, Richard Stone, Palgrave Publication, 4th Edition
10. Internal Combustion Engine, S.L. Beohar
11. Internal Combustion Engine, P.M Heldt.
12. Internal Combustion Engines, V.L. Maleeve
13. Internal Combustion Engine, E.F. Oberi.
14. Internal Combustion Engine by Domkundwar

BTECHME- 502 (MECHANICAL MESUREMENT & CONTROL)

Module	Contents	Hours
01	1.1 Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. 1.2 Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. 1.3 Errors in measurement: Types of errors, Effect of component errors, Probable errors.	08
02	2.1 **Displacement Measurement**: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder) , Nozzle Flapper Transducer 2.2 **Strain Measurement**: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors 2.3 **Measurement of Angular Velocity**: Tachometers, Tachogenerators, Digital tachometers and Stroboscopic Methods. 2.4 **Acceleration Measurement:** theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectric accelerometers	08
03	3.1 **Pressure Measurement:** Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges 3.2 **Flow Measurement**: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter 3.3 **Temperature Measurement**: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers 3.4 **Sensitivity analysis of sensor-**influence of component variation 3.5 **Signal conditioning**: Amplifier, Conversion, Filtering, Impedance Buffering, Modulation / Demodulation, Linearization, Grounding and Isolation	08
04	**4.1** Introduction to control systems, Classification of control system. Open loop and closed loop systems. **4.2** Mathematical modelling of control systems, concept of transfer function, Block diagram algebra	06
05	**5.1 Transient and steady state analysis of first and second order system.** Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	06

06	**Stability analysis** 6.1 Introduction to concepts of stability, The Routh criteria for stability 6.2 Experimental determination of frequency response, Stability analysis using Root locus, Bode plot and Nyquist Plots 6.3 State space modeling 6.4 Process control systems, ON-OFF control. P-I-D Control	12

References

1. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition,*McGraw Hill*
2. Mechanical Engineering Measurements, A K Sawhney, *Dhanpat Rai& Sons, New Delhi*
3. Instrumentation & Mechanical Measurements, A K Thayal
4. Control System Engineering by Nagrath IJ and Gopal M, *Wiley EasternLtd.*
5. Modem Control engineering: by KOgata, *Prentice Hall*
6. Control systems by DhaneshManik, Cengage Learning
7. Engineering Metrology and Measurementsby N V Raghavendra and L Krishnamurthy, Oxford University Press
8. Instrumentation and Control System, W. Bolton, Elsevier
9. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
10. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
11. Mechanical Measurements by S P Venkateshan, Ane books, India

BTECHME- 503 (HEAT TRANSFER)

Module	Detailed Contents	Hrs.
01	**Basic concepts of heat transfer:** Define heat transfer and its importance in engineering applications, Difference between heat transfer and Thermodynamics, Physical Mechanism of modes of heat transfer, Governing laws of heat transfer, Conduction mode: Thermal conductivity, Thermal diffusivity, Convection mode: Free and Forced convection, Heat transfer Coefficient, Radiation mode: Emissivity, transmissivity, reflectivity, absorptivity, Black body, Grey body, Opaque body, Steady and unsteady heat transfer, One dimensional, two dimensional and three dimensional heat transfer, Thermal resistance concept in heat transfer, Thermal contact resistance	04
02	**Conduction:** Assumptions in heat conduction, Generalized heat conduction equation in rectangular, cylindrical coordinates, Initial and boundary conditions, Steady state heat conduction through plane wall, Composite wall, cylinder, composite cylinder wall, sphere, Internal Heat generation concept, Heat conduction with heat generation in plane wall, solid cylinder and solid sphere, Critical radius of insulation in cylinder and sphere	08
03	**Heat transfer from Extended Surface:** Types of extended surface and its significance, Governing differential equation for fin and its solution, Fin performance: Fin effectiveness and Fin efficiency, Thermo Well **Unsteady state heat transfer:** Applications of unsteady state heat transfer, Lumped system Analysis, Criteria for lumped system analysis: characteristic length, Biot Number, Thermal time constant and Response of a thermocouple, Heisler Charts **Numerical methods in heat transfer:** Significance of numerical methods in heat transfer, Finite difference formulation of differential equations, One-dimensional heat conduction.	08
04	**Convection:** Determination of heat transfer coefficient, Dimensional Analysis, Dimensionless numbers in free and forced convection and their significance **External Flow:** Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate, Flow across cylinder and sphere, Flow across bank of tubes **Internal Flow:** Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes, General thermal analysis: Constant heat flux and constant surface temperature	10
05	**Radiation:** Basic laws of radiation, Black body radiation, Planck's law, Kirchhoff's law, Wein displacement law, Lambert cosine law, Radiation intensity, Radiation heat exchange between black bodies, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield	08
06	**Boiling and Condensation:** Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flow boiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation **Heat Exchangers:** Types of heat exchangers, Overall heat transfer coefficient, Fouling factor, Analysis of heat exchangers, LMTD, Effectiveness –NTU method, Correction factor, Effectiveness of heat exchangers **Heat Pipe:** Introduction and application	10

ReferenceBooks:

1. Introduction to thermodynamics and Heat transfer by Yunus A Cengel 2ndEdition, McGraw Hill International
2. Fundamentals of Heat and Mass Transfer by FPIncropera and D P deWitt, Wiley India
3. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press
4. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy,2ndEdition, PEARSON
5. Heat Transfer by J P Holman, Mcgraw Hill
6. Heat Transfer by S P Sukhatme, University Press
7. Heat and Mass Transfer by PK Nag, TMH
8. Heat and Mass Transfer by Mahesh Rathod, Laxmi Publications
9. Heat and Mass Transfer byR K Rajput, S Chand and company

BTECHME- 504 (DYNAMICS OF MACHINERY)

Module	Details	Hrs.
1	**Governors and Gyroscopes:** 1.1 **Governors:** Introduction to Centrifugal and Inertia governors, Force analysis of governors- Porter and Hartnell governors, Performance characteristics of governors, Governors effort and power 1.2 **Gyroscope:** Introduction, Gyroscopic couple and its effect on spinning bodies, naval ships during steering, pitching, rolling and their stabilization. Effect of gyroscopic and centrifugal couples, permissible speeds on curve paths, gyroscopic effect due to lateral misalignment of rigid disc mounted on shaft.	09
2	2.1 **Static and Dynamic force analysis,** in slider crank mechanism (neglecting mass of connecting rod and crank), Engine force analysis, Turning moment on crank shaft 2.2 **Dynamically equivalent systems,** to convert rigid body in to two mass with and without correction couple	06
3	3.1 **Basic Concepts of Vibration:** Vibration and oscillation, causes and effects of vibrations, Vibration parameters - springs, mass, damper, damper models, Motion- periodic, non-periodic, degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis 3.2 **Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional, vibration system, methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method	08
4	4.1 **Free Damped Single Degree of Freedom Vibration System:** Viscous damped system - under damped, critically damped, over damped; Logarithmic decrement; Coulomb's damping 4.2 **Equivalent Single Degree of Freedom Vibration System:** Conversion of multi-springs, multi masses, multi-dampers into a single spring and damper with linear or rotational co-ordinate system, Introduction to free multi-degree of freedom vibration systems	07
5	5.1 **Forced Single Degree of Freedom Vibratory System:** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper) 5.2 **Vibration Isolation and Transmissibility:** Force Transmissibility, motion transmissibility, typical isolators & mounts.	10

	5.3 **Vibration Measuring instruments:** Principle of seismic instruments, vibrometer, accelerometer - undamped and damped, Introduction to conditioning monitoring and fault diagnosis	
6	6.1 **Rotor Dynamics:** Critical speed of single rotor, undamped and damped 6.2 **Balancing:** Static and Dynamic balancing of multi rotor system, balancing of reciprocating masses in In-line engines, V-engines (excluding other radial engines)	08

References:

1. Theory of Machines Thomas Bevan CSB Publishers & Distributors
2. Theory of Machines by Jagdishlal Metropolitan Book New Delhi, Company, Daryaganj, Delhi
3. Theory of Machines by S.S.Ratan Tata McGraw Hill , New Delhi
4. Theory of Machines by P.L.Bellaney Khanna publication, NewDelhi
5. Theory of Machines and Mechanisms by John J Uicker, Gordon R Pennock and Joseph E Shigley, Oxford University Press
6. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
7. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
8. Mechanical Vibraitons by G.K.Grover
9. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
10. Principles of Vibration by Benson H Tongue, 2nd Edition, Oxford University Press
11. Vibration Analysis by P. Srineevasan, TMH
12. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
13. Theory and Practice of Mechanical Vibrations by J S Rao and K Gupta, New Age International
14. Elements of Vibration Analysis by Leonard Meirovitch, McGrav- Hill, New York

BTECHME- 505 (i) (PRESS TOOL DESIGN)

Module	Contents	Hours
1	**Introduction to Press Working –** 1.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. 1.2 Theory of Shearing in Press Working. Optimum Cutting clearance & its effect on tolerances of pressed components. Construction of Basic shearing die. Functions of different elements of a press tool. Methods of feeding the strip/coil material.	08
2	**Design and Calculations** of Piercing & Blanking Die– 2.1 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force, Recommending minimum tonnage of a press. Centre of Pressure (its importance and calculation) 2.2 Design aspects of Press tool elements viz. Punches & methods of retaining punches, Die block, Stripper, Pilot, etc. Methods of reducing cutting loads on press tools 2.3 Different types Die sets and its selection	14
3	3.1 **Selection of Material & Hardware** –Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools.	03
4	**Bending and Drawing-** 4.1 Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies 4.2 Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup 4.3 Defects in drawn as well as bent parts, Presses selection for drawing/forming operations 4.4 Basic construction and working of Bending and Drawing dies	12
5	5.1 **Miscellaneous Dies-** Basic construction & working of Shaving dies, Trimming dies,Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies	05
6	**Selection of Presses and its setting –** 6.1 Selection of Press and Press setting for Shearing, Bending, Progressive and Drawing dies, Equipment for Sheet metal operations (Basics only), Overloading of presses (load, energy considerations) 6.2 Introduction to Automation & Safety in Press shop	06

References

1. Die Design Fundamentals by J. R. Paquin, Industrial Press
2. Techniques of Press Working Sheet Metal by D F Eary and E A Reed
3. Press Tools Design and Construction by P H Joshi, S Chand Publishing
4. Tool Design by C. Donaldson and V C Goold, TMH
5. Production Engineering by P. C. Sharma, S Chand Publishing
6. Metal working ASM Handbook

BTECHME- 505 (ii) (MACHINING SCIENCES & TOOL DESIGN)

Module	Details	Hrs.
01	**1.1 Metal Cutting Theory:** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's model& modified model for orthogonal cutting, Lee and Shaffer model, Analytical modelling of machining operations, mechanistic modelling of machining, slip line field analysis, finite element analysis, modelling of material properties **1.2 Dynamometry:** Dynamometer requirements, force measurement, electric transducers, strain gage lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, surface grinding dynamometer, piezoelectric dynamometry	10
02	**2.1 Temperatures in metal cutting and cutting fluids:** Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, temperature in primary deformation zone, temperature in secondary deformation zone, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work-tool thermocouple, direct thermocouple measurement, radiation methods, hardness and microstructure changes in steel tools Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, cutting fluid maintenance and environmental considerations, disposal of cutting fluids, dry cutting and minimum quantity lubrication, cryogenic cooling	06
03	**Cutting tool materials and machining induced surface integrity** 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish,	06

	geometrical contribution to roughness, edge finishing, residual stress and micro hardness	
04	4.1 **Tool life and machining economics:** Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, Experimental methods to find Taylor exponents, Components of product cost,Optimum cutting velocity for minimum cost of production and maximum production rate	06
05	5.1 **Design of single point cutting tools :** Different systems of tool nomenclature like MRS, ORS and NRS, Interrelationship among different systems of nomenclature for tool angles, Constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders	08
06	6.1 **Design of multi point cutting tools :** Various types such as flat form tool, tangential form tool, circular form tool, constructional details and fields of application, Profile design of flat and circular form tools,Broach nomenclature, design steps for circular pull type, key way and spline broaches, Design of face and peripheral milling cutters	10

References

1. Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group
2. Metal Cutting Principles by Milton Clayton Shaw,2nd Edition, Oxford University Press
3. Cutting Tools by P H Joshi, A H Wheeler Publishing Co Ltd
4. ASM Handbook, Vol. 16: Machining by Joseph R. Davis,9th Edition, ASM International
5. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth,2nd Edition, New Age International
6. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow
7. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow

BTECHME- 505 (iii) (DESIGN OF JIGS & FIXTURES)

Module	Details	Hrs
01	**1.1 Introduction to Tool Design** Production Tooling's Jigs, Fixtures and their difference, their requirement(accuracy, machinability, quantity modifications so as to assist production, Interchange ability, Simplicity, Swarf disposal, Handling, Ease of operation, Skill reduction, Cost reduction), Analysis for Operation planning, sequencing of operations.	08
02	**Basic Construction of Jig & Fixture** **1.1 Location & Locating Devices** Locating principles: Degrees of freedom, Redundant location, Fool-proofing, nesting, Locators: locators that control work piece on flat surfaces, location of cylindrical surfaces, conical locators, centralizers. **1.2 Clamping & clamping Devices** Requirement of clamping system, Position of clamps, Types of clamps, Clamping devices; examples of typical clamps(multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic, hydraulic and electric devices), Component distortion under clamping and cutting forces, Material used for different clamping devices of jigs/fixture and recommended hardness	10
03	**3.1 Construction of Drill Jig** Introduction, Selection of location, supporting and clamping faces /points, cutting tools and means of guiding and supporting Jigs, various types of Jig Bushes, Commonly used drill jigs, Case Study on Design of Drill Jig	10
04	**4.1 Construction of Milling fixture** Introduction, Selection of location, supporting and clamping faces /points choice, tool setting block and Tennon's, Case Study on Design of Milling Fixture	08
05	**5.1 Introduction to Commonly used Fixtures** Turning Fixture (Chucks, collets, Mandrels) Grinding Fixture, Broaching Fixture, and Welding Fixture	08
06	**6.1 Indexing Jig & Fixture** Introduction, Application of indexing, Essential features of an indexing jig /fixture, Indexing Devices	04

References
1. Jig and Fixture Design Manual, Erik K. Henrikson, Industrial Press
2. An introduction to jig and tool Design, MH A Kempster, 3rd Edition, ELBS
3. Jigs and Fixture, P. H. Joshi, TMH
4. Tool design, C. Donaldson, George H. Lecain, V.C. Goold, TMH
5. Jigs and Fixture Handbook, A.K. Goroshkin, Mir Publication
6. Jigs and Fixture, ASTME
7. Non- Standards Calming Devices, Hiran E. Grant TMH, New Delhi

BTECHME- 551 (INTERNAL COMBUSTION ENGINES LAB)

Part A: Dismantle, overhaul and assemble the following

1. 2 Stroke/ 4 Stroke Engines
2. Carburettor
3. Ignition system
4. Fuel injection system

Part B: Performing experiments on engine test rigs

1. Morse Test on petrol engine
2. Speed Test on petrol or/and diesel engine
3. Load Test on diesel engine (engines)
4. Heat Balance test on diesel or petrol engines
5. Experimental determination of Air fuel ratio and volumetric efficiency of the engine
6. Exhaust Gas/Smoke analysis of S.I./ C.I. engines
7. Effect of Supercharging on Performance Characteristics of an engine

BTECHME- 552 (MECHANICAL MEASUREMENT & CONTROL LAB)

Sr. No.	Topic
1	Calibration of Displacement sensors like LVDT, Potentiometers etc.
2	Calibration of Pressure Gauges
3	Calibration of Vacuum Gauges
4	Torque measurement using strain gauges
5	Calibration of tachometers
6	Vibration Measurement & Calibration of Accelerometers.
7	Experiments on feedback control systems and servomechanisms
8	System Identification of any one of the sensor
9	Experiment on frequency response system identification
10	Experiment on transient state response of a control system.
11	Experiment on design of PID controller for a system.

BTECHME- 553 (HEAT TRANSFER LAB)

Expt.No	Name of Experiments
1	**Conduction: (Any Two)** 1. Measurement of thermal conductivity of metal rod 2. Measurement of thermal conductivity of insulating material 3. Measurement of thermal conductivity of liquid 4. Determination of contact resistance 5. Effect of area on heat transfer
2	**Convection: (Any One)** 1. Measurement of heat transfer coefficient in natural convection 2. Measurement of heat transfer coefficient in forced convection 3. Comparison of heat transfer coefficient of free and forced convection
3	**Radiation: (Any One)** 1. Verification of Stefan Boltzmann Law 2. Measurement of Emissivity of Grey surface
4	**Transient Conduction:** 1. Unsteady state heat transfer in cylinder/rod/wall
5	**Fins: (Any One)** 1. Determination of fin efficiency and fin effectiveness 2. Comparison of fin performance of Various type of fins
6.	**Boiling and Condensation: (Any One)** 1. Measurement of heat transfer coefficient in boiling process of water. 2. Measurement of heat transfer coefficient in condensation of saturated steam.
7	**Heat Exchangers: (Any One)** 1. Estimation of overall heat transfer coefficient and effectivenessof double pipe heat exchanger (parallel flow and Counter flow arrangement) 2. Estimation of overall heat transfer coefficient and effectivenessof shell and tube heat exchanger (parallel flow and Counter flow arrangement) 3. Estimation of overall heat transfer coefficient and effectiveness of plate type heat exchanger.

BTECHME- 554 (DYNAMICS OF MACHNINERY LAB)

Sr. No.	Title of Experiment
1	Experiments on Governors- Porter Governor, Hartnell Governor
2	Experiments on Gyroscope
3	Determine natural frequency of compoundpendulum, equivalent simple pendulum system.
4	Determine natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel
5	Determine natural frequency and nodal points for single rotor and two-rotor vibratory system
6	Experimenton whirling of shaft
7	Determination of damping coefficient of any system/media
8	Experimental balancing of single and multi-rotor system
9	Measurement of vibration response of a system
10	Vibration analysis of mechanical system using MATLAB/SCILAB/GNU Octave

BTECHME- 555 (MANUFACTURING SCIENCES LAB)

Sr No.	Details
1	Introduction to machining operations
2	Introduction to lathe machine (other than plain turning operation) and shaping machine
3	Machining and machining time estimation for taper turning
4	Machining and machining time estimation for thread cutting
5	Machining and machining time estimation for internal thread cutting
6	Machining and machining time estimation for knurling
7	Machining and machining time estimation for eccentric turning
8	Machining of hexagon and square in shaping machine
9	NC, CNC, DNC machining operations
10	CNC programming for Turning and Drilling operations
11	Different Non Traditional machining operations with process parameters

BTECHME- 556 (BUSINESS COMMUNICTION & ETHICS LAB)

Module	Detailed Contents
01	**Report Writing**
1.1	Objectives of Report Writing
1.2	Language and Style in a report
1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility)and Formats of reports (Memo, Letter, Short and Long Report)
02	**Technical Writing**
2.1	Technical Paper Writing (IEEE Format)
2.2	Proposal Writing
03	**Introduction to Interpersonal Skills**
3.1	Emotional Intelligence
3.2	Leadership and Motivation
3.3	Team Building
3.4	Assertiveness
3.5	Conflict Resolution and Negotiation Skills
3.6	Time Management
3.7	Decision Making
04	**Meetings and Documentation**
4.1	Strategies for conducting effective meetings
4.2	Notice, Agenda and Minutes of a meeting
4.3	Business meeting etiquettes
05	**Introduction to Corporate Ethics**
5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.
5.2	Introduction to Intellectual Property Rights
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)
06	**Employment Skills**
6.1	Group Discussion

6.2	Resume Writing
6.3	Interview Skills
6.4	Presentation Skills
6.5	Statement of Purpose

References:

1. Fred Luthans, "Organizational Behavior", Mc Graw Hill,
2. Lesiker and Petit, "Report Writing for Business", Mc Graw Hill
3. R.Subramaniam, "Professional Ethics" Oxford University Press
4. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw
5. Raman and Sharma, Fundamentals of Technical Communication, Oxford University Press
6. Hill Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 12th Edition
7. Heta Murphy, "Effective Business Communication", Mc Graw Hill, edition
8. R.C Sharma and Krishna Mohan, "Business Correspondence and Report Writing",
9. Raman Sharma, Communication Skills, Oxford University Press
10. B N Ghosh, "Managing Soft Skills for Personality Development", Tata McGraw Hill Lehman,
11. Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
12. Bell . Smith, "Management Communication" Wiley India Edition, 3rd edition.
13. Dr. K. Alex ,"Soft Skills", S Chand and Company

14. Robbins Stephens P., "Organizational Behavior", Pearson Education

15. https://grad.ucla.edu/asis/agep/advsopstem.pdf

SEMESTER-6

BTECHME- 601 (METROLOGY & QUALITY ENGINEERING)

Module	Details	Hours
1	1.1 **Introduction to Metrology:** Fundamental Definitions, Types of Standards, Precision and Accuracy, Measurement Errors, linear measurements by Vernier calliper, micrometer, slip gauges, Angular Measurement: Universal bevel protractor, clinometers, sine bar, angle gaugescase studies on Industrial and Research Applications and Scope 1.2 **Introduction to Nano-Metrology**	06
2	1.3 **Design of Gauges :** Limits, Fits, Tolerances, Types of Gauges, Taylor's Principle of Limit Gauges, IS 919 for design of gauges 1.4 **Comparators :** Definition, Classification, Working principle of Mechanical, Opto-mechanical, Pneumatic and Electrical/Electronic comparators with advantages, limitations and uses 1.5 **Surface Texture measurement:** Surface roughness, Waviness, Roughness Parameter Ra, Rz, RMS etc., working of Tomlinson surface meter, Taly-surf surface roughness tester, Surface roughness symbols 1.6 **Flatness Test measurement by Interference principle:** Concept of Flatness, Interferometer principle for measurement, Optical Flats – study of Surface textures under monochromatic light source, fingertip test technique	14
3	3.1 **Screw Thread Measurement :** Screw threads Terminology, screw thread errors, Effective diameter measurement of screw thread by Floating Carriage micrometer 3.2 **Gear Measurement :** Gear Terminology, Gear errors, Measurement by Parkinson Gear tester and Gear tooth Vernier Calliper 3.3 **Special Measuring Instruments :** Measurement by Tool Maker's Microscope, Optical Profile Projector, CMM and Autocollimator	12

Module	Details	Hours
4	4.1 **Quality Engineering** Introduction to Quality, Classification of Quality Tools, Quality of Design, Quality of Conformance, Compromise between Quality and Cost, Introduction to Six Sigma 4.2 **SQC & SQC tools** Statistics in Quality control, Variables and Attributes data, Process Capability, Control charts for variables and for attribute data($\bar{X}$ and R-Chart, p-chart np-chart, c-chart, U-chart), Applications of SQC in engineering – case studies	08
5	5.1 **Sampling Techniques** Advantages of Sampling Inspection, operating characteristic (OC) curve. Choosing OC curve for appropriate sampling plan, acceptance sampling 5.2 **Role of computers in metrology**	04
6	6.1 **Non-destructive Testing** Visual, Dye Penetrant, Magnetic Particle, X ray Radiography, Ultrasonic Testing, Eddy Current testing methods.	04

References

1. Engineering Metrology,K.J. Hume, Kalyani Publications
2. Mechanical Measurements and Metrology by RKJain,   Khanna Publishers
3. A text book of Engineering Metrology by IC Gupta, DhanpatRai Publications
4. Metrology and Measurement by Anand,Bewoor and VinayKulkarni, McGraw Hill
5. Engineering Metrology and Measurement by N V Raghavendra and Krishnamurthy, Oxford University Press
6. Engineering Metrology and Measurements, Bentley,   Pearson Education
7. Statistical Quality Control by AL Grant, McGraw Hill, New York
8. Statistical Quality Control by R C Gupta, Khanna Publishers
9. Juran on Planning for Quality,Juran J M,TheFree Press, 1988.
10. Statistical Quality Control by M Mahajan, Dhanpat Rai and Sons

BTECHME- 602 (MACHINE DESIGN I)

Modules	Details	Hrs.
1	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic principle of Machine Design, Modes of failures, Factor of safety, Design stresses, Theories of failures (Selection in the process of designing), Standards, I.S. Codes, Preferred Series and Numbers	06
2	**Curved Beams:** Assumptions made in the analysis of curved beams, Design of curved beams: Bending stresses in curved beams, such as crane hook, C-frame, etc. **Thick Cylinders:** Design of thick cylinders subjected to an internal pressure using Lame's equation	06
3	**Design against static loads:** Cotter joint, Knuckle joint, Turn buckle, Bolted and welded joints under eccentric loading; Power Screw – screw presses, C-clamps along with the Frame, Screw Jack	12
4	**Design against fluctuating loads:** variables stresses, reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit- estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, Fatigue design under combined stresses	06
5	**Design of Shaft:** power transmitting, power distribution shafts, Module (excluding crank shaft) under static and fatigue criteria **Keys:** Types of Keys and their selection based on shafting condition **Couplings:** Classification of coupling, Design of Flange couplings, Bush pin type flexible couplings	11
6	**Design of Springs:** Helical compression, Tension Springs under Static and Variable loads, Leaf springs	07

References:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jannadas & Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts

BTECHME- 603 (FINITE ELEMENT ANALYSIS)

Module	Details	Hrs.
01	**Introduction:** 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM 1.2 Mathematical Modelling of field problems in engineering, Governing equations, Differential equations in different fields 1.3 Approximate solution of differential equations, Weighted residual techniques, Boundary value problems	08
02	**FEA Procedure:** 2.1 Discrete and Continuous Models, Weighted Residual Methods - Ritz Technique- Basic Concepts of the, Finite Element Method 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, boundary conditions. 2.3 Minimization of a functional, Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of 'stiffness matrix', transformation and assembly concepts	08
03	**One Dimensional Problems:** 3.1 One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors 3.2 Assembly of Matrices- solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network, spring-Cart Systems) 3.3 Analysis of Plane trusses, Analysis of Beams 3.4 Solution of one dimensional structural and thermal problems using FE Software, Selection of suitable element type, modelling, meshing, boundary condition, convergence of solution, result analysis, case studies	10
04	**Two Dimensional Finite Element Formulations:** 4.1 Introduction, three node triangular element, four node rectangular element, four node quadrilateral element, eight node quadrilateral element 4.2 Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular and quadrilateral element 4.3 Sub parametric, Isoparametric, super parametric elements, Compatibility, Patch test, Convergence criterion, sources of errors	08

05	**Two Dimensional Vector Variable Problems:** 5.1 Equations of elasticity - Plane stress, plane strain and axisymmetric problems 5.2 Jacobian matrix, stress analysis of CST and four node Quadratic element	08
06	**Finite Element Formulation of Dynamics and Numerical Techniques:** 6.1 Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices 6.2 Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transverse deflections and natural frequencies of beams	06

References:

1. Text book of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by JNReddy, TMH
3. 'Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu,Pearson Education
4. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
5. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd
6. 'Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John-Wiley Sons
7. The Finite Element Method in Engineering by SSRao, Butter WorthHeinemann
8. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd.

BTECHME- 604 (REFRIGERATION & AIRCONDITIONING)

Module	Detailed Contents	Hrs.
01	**Introduction to Refrigeration:** Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator, Carnot heat pump, unit of refrigeration, Co-efficient of Performance, Energy Efficiency Ratio (EER), and BEE star rating Air refrigeration systems: Bell Coleman cycle, applications Aircraft air refrigeration systems: Need for aircraft refrigeration, Simple, Bootstrap including evaporative cooling, Reduced ambient, Regenerative air cooling system, Comparison of these systems based on DART rating.	08
02	**Vapour Compression Refrigeration System**: Simple vapour compression cycle, Effect of liquid sub cooling& superheating, effect of evaporator and condenser pressures, methods of subcooling, use of P-h charts, Actual VCR cycle, Use of P-h Charts, Comparison between air-cooled and water-cooled condenser based air conditioning systems, Types of condensers, evaporators, expansion devices and Compressors **Cooling tower:** Types of cooling towers, tower approach, tower range, tower efficiency, tower losses, tower maintenance **Refrigerants**: Desirable properties of refrigerants, ASHRAE numbering system for refrigerants. Thermodynamic, Chemical and Physical properties, Secondary refrigerants, ODP and GWP, Montreal protocol and India's commitment, Recent substitutes for refrigerants	12
03	**Other Refrigeration Systems**: Vapour Absorption Refrigeration, Importance of VAR system, COP of ideal VAR system, Ammonia-water VAR system, Lithium Bromide – Water VAR system, Single and double effect, Electrolux refrigeration system, **Non-Conventional Refrigeration Systems:** Thermoelectric Refrigeration, Thermo-acoustic Refrigeration, Vortex Tube Refrigeration	06
04	**Psychrometry:** Need for air conditioning, Principle of psychromerty, Psychrometric properties, chart and processes, air washers, requirements of comfort air conditioning, summer and Winter Air conditioning	05
05	**Design of Air Conditioning Systems**: Different Heat sources,- Adiabatic mixing of two air streams, Bypass factor, sensible heat factor, RSHF, GSHF, ERSHF, Room apparatus dew point and coil apparatus dew point, Ventilation and infiltration, Inside and Outside Design condition, Cooling Load estimation , Introduction to Unitary Products viz. Room/Split and Packaged Air Conditioners, Introduction to recent developments viz. Variable Refrigerant Flow systems, VAV control systems, Inverter Units. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone, Indoor Air Quality, Green Buildings	12

Module	Detailed Contents	Hrs.
	Duct Design Friction chart for circular ducts, Equivalent diameter of a circular duct for rectangular ducts, Static pressure regain and equal pressure drop methods of duct design, Factors considered in air distribution system, Air distribution systems for cooling and heating	
06	**Controls and Applications**: Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers Applications Refrigeration & A/C Ice plant – food storage plants – diary and food processing plants, Food preservation ,Freeze Drying, A/c in textile ,printing pharmaceutical industry and Hospitals , Liquefaction of LNG, Liquefaction of gases (cryogenics), Deep sea water air-conditioning	05

References

1   Refrigeration and air-conditioning – C P Arora, TMH
2   Principles of refrigeration – R J Dossat, Willey Eastern Publication
3   Refrigeration and air-conditioning – W F Stoeker and J W Jones, TMH
4   Modern Air-conditioning practice – C P Arora, TMH
5   Refrigeration and air-conditioning- Manohar Prasad, New Age Int (P) Ltd
6   Basic Refrigeration and air-conditioning- P.Ananthanarayana, TMH
7   ASHRAE Handbook of Fundamentals
8   ASHRAE Handbook of Systems
9   ASHRAE Handbook of Equipment
10 ISHRAE Air Conditioning Handbook
11 ISHRAE Refrigeration Handbook

BTECHME- 605 (i) (MECHATRONICS)

Module	Detailed Contents	Hrs.
1	**Introduction of Mechatronics and its block diagram representation** Key elements of mechatronics, Applications of Mechatronics domestic, industrial etc. Representation of mechatronic system in block diagram and concept of transfer function for each element of mechatronic system, Reduction methods and its numerical treatment for represented block diagram	08
2	**Selection of Sensors & Actuators** Sensors: Criteria for selection of sensors based on requirements, principle of measurement, sensing method, performance chart etc. (Displacement, temperature, acceleration, force/pressure) based on static and dynamic characteristics. Actuators: Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety etc. Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08
3	**Data Acquisition, Signal Conditioning & Microcontroller System Theory:** Concept of Bit accuracy/width and Sampling speed, sampling theorem, aliasing, Nyquist criteria, ADC (Analog to Digital Convertor) Successive approximation method and sample and hold circuitry, DAC (Digital to Analog Convertor) R-2R circuit and DAC resolution Signal Filters: Low pass, High Pass and Band Pass with circuit diagrams for simple cases	08
4	**Pneumatics and hydraulics:** Hydraulic and pneumatic devices: Different types of valves, Actuators and auxiliary elements in Pneumatics and hydraulics, their applications and use of their ISO symbols, Synthesis and design of circuits (up to 2 cylinders)–pneumatic, electro- pneumatics and hydraulics, electro-hydraulics	08
5	**Control System** Control system design and analysis by Root Locus Method, Control system Design by Frequency response method, stability margin, Nyquist diagram, Bode diagram P, I and D control actions, P, PI, PD and PID control systems, Transient response:- Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual), Zigler Method	08
6	**Discrete Control System PLC (Programming Logic Control)Theory:** Introduction to PLC, Architecture, Ladder Logic programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	08

References

1. Mechatronics, Kenji Uchino and Jayne R. Giniewicz, publication: Marcel Dekker, Inc
2. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
3. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
4. Introduction to Mechatronics and Measurement Systems, Alciatore and HistandTata McGraw-Hill
5. Mechatronics, Necsulescu, Pearson education
6. Mechatronics - Electromechanics and Control Mechanics , Mill Springer-Verlag
7. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson eduaction
8. Mechatronics - Electronics in products and processes , Bradley, et al. Chapman and Hall
9. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, Prentice Hall
10. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
11. Pneumatic Circuits and Low Cost Automation by Fawcett JR
12. The Art of Electronics, Horowitz and Hill Cambridge, University Press
13. Electromechanical Design Handbook , Walsh, McGraw-Hill
14. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
15. Handbook of Electromechanical Product Design , Hurricks Longman, John Wiley, Addison Wesley
16. Principles and Applications of Electrical Engineering , Rizzoni, Irwin Publishing
17. Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics , KammIEEE
18. Modeling and control of Dynamic Systems, Macia and Thaler, Cengage Learning, India Edition
19. Mechatronics, A. Smaili, F. Mrad, OXFORD Higher Education.
20. Pneumatic and Hydraulic Control Systems: Aizerman. M.A.
21. Industrial Hydraulics: Pippenger
22. Vickers Manual on Hydraulics
23. Computer Numerical Control of Machine Tools: Thyer. G.R.
24. Pneumatic Applications: Deppert Warner & Stoll Kurt
25. Mechanization by Pneumatic Control: Vol. 1 & 2 Deppert Warner & Stoll kurt
26. Hydraulics and Pneumatics for Production: Stewart
27. Hydraulic Valves and Controls: Pippenger
28. Fundamentals of pneumatics: Festo series
29. Automatic Control Engineering: Francis. H. Raven.
30. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
31. Mechatronics, HMT
32. System Identification: Theory for the User (2nd Edition) , Lennart Ljung
33. Design with Microprocessors for Mechanical Engineers, StifflerMcGraw-Hill

BTECHME- 605 (ii) (ROBOTICS)

Module	Details	Hrs.
01	**Introduction** Definition of robot, Evolution of robots, Laws of robots, International Robotic Standards, Types of robots, Selection of robots, Robot Classifications, Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Actuators and sensors, Drives and transmission systems, End effectors, Applications of robots	08
02	**Kinematics of Robots** **Direct:** Link coordinates D-H Representation, The ARM equation, Direct kinematic analysis for Four axis, SCARA Robot and three, five, and six axis Articulated Robots. **Inverse:** The inverse kinematics problem, General properties of solutions, Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis Articulated robot. **Mobile Robot Kinematics** Introduction, Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Robot kinematic constraints, Mobile robot maneuverability, Degree of mobility, Degree of steerability, Mobile robot workspace, Degree of freedom, Holonomic robots, Path and trajectory considerations, Motion control, Open loop control, Feedback control.	10
03	**Workspace Analysis and Trajectory Planning** Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - Continuous path motion, Interpolated motion, Straight line motion and Cartesian space technique in trajectory planning.	10
04	**Sensors & Actuators** Sensors: Selection of sensors (Displacement, temperature, acceleration ,force/pressure) based on static and dynamic charecterstics, Interfacing: Concept of interfacing, bit accuracy and sampling speed, amplifying electronics, and microcontroller Actuators: Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08
05	**Robots for Inspection and Material Handling** Robotic vision systems, Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection, Software considerations Concepts of material handling, Principles and considerations in material handling systems design, Conventional material handling systems - Industrial trucks, Monorails, Rail guided vehicles, Conveyor systems, Cranes and Hoists, Advanced material handling systems, Automated guided vehicle systems, Automated storage and retrieval systems, Bar code technology, Radio frequency identification technology	08
06	**Humanoids** Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, and sound, Vision, Tactile Sensing, Models of emotion and motivation, Performance, Interaction, Safety and robustness, Applications, Case studies	08

References

1. Yoram Korean, "Robotics for engineers", McGrew Hill Co.
2. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, "Industrial Robotics Technology programming and Applications", McGraw-Hill,
3. Robotics: Fundamental Concepts and Analysis by Ashitava Ghosal, Oxford University Press
4. R.K. Mittal and I.J. Nagrath, "Robotics and Control", TMH Publications
5. Robert J. Schilling, "Fundamentals of Robotics Analysis and Control", PHI Learning
6. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robtics and Automation Sensor – Based integration, Academic Press
7. K.S.Fu, R.C.Gonzalex, and C.S.G.Lee, "Robotics Control Sensing, Vision and Intelligence", McGrew hill Book co.
8. Hartenberg and Denavit, "Kinematics and Synthesis of linkages", McGrew Hill Book Co.
9. A.S. Hall, "Kinematics and Linkage Design", Prentice Hall
10. J.Hirchhorn, "Kinematics and Dynamics of Machinery", McGrew Hill Book Company

BTECHME- 605(iii) (INDUSTRIAL AUTOMATION)

Module	Detailed Contents	Hrs.
01	**Introduction to Automation**: Definition and fundamentals of automation, reasons for Automating, basic elements of an automated system: Power, Program and control system **Advanced automation functions:** safety, maintenance & repair diagnosis, error detection and recovery **Levels of automation** **Automation principles and strategies:** USA principle, ten strategies of automation and production system, automation migration strategy	06
02	**Mechanization and Automation:** Mechanization and automation, product cycle, hard Vs flexible automation, Capital- intensive Vs low cost automation Types of systems-mechanical, electrical, hydraulic, pneumatic and hybrid systems Automation using CAMS, Geneva mechanisms, gears etc. Assembly line Automation: automated assembly systems, transfer systems, vibratory bowl feeders, non-vibratory feeders, part orienting, feed track, part placing & part escapement systems Introduction to Material storage/ handling and transport systems, and its automation using AS/RS, AGVS and conveyors etc.	08
03	**Pneumatics and hydraulics:** Hydraulic and pneumatic devices-Different types of valves , Actuators and auxiliary elements in Pneumatics & hydraulics , their applications and use of their ISO symbols Synthesis and design of circuits (up to 3 cylinders)–pneumatic, electro pneumatics and hydraulics Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping	14
04	Sensors & Actuators Sensors: Selection of sensors (Displacement, temperature, acceleration, force /pressure) based on static and dynamic characteristics Interfacing: Concept of interfacing, bit accuracy and sampling speed, amplifying electronics, and microcontroller Actuators: Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	06

Module	Detailed Contents	Hrs.
05	**Industrial control systems:** Process industries versus discrete manufacturing industries, Continuous verses discrete control, Computer process control, Forms of computer process control Discrete control using PLC- discrete process control, Programmable logic controller, its architecture,ladder digs, Ladder Logic Programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	10
06	**Robots and their applications:** Introduction to robots, Types, Classifications, Selection of robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications of robots	08

Reference Books:

1. M.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education,New Delhi
2. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press
3. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, "Industrial Robotics Technology programming and Applications", McGraw-Hill,
4. Yoram Korean, "Robotics for engineers", McGrew Hill Co
5. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall.
6. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
7. Industrial Hydraulics: Pippenger
8. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, Prentice Hall
9. Pneumatic Circuits and Low Cost Automation: by Fawcett J.R.
10. Fundamentals of pneumatics: Festo series

BTECHME- 651 (METROLOGY & QUALITY ENGINEERING LAB)

Sr. No.	Topic
1	Vernier Calliper, Micrometer and Bevel Protractor for linear and angular measurement
2	Surface measurement by Surface roughness tester
3	Gear measurement – Gear tooth Vernier calliper / Parkinson gear tester
4	Screw Thread Measurement – screw thread Micrometer, Floating carriage micrometer /bench micrometer
5	Optical profile projector for miniature linear / angular measurements of screw / gear or components
6	Tool maker's microscope for linear / angular measurement of single point tools
7	Comparator – Mechanical / Pneumatic type
8	Flatness measurement by Autocollimator / Interferometry method
9	QC charts for 50 sample readings of OD / ID of specimen and printouts

BTECHME- 652 (MACHINE DESIGN I LAB)

a) **Term work** - Shall consist of (minimum 3) design exercises from the list which may include computer aided drawing on **A3 size sheets**.

1) Knuckle Joint / cotter joint
2) Screw Jack
3) Flexible flange couplings
4) Leaf springs
5) C-clamps along with the Frame

b) **Assignment:** Design exercises in the form of design calculations with sketches and/ or drawings on following machine elements.

1) Bolted and welded joints
2) Combined stresses problem using theory of failure.
3) Shaft design (solid and hollow shaft)
4) Design against fluctuating loads (finite and infinite life)

BTECHME- 653 (FINITE ELEMENT ANALYSIS LAB)

a) List of Experiments: Students should use the commercial software or programmes form the text-books or self-developed programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs should be included in the Journal. The proposed list is given below:

1. Any two problems using bar element
2. Any two problems using truss element
3. Any two problems using CST element
4. Any two problem using axisymmetric element
5. Any one problem of free vibration analysis using bar element
6. Any one problem on steady state heat conduction

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.

b) Course Project:

A group of not more than four students, shall do Finite Element Analysis of any mechanical engineering element /system, which involves element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation.

BTECHME- 654 (REFRIGERATION & AIRCONDITIONING LAB)

Part A: List of Experiments

Trial on window air conditioner or Air Conditioning Test Rig

Trial on water cooler/Refrigeration Test Rig

Trial on Ice Plant

Trial on cooling tower

Part B: Demonstrations/Reports/Assignments/Simulations

Demonstration of domestic refrigerator along with wiring diagram

Demonstration of leak detection, evacuation and charging of refrigerant

Report on different protocols to regulate global warming

Visit report of Refrigeration establishment like Cold storage plant or ice plant or air-conditioning plant

Assignment on humidification and dehumidification, heating and cooling, mixing of two air streams

Steady state Simulation of VCR system with developed code or any analytical software

BTECHME- 655 (MECHATRONICS LAB)

Group 1: Sensors & Actuators

1. Theoretical & Experimental Implementation of Interfacing of Sensors using microcontroller and determination of sensor characteristics such as Static Characteristics (Sensitivity, Accuracy, Range, Resolution etc.), Dynamic Characteristics (Transient Response and Frequency Response)

2. Measurement and Calibration of Load / Force *(It is suggested to determine all characteristics of sensor mentioned in previous experiments)*

3. Measurement, Calibration and Comparison of Temperature Sensors (Thermocouple, RTD and Thermistor) *(It is suggested to determine all characteristics of sensor mentioned in previous experiments)*

4. Interfacing of Stepper Motor with microcontroller and its programming for Rotational or XY table *(It is suggested to program to vary the position of rotary or XY table and compare the positioning accuracy using standard calibrated angular or linear sensor)*

5. Interfacing of DC Motor with microcontroller and its programming for characterization of DC motor setup *(It is suggested to program to vary the speed of DC motor and determine its load-speed characteristics)*

6. Interfacing of Water Heater with microcontroller and its programming for determination of its transient and steady state characteristics *(It is suggested to program to vary the input current to heater and determine its transient and steady state characteristics)*

Group 2: Control Systems

1. Experimental demonstration of Discrete control system using PLC microcontroller using standard PLC demo setup (Bottle filling Machine, Traffic Light Signal, Water heater and its stirring System etc.). *(here it is suggested to carry out ladder programing and demonstrate its operation)*

2. System Identification of Spring Mass Damper System for step input & harmonic input and determination of poles and zeros of system. *(Spring Mass Damper setup with all required position sensors mounted is to be characterized for step input, it is suggested to determine transfer function (i.e. input output relation) of the setup and plotting its transient and frequency response (Bode plot))*

3. Design & Experimental Implementation of PID control strategy for Spring Mass Damper Setup to control precisely position of mass. *(it is suggested to conduct experimental study on effect of variation of controller parameters on its transient characteristics also to study the changes in poles and zeros of system).*

4. Design & Experimental Implementation of PID control strategy for DC motor speed control under varying loading conditions and effect of variation of load is to be studied.

5. Design & Experimental implementation of PID control strategy for Real Time Temperature Control of furnace *(it is suggested to conduct experimental study on effect of variation of controller parameters on its transient characteristics also to study the changes in poles and zeros of system).*

6. Modeling and design of control system for quarter car suspension model using any suitable modeling and analysis software.

Group 3: Automation

1. Real time Logic implementation for traffic Control demo setup and it is necessary to carry out ladder programming and implement program to PLC system and demonstrate its operations

2. IOT: Real time interfacing of sensors (temperature, humidity, position, level etc.) and actuator (stepper motor, dc motor, servo motor etc.) with microcontroller and Ethernet shield and controlling the actuator and monitoring of sensor output remotely using internet.

3. Robotics: Real Time demonstration of line following robot using standard robotic kit

4. Demonstration and study of functions of components of robotics arm.

5. Visualization of DH parameters in Roboanalyzer.(*Roboanalyzer is free software developed by IIT Delhi, available on www.roboanalyzer.com)

6. Designing sequential operation for two cylinders using electro-hydraulic circuits

7. Designing sequential operation for two cylinders using electro- pneumatic circuits

8. Development of pneumatic circuits to understand pneumatic components and their working

SEMESTER-7

BTECHME- 701 (MACHINE DESIGN II)

Module	Details	Hrs.
01	**Design of Gears:** 1.1 **Gears:** Design of spur, helical, bevel and worm gears with strength, wear and thermal considerations 1.2 **Gear Box:** Two stage Gear box with fixed ratio consisting of spur, helical and bevel gear pairs: gear box housing layout and housing design	14
02	2.1 **Rolling Contact Bearings:** Types of bearing and designation, selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing)	05
03	1.1 **Sliding Contact Bearings:** Design of hydro dynamically lubricated bearings (self-contained), Introduction to hydro static bearings, Types and selection of Mechanical seals	05
04	4.1 **Design of Cams and Followers:** Design of Cam and Roller follower mechanisms with spring and shaft	06
05	5.1 **Design and selection of Belts:** Flat and V-belts with pulley construction 5.2 **Design of Flywheel** – Introduction, Fluctuation of energy and speed, turning moment diagram, estimating inertia of flywheel for reciprocating prime movers and machines, Weight of the flywheel, flywheel for punches, rim constructions, stresses in rims and arms, Construction of flywheel 5.3 Design and selection of standard roller chains	10
06	6.1 **Design of Clutches:** Introduction, types, Basic theory of plate and cone type clutches, Design of single plate, multi-plate and cone clutches, with spring, lever design and thermal, wear considerations. 6.2 **Design of Brakes:** Design of single shoe brake	08

References:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts

BTECHME- 702 (CAD/CAM/CAE)

Modules	Details	Hrs.
01	**Computer Graphics and Techniques for Geometric Modeling** Computer Graphics: Two dimensional computer graphics, vector generation, the windowing transformation, Three dimensional Computer graphics, viewing transformation, Homogeneous coordinates, Perspective projection, Hidden line removal & hidden surface removal algorithm, light & shade ray tracing. The parametric representation of geometry, Bezier curves, Cubic Spline curve, B-Spline curve, parametric representation of line, circle, ellipse & parabola. Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Feature recognition, Design by feature.	08
02	**Transformation, Manipulation & Data Storage** 2D & 3D Transformations (Translation, Rotation, & Scaling & Magnification), Concatenations, Matrix representation, Problems & object oriented programming on Transformations. Object transformation, mirror transformation, Artificial Intelligence in Design & Manufacturing, Representation of Knowledge, and Knowledge base Engineering. **Application Programming Interface (API)** Concept of customizing applications by writing programs, Fusion Object Model, Creating Scripts and Add-Ins, Document and assembly structure, Attributes, Creating Programs for Assemblies, Joint, B- Rep & Geometry.	08
03	**Design to Manufacturing (CAM)** 2D Machining Strategies, 3D Machining Strategies, Fixture Component Terminology, Work Coordinate System Terminology, Create setups, Apply 2D operations, Facing, 2D adaptive clearing, 2D contour. Chamfer milling, Bore ,Tool simulation and stock material removal , Produce setup sheets , Product NC code via post processing,	08
04	**Computer Aided Engineering (CAE)** Fundamentals of computer aided engineering, CAE includes mass property calculations, kinematic analysis and animation (movement, visualization, simulation and FEA). Case study based on modeling and analysis of structural, thermal/fluid, and dynamic (vibration analysis) system. Parameter optimization.	08
05	**Computer Integrated Manufacturing & Technology Driven Practices** Introduction, Evolution, Objectives, CIM Hardware and Software, CIM Benefits, Nature and role of the elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, Concept of the future CIM systems, Socio -techno- economic aspects of CIM.	08

Modules	Details	Hrs.
06	**Rapid Prototyping and Tooling** Introduction to RP, Technology Description, Overview of RP, Benefits and Application. RP Processes: Process overviews, STL file Generation, Classes of RP systems: Stereo-lithography Approach (SLA), SLA with photo-polymerization (mathematical modelling of the process), SLA with liquid thermal polymerization, Selective Laser Sintering (SLS), Fused deposition modelling, Laminated object manufacturing, Laser powder forming. Prototype properties: Material properties, colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties. RP Applications: Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, RP processes for MEMS, Photolithography, Direct Laser Writer, Bulk Lithography for 3D micro fabrication (Modelling of beam propagation and curing in resin system).	08

References:

1. "CAD/CAM Computer Aided and Manufacturing" by Mikell P. Groover and Emory W. Zimmers, Jr., *Eastern Economy Edition*
2. "CAD/ CAM , Theory & Practice" by Ibrahim Zeid, R. Sivasubramanian, *Tata McGraw Hill Publications*
3. "Computer Graphics" by Donald Hearn and M. Pauline Baker, *Eastern Economy Edition*
4. "CAD/CAM Principles, Practice and Manufacturing Management" by Chris McMahon, Jimmie Browne, *Pearson Education*
5. "CAD/CAM/CIM" by P. Radhakrishan, S. Subramanyan, V. Raju, *New Age International Publishers*
6. "CAD/CAM Principles and Applications" by P.N. Rao, *Tata McGraw Hill Publications*
7. "Principle of Computer Graphics" by William .M. Neumann and Robert .F. Sproul, *McGraw Hill Book Co. Singapore.*
8. David L. Goetsch, Fundamental of CIM technology ,Delmar publication
9. David Bedworth, Computer Integrated Design and Manufacturing, *McGraw Hill.*
10. "CNC Machines" by B.S. Pabla and M. Adithan, *New Age International Publishers.*
11. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
12. "CNC Technology and Programming", Krar, S., and Gill, A., *McGraw Hill publishers*
13. "Computer Integrated Manufacturing- An Introduction with Case Studies" by Paul G. Ranky, *Prentice Hall International*

BTECHME- 703 (PRODUCTION PLANNING & CONTROL)

Module	Details	Hrs
1	**Concepts of PPC:** 1.1. Manufacturing systems- components and types, need for PPC, functions of PPC, relationship of PPC with other functions 1.2. Factors influencing PPC in the organization, manufacturing methods- projects & jobbing products, batch, mass / flow production, continuous / process production. 1.3. Organization of PPC- status of PPC department, internal structure, degree of centralization, PPC as an integrated approach 1.4. Prerequisites of PPC – data pertaining to design, equipment, raw materials, tooling, performance standards, labour and operating systems	06
2	**Forecasting, Aggregate planning, Capacity planning** 2.1. Forecasting: Need for forecasting, role of forecasting in PPC, forecasting methods of qualitative type like judgment techniques. Forecasting methods of quantitative types like time series analysis, least square method, moving averagemethod, exponential smoothing method. Forecasting Errors and Forecasting Bias 2.2. Aggregate planning : Concept of aggregate planning, decision rules, strategies and methods 2.3. Capacity Planning: Measurement of capacity, Measures of capacity, Factors influencing effective capacity, short range, medium range and long range capacity planning, Rough cut capacity planning.	08
3	**Inventory Control:** 3.1. Basic concepts of inventory, Types of inventory, purpose of holding stock and influence of demand on inventory, Costs associated with Inventory management. 3.2. Inventory Models: Deterministic models - instantaneous stock replenishment model, Production model, planned shortages and price discount model, Probabilistic models- fixed quantity system(Q-system) and Fixed period system (p-system) 3.3. Selective Inventory Control techniques - ABC analysis, HML analysis and VED analysis	08
4	**Process Planning and Line Balancing** 4.1 Process planning: Prerequisite information requirement, steps in process planning, process planning in different situations, documents in process planning, machine / process selection & Computer Aided Process Planning 4.2 Line Balancing: objectives, constraints, terminology in assembly line, heuristic methods like Kilbridge-Wester, Largest Candidate rule, Rank positional weight	08
5	**Production Scheduling and Sequencing** 5.1 **Scheduling**: Inputs for scheduling, loading and scheduling devices, factors influencing scheduling, scheduling techniques, use of Gantt Charts and basic scheduling problems.	10

	Project scheduling by using elements of network analysis –PERT & CPM, cost analysis & crashing, resource leveling 5.2 **Sequencing:** Product sequencing, dispatching, progress report & expediting and control. Johnson's Rule for optimal sequence of N jobs on 2 machine. Process n Jobs on 3 Machines (n/3 problem) and Jackson Algorithm. Processing of 2 Jobs on m Machine (2/m) problem	
6	**MRP, MRP II, ERP** 6.1. Material Requirement planning(MRP) and Manufacturing Resource Planning (MRP-II) - general concepts, types of demands, Inputs to MRP, MRP objectives, outputs of MRP, Estimation of planned orderreleases. Benefits and Limitations of MRP II 6.2. Enterprise Resource Planning (ERP): Evolution, features, purpose of modeling an enterprise, information mapping, generic model of ERP, Modules in ERP, Methodology of implementation, critical success factors of ERP, Case studies of success and failure of ERP implementations, ERP packages	08

References

1. Production Planning and Control – Samuel Eilon.
2. Production Planning and Control – L C Jamb
3. Production Planning and Control, W. Boltan-Longman Scientific & Technical
4. Production Systems- Planning, Analysis& Control, James. L. Riggs-John Wiley &Sons
5. Manufacturing Planning and Control Systems, Thomas E. Vollman, WilliamL.Berry& Others- Galgotia Publishers
6. Manufacturing Process Planning and Systems Engineering, AnandBewoor-Dreamtech Press
7. Production and Operations Management, S.N.Chary- TMH publishing company
8. Modernization & Manufacturing Management, L.C. Jhamb - Everest PublishingHouse

BTECHME- 704 (i) (MECHANICAL VIBRATION)

Module	Details	Hrs.
1	**1.1 Basic Concepts of Vibration:** Introduction, classification, terminology, modelling vibration analysis **1.2 Free Undamped Single Degree of Freedom Vibration System:** Longitudinal, transverse, torsional, vibration system, methods for formulation of differential equations by D'Alembert's Principle, Newton, Energy, Lagrangian and Rayleigh's method	08
2	**Multi Degree of Freedom System:** **2.1 Undamped free vibration:** Free vibration equation of motion, Influence coefficients (stiffness and flexibility), Reciprocity theorem, Generalized Coordinates, and Coordinate Coupling, Lagrangian equations, Rayleigh and Dunkerley method, two rotor and geared systems **2.2 Eigen Values and Eigen vectors:** for translatory and torsional two d.o.f. systems, Matrix method, Holzer's method (translatory and torsional unbranched systems)	10
3	**Free Damped Single Degree of Freedom Vibration System:** Types of dampers, Viscous damped system- translatory and rotary systems, Coulomb's damping- final rest position of body in coulomb damping, motion with negative damping factor,	06
4	**4.1 Forced Single Degree of Freedom Vibratory System:** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation **4.2 Vibration Isolation and Control:** Conventional Methods: By mass /Inertia, stiffness, damping (vibration isolation principles) Force Transmissibility, motion transmissibility, typical isolators & mounts. Introduction to Semi-Active and Active Vibration control.	10
5	**5.1 Vibration Measuring Instruments:** Principle of seismic instruments, vibrometer, accelerometer- undamped, damped **5.2 Introduction to Conditioning Monitoring and Fault Diagnosis:** Introduction to conditioning monitoring and fault diagnosis, Condition & Vibration Monitoring Techniques, Condition / vibration monitoring data collection. Signature analysis	07
6	**Non-Linear Vibration:** Basics of Non-linear vibration, systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase –plane technique, Duffing's equation, Jump phenomenon, Limit Cycle, Perturbation method.	07

References:
1. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
2. Mechanical Vibraitons by G. K. Grover
3. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hll
4. Vibration Analysis by P. Srineevasan, Tata McGraw Hill
5. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
6. Theory and Practice of Mechanical Vibrations by J.S.Rao, K. Gupta, New Age International Publications

7. Mechanical Vibrations by Den, Chambil, Hinckle
8. Mechanical Vibrations by J.P.Den Hartog, McGraw Hill Book Company Inc
9. Introduction to Dynamics and Control by Leonard Meirovitch, Wiley, New York
10. Elements of Vibration Analysis by Leonard Meirovitch, McGrmv- Hill, New York
11. Dynamics and Control of Strucdtures by Leonard Meirovitch, Wiley, New York
12. Matrices and Transformations by Antony J. Pettofrezzo, Dover, New York
13. Principles of Vibration by Benson H. Tongue, Oxford University Press
14. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
15. Vibrations by Balakumar Balachandan, Edward Magrab, Cengagae Learning

BTECHME- 704 (ii) (AUTOMOBILE ENGINEERING)

Module	Details	Hrs
1	**Clutch :** Requirements of Clutches, Types of Clutches; Single Plate, Multi-plate, Wet Clutch, Semi-centrifugal, Centrifugal. Clutch materials. Clutch operating mechanisms; Mechanical, Electric, Hydraulic and Vacuum. Free Pedal Play. **Transmission:** Necessity of gear box. Sliding mesh, Constant mesh, and Synchromesh Gear selector mechanisms. Overdrives and hydrodynamic torque converter, Trouble shooting and remedies. **Propeller Shaft and Axle:** Propeller shafts and universal joints: Types and construction, Different types of universal joints and constant velocity joints Types of live axles; semi, three quarter and full floating axles Types of Front Stub Axles; Elliot, Reverse Elliot, Lamoine and Reverse Lamoine	09
2	**Final Drive and Differential :** Types of Final drive; spiral, bevel, Hypoid and worm drives. Necessity of differential, Working of differential, Conventional and non-slip differential, Trouble shooting and remedies **Steering System :** Steering geometry, Steering requirements, Steering linkages and steering gears. Over steer and under steer, Cornering power, Reversibility of steering gears. **Braking System:** Requirement of brake, Classification of brakes, Brake Actuation Methods; Mechanical, Hydraulic, Pneumatic, Electro and vacuum brakes. Types of Disc brakes and Drum Brakes, Brake trouble shooting, Introduction to antilock braking system (ABS)	08
3	**Suspension System** Objects of suspension, Basic requirements, Sprung and un-sprung mass, Types of Independent and rigid axle suspension. Air suspension and its features. Pitching, rolling and bouncing. Shock absorbers and its types **Wheels and Tyres:** Requirements of wheels and tyres. Types of wheels, types of tyres and types of carcass	07
4	**Automotive Electrical System :** **Storage System:** Lead-Acid Battery; construction, working, ratings, types of charging methods, Alkaline, ZEBRA, Sodium Sulphur and Swing batteries **Charging System:**	06

	Dynamo: Principle of operation, Construction and Working. Regulators, combined current and voltage regulator. Alternator: Principle of operation, Construction, Working. Rectification from AC to DC **Starting system:** Requirements, Various torque terms used, Starter motor drives; Bendix, Rubber compression, Compression Spring, Overrunning Clutch. Starter motor solenoids and switches	
5	**Body Engineering:** Importance of Body design, Materials for body construction-Styling forms-Coach and bus body style, layouts of passenger cars, Bus and truck bodies. Chassis types and structure types: Open, Semi integral and integral bus structure Frames: functions and types of frames, Loads on frames, Load distribution of structure, Location of power plant	06
6	**Recent trends in Automobiles :** **Intelligent Vehicle Systems :** Cruise Control, Adaptive Cruise Control (ACC), Electronic Stability Program (ESP), Electronic Brake Distribution (EBD), Traction Control System (TCS). Integrated Starter Alternator (ISA)	04

Reference Books:

1. Automobile Engineering, Kirpal Singh, Vol I & II, Standard publishers Distributors ,Delhi
2. The Automobile by Harbans Singh Reyat
3. The Automobile Engineering by T.R. Banga and Nathu Singh
4. Automotive Engineering Fundamentals by Richard Stone, Jeffrey K. Ball,SAE International
5. Vehicle body engineering by J Powlowski
6. Automobile Mechanics, N. K. Giri, 8th Edition, Khanna Publishers
7. Bosch Automotive Hand Book, 6th Edition, SAE Publications
8. Automotive Mechanics by William H. Crouse and Donald L. Anglin, 10th Edition, McGraw Hill
9. Motor vehicles by T. K. Garrett, K. Newton and W. Steeds
10. Automotive Mechanics by Joseph Heitner
11. Automobile Electrical and Electronics by Tom Denton
12. Automotive Electrical Equipment by P. L. Kohli
13. Computerised Engine Control by Dick H. King

BTECHME- 704 (iii) (PUMPS, COMPRESSORS, & FANS)

Module	Detailed Contents	Hrs.
01	**Introduction to Fluid Machinery:** Introduction to pumps, Introduction to blowers and compressors, Basic equations of energy transfer between fluid and rotor, Performance characteristics, Dimensionless parameters, Specific speed, stage velocity triangles, work and efficiency.	04
02	**Reciprocating Pumps and Centrifugal Pumps:** Introduction: Types, Component and Working of Reciprocating pump and Centrifugal Pumps, Discharge, Work done and power required to drive for single acting and double acting, Coefficient of discharge, slip, Effect of acceleration of piston on velocity and pressure, indicator diagram, Air Vessel, Operating characteristics.	06
03	**Design & Analysis of Pumps:** Design procedure and design optimization of Pumps, selection of pumps, Thermal design- Selection of materials for high temperature and corrosive fluids, Hydraulic design- Selection of impeller and casing dimension using industrial manuals	08
04	**Introduction to Fans, Blowers and Compressors:** Classification of blowers, Basics of stationary and moving air, Eulers characteristics, velocity triangles and operating pressure conditions, Equations for blowers, Losses and hydraulic efficiency, flow through impeller casing, inlet nozzle, Volute, diffusers, leakage, mechanical losses, surge and stall, Applications of blowers and fans **Compressors:** Basic theory, classification and application, Working with enthalpy-entropy diagram	06
05	**Design and Analysis of Fans and Blowers:** Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, Design procedure for selection and optimization of Blowers. Stage pressure rise, stage parameters and design parameters, Design of impeller and casing dimension in aerodynamic design	06
06	**Design & Analysis of Compressors:** Construction and approximate calculation of centrifugal compressors, impeller flow losses, slip factor, diffuser analysis, performance curves of centrifugal compressors, Basic design features of axial flow compressors; velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage of axial flow compressors	06

Reference Books:

1. Principles of Turbo machinery by Shepherd, D.G., Macmillan
2. Centrifugal Pump Design by John Tuzson, John Wiley
3. Blowers and Pumps by Stepanff, A.J., John Wiley and Sons Inc.
4. Centrifugal pumps and blowers by Austin H. Chruch, John Wiley and Sons
5. Centrifugal Pumps Design and Applications by Val S.Labanoff and Robert Ross, Jaico P House
6. Pump Hand Book by Igori Karassik, McGraw-Hill International Edition
7. Pumps by G.K.Sahu, New age international
8. Turbine, Compressors and Fans by S.M.Yahya, Tata Mc-Graw Hill Publishing Company
9. Fluid Mechanics and Hydraulic Machines by R. K. Bansal, Laxmi Publication
10. Gas Turbines by V. Ganeshan, Tata Mc-Graw Hill Publishing Company
11. Steam and Gas Turbine by R. Yadav,Central Publishing House, Allahabad

BTECHME- 704 (iv) (COMPUTATIONAL FLUID DYNAMICS)

Module	Detailed Contents	Hrs.
01	**Introduction:** What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Software, Solution methodology-Preprocessing, Solver, Post processing.	04
02	**Mathematical description of Physical Phenomenon:** Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems.	06
03	**Grid Generation and Discretization Methods:** Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discritization Concept, The Structure of the Discritization Equation. Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods. Methods of Deriving the Discretization Equations, Taylor-Series Formulation, Variational Formulation, Method of Weighted Residuals, Control Volume Formulation	08
04	**Heat Conduction, Convection and Diffusion:** Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, Over relaxation and Under relaxation, Steady One-dimensional and Two Dimensional Convection-Diffusion, Unsteady One-dimensional Convection.	
05	**Incompressible Fluid Flow:** Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, The Time-Averaged Equations for Turbulent Flow.	
06	**Finite Volume Methods:** FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling	08

References:

1. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. , Malalasekera.W., Prentice Hall
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984
3. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India
4. Computational Fluid Flow and Heat Transfer, Muralidhar, K.,andSundararajan,T., Narosa Publishing House ,New Delhi
5. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd
6. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.
7. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag
8. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House
9. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press
10. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill

BTECHME- 705 (i) (PRODUCT LIFE CYCLE MANAGEMENT)

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life	05

	Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Inmonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

BTECHME- 705 (ii) (RELIABILITY ENGINEERING)

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

BTECHME- 705 (iii) (MANAGEMENT INFORMATION SYSTEM)

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

BTECHME- 705 (iv) (DESIGN OF EXPERIMENTS)

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07

Module	Detailed Contents	Hrs
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

BTECHME- 705 (v) (OPERATIONS RESEARCH)

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05

05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

BTECHME- 705 (vi) (CYBER SECURITIES & LAWS)

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

BTECHME- 705 (vii) (DISASTER MANAGEMENT & MITIGATION MEASURES)

Module	Detailed Contents	Hrs
01	Introduction *1.1* Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.	09

BTECHME- 705 (viii) (ENERGY AUDIT & MANAGEMENT)

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10

Module	Detailed Contents	Hrs
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

BTECHME- 705 (ix) (DEVELOPMENT ENGINEERING)

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

BTECHME- 751 (MACHINE DESIGN II LAB)

a)

1. **Term work** - Shall consist of design and detailed assembly drawing of minimum two design problems form the mentioned list (computer aided drawing on **A3 size sheets**):
    1. Design of Gears and gear box
    2. Design of cam and followers
    3. Design of clutches
    4. Design of brakes

2. **Course Project:** Students in a group of two to four will be able to design and prepare working drawings of any system having minimum 5 to 6 components by applying the knowledge gained during the course.

b) **Assignment :** Each assignment containing at least 2- numerical based on following topics. These design exercises should be in the form of design calculations with sketches and/ or drawings.
    1. Rolling contact bearings
    2. Sliding contact bearing
    3. Design of belt, chain and flywheel

BTECHME- 715 (CAD/CAM/CAE LAB)

List of Exercises
1. Programming for transformations,
2. API on Creating As built joints, Slider Joint Motion
3. Get the physical Properties API
4. Get the circle and arc data from the edge
5. Sketch spline through points creation : API
6. Solid modeling using any 3D modeling software
7. Part programming and part fabrication on CNC trainer (Turning / Milling)
8. Geometrical optimization of any mechanical component using computer aided engineering concepts. (Shape optimization)
9. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.

BTECHME- 751 (PRODUCTION PLANNING & CONTROL LAB)

Sr No	List of Laboratory Exercises (Any Six)
1	Preparation of a Process sheet of a simple turned/milled component
2	Numerical example on Johnson's Algorithm
3	An example on network crashing
4	Preparation of a Gantt Chart
5	A real life example on ABC analysis
6	An example on MRP for planned released orders
7	An example on line balancing
8	Preparation of organization charts with functional relationship for any SME.

SEMESTER-8

BTECHME- 801 (DESIGN OF MECHANICAL SYSTEMS)

Module	Details	Hrs.
01	Methodology & Morphology of design, Optimum design, system concepts in design.	04
02	**Design of Hoisting mechanism:** Design of Snatch Block Assembly including Rope Selection, Sheave, Hook, Bearing for hook, cross piece, Axle for sheave and shackle plate, Design of rope drum, selection motor with transmission system.	10
03	**Design of belt Conveyors-** Power requirement, selection of belt, design of tension take up unit, idler pulley	06
04	**Engine Design (Petrol and Diesel):** Design of cylinder, Piston with pin and rings, connecting rod & crank shaft with bearings	10

05	**Design of Pump:**
	5.1 Design of main components of gear pump.
	   1 Motor selection
	   2 Gear design
	   3 Shaft design and bearing selection
	   4 Casing and bolt design
	   5 Suction and delivery pipe
	5.2 Design of main components of Centrifugal Pump:
	   1 Motor selection
	   2 Suction and Delivery pipe
	   3 Design of Impeller, Impeller shaft
	   4 Design of Volute Casing
		10

06	**Design of Gear Box:** Design of gear boxes for machine tool applications(Maximum three stages and twelve speeds), Requirements of gear box, determination of variable speed range, graphical representation of speeds, structure diagram, ray diagram, selection of optimum ray diagram, estimation of numbers of teeth on gears, deviation diagram, layout of gear box	08

References:

1. Machine Design Exercises by S.N.Trikha, Khanna Publications, Delhi
2. Mechanical Engineering Design byShigley J E and Mischke C R, McGraw Hill
3. Mechanical design analysis byM FSpotts, Prentice Hall Inc
4. Design of Machine Elements, Bhandari VB, TMH
5. Machine Design by Black PH and O Eugene Adams, McGraw Hill
6. Design Data by P.S.G. College of Technology, Coimbatore.
7. I S: 2825 Code for unfired pressure vessels
8. Mechanical Design Synthesis with Optimisation Applications byJohnson R C, Von Nostrand-Reynold Pub
9. Engineering Design by Dieter G E, McGraw Hill Inc
10. Design of machine tools by S K Basu and D K Pal, Oxford and IBH Pub. Co.
11. Machine tool design by NKMehta, TMH
12. Mechanical System Design by SP Patil, JAICO students Ed., JAICO Publishing House
13. Material Handling Equipment by Rudenko, M.I.R. publishers, Moscow
14. Machine Design-An Integrated Approach by Robert L. Norton, Pearson Education
15. Material Handling Equipments by N. Rudenko, Peace Publication
16. Material Handling Equipments by Alexandrov, Mir Publication
17. Machine Desgin by Reshetov, Mir Publication
18. Machine Design by R.C.Patel, Pandya, Sikh, Vol -I & II, C. Jamnadas & Co
19. Design of Machine Elements by V. M. Faires
20. Pumps: Theory, Design and Applications by G K Sahu, New Age International
21. Gear Design Handbook by Gitin Maitra
22. Design Data Book- Design of engine parts by Khandare S.S & Kale A.V

BTECHME- 802 (INDUSTRIAL ENGINEERING & MANAGEMENT)

Modules	Detailed contents	Hrs.
01	**Introduction to Industrial Engineering** History and contribution, Industrial engineering approach, techniques of industrial engineering, objectives of industrial engineering, system approach to industrial engineering, definition and concept of productivity, productivity measurements, factors influencing productivity and productivity improvement techniques.	06
	Value Engineering and Value Analysis: Distinction between value engineering & value analysis and their Significance. Steps in value engineering & analysis and Check lists.	05
03	**Work study:** Method study, micro-motion study and principles of motion economy, Work measurement: time study, work sampling, standard data, PMTS; MOST	10
04	**Work system design:** Introduction to ergonomics and its scope in relation to work. Outline of discipline of anatomy, physiology and psychology, with respect to ergonomics building blocks such as anthropometry and biomechanics Job evaluation, merit rating, incentive schemes, wage administration and business process reengineering	08
05	**Facility Design:** Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems Concepts of Group Technology and cellular manufacturing	09
06	**Agile manufacturing:**Introduction, Developing agile manufacturing, Integration of Product/Process Development, Application of IT/IS concepts, Agile supply chain management, Design of skill and knowledge and Computer control of Agile manufacturing. Flexible manufacturing, Lean Manufacturing, Value Stream Mapping	10

References

1. Introduction to Work study, ILO, Geneva, and Oxford & IBH Pub Co. Pvt. Ltd.
2. Ergonomics at Work, Murrell
3. Plant Layout and Material Handling, James M. Apple, John Wiley & Sons
4. Facility Layout and Location – An Analytical Approach, Richard L. Francis& John A. White, Prentice Hall
5. Production Planning and Control, Samuel Elion
6. Production and Operations Management, Joseph G. Monks
7. Quality planning and analysis, J M Juran, FM Gryana, TMH
8. Total Quality Management, D. H. Bester Field et al. prentice hall
9. TQM in new product manufacturing, HG Menon; TMH
10. Industrial Engineering and Management by Dr Ravi Shankar

BTECHME- 803 (POWER ENGINEERING)

Module	Detailed Contents	Hrs.
01	**Combustion of Reactive Mixtures** Combustion reactions, Stoichiometric A/F ratio, Actual A/F ratio, Heat of combustion, Enthalpy of formation, First law of reactive system, Adiabatic flame temperature.	04
02	**Steam Generators** Fire tube and Water tube boiler, Low pressure and high pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance, Boiler efficiency **Steam Turbine-** Basic of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram, Condition for max efficiency Reaction turbine - velocity diagram, degree of reaction, Parson's turbine, Condition for maximum efficiency	12
03	**Gas Turbines** Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration, Effect of operating variable on thermal efficiency and work ratio	05
04	**Jet Propulsion Engines** Classification of jet propulsion engines, Thrust, Thrust power, Propulsive efficiency and thermal efficiency, Afterburner, Introduction to Turbojet, Turbofan, Ram jet, Turboprop and Rocket engine	05
05	**Impact of Jets:** Impact of jet on flat and curved plates **Water Turbines:** Types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done. **Impulse Turbine:** Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. **Reaction Turbines:**Types of reaction turbines - inward and outward flow, radial mixed and axial; elements of the turbine, estimation of various parameters	12
06	**Pumps** Classification of pumps - positive displacement and non - positive displacement Positive Displacement pumps: Types and applications, general features of rotary pumps, general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel. **Centrifugal Pumps**	10

	Types - radial flow, mixed flow and axial flow, Priming of pumps, components of the pump, Euler's equation and velocity triangles, correction factors for the head, design constant e.g., head constant, flow constant etc., self-priming pumps, series and parallel operation of pumps, system curve for branch network, determination of operating point, Cavitation in pumps, Determination of available and required NPSH	

Reference Books:

1. Thermal Engineering, R K. Rajput, Laxmi Publication
2. Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, Dhanpatrai & Sons
3. Steam and gas turbine, R Yadav.
4. Fluid Mechancis and Machinery, C P S Ojha, Chandramouli and R Berndtsson, Oxford University Press
5. Fluid Mechanics and Hydraulic Machinery, Modi and Seth, Standard Book House
6. Hydraulic Machinery, Jagdish Lal
7. Hydraulic Machines, R K Rajput, S.Chand Publication

BTECHME- 804 (i) (POWER PLANT ENGINEERING)

Module	Detailed Contents	Hrs.
01	Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants	06
02	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	10
03	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	08
04	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	08
05	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.	08
06	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.	08

References
1. Power Plant Engineering, A K Raja, Amit Praksh Shrivastava, Manish Dwivedi, New Age International Publishers
2. Power Plant Familiarization, Manual of Central Training Resources Unit of NTPC India, 1991
3. Power Plant Engineering, P.K. Nag, 2nd Edition, TMH, New Delhi
4. A Text Book of Power Plant Engineering, R.K. Rajput, Laxmi Publications
5. Hydro-Electric and Pumped Storage Plants, M G Jog, New Age International Publishers
6. A Course in Power Plant Engineering, Arora, Domkundwar, DhanpatRai & Co
7. Power Plant Engineering, P.C. Sharma, S.K. Kataria& Sons
8. Power Plant Engineering, G.R. Nagpal, Khanna Publishers
9. Power station Engineering and Economy by Bernhardt G.A. Skrotzki and William A. Vopat, TMH
10. Power Plant Engineering, Manoj Kumar Gupta, PHI Learning
11. Nuclear Power Plant Engineering, James Rust, Haralson Publishing Company
12. Nuclear Power Plants, Edited by Soon Heung Chang, InTech Publishers

BTECHME- 804 (ii) (RAPID PROTOTYPING)

Module	Detailed Contents	Hrs.
01	Introduction: Product Development Cycle and the product Life Cycle. Problems in Product Development and the use of Synergic Integration Technologies. Relationship between Product Development Cost and the Selling Price. Where does RP stand. Classification of RP systems, advantages and limitations of RP, Applications and scope of RP, supported file formats and introduction to Solid Modelling.	10
02	Laminated Object Manufacturing (LOM), principle of operation, possible approaches, steps, advantages and limitations. Stadard Machine Specifications. Fused Deposition Modelling (FDM), principle of operation, process steps, advantages and limitations. Stadard Machine Specifications. Stereolithography Apparatus (SLA): Principle, process steps, advantages and limitations, Stadard Machine Specifications. Selective Laser Sintering (SLS): Principle, process steps, advantages and limitations, Stadard Machine Specifications.	12
03	Solid Ground Curing (SGC): Principle, process steps, advantages and limitations, PhotoMasking comparative with SLA and LOM ObJet: Principle, process steps, advantages and limitations, applications, Stadard Machine Specifications. 3D Printing: Principle, process steps, advantages and limitations, classification of printer family, Stadard Machine Specifications, DIY procedures.	12
04	Rapid Tooling: Need for metallic tooling, approaches, RP Processes for Tooling, Silicon Rubber Molding, Epoxy Tooling, Spray Metal Tooling, Cast Kirksite Tooling, 3D KelTool, QuickCast.	05
05	Materials for Rapid Prototyping Systems: Nature of material, types of material; polymers, metals, ceramics and composites, liquid based materials; photo polymer development, solid based materials; powder based materials.	05
06	Reverse Engineering: Introduction to Digitizing Methods; contact type and non-contact type, brief introduction to the types of medical imaging. Virtual reality: Definition, features of VR, Technologies used in VR, Introduction to Augmented reality.	04

References:

1. Rapid Prototyping, Principles and Applications byRafiq I. Noorani, Wiley & Sons
2. Rapid Prototyping: Principles and Applications byChua C.K, Leong K.F and Lim C.S, 2nd Edition, World Scientific
3. Rapid Manufacturing – An Industrialrevolution for the digital age by N.Hopkinson, R.J. M. Hauge, P M, Dickens, Wiley
4. Advanced Manufacturing Technology for Medical applications: Reverse Engineering, Software conversion and Rapid Prototyping byIan Gibson, Wiley
5. Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography byPaul F.Jacobs, McGraw Hill
6. Rapid Manufacturing byPham D T and Dimov S S, Springer Verlog

BTECHME- 804 (iii) (RENEWABLE ENERGY SOURCES)

Module	Detailed Contents	Hrs.
01	**Introduction to Energy Sources**: Renewable and non-renewable energy sources, Need for 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, Present status and current installations, Introduction to Hybrid Energy Systems.	07
02	**Solar Energy**: Merits and demerits, 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, Methods of Solar Radiation estimation. **Solar Energy collection devices and Classification:** 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, Solar Photovoltaic systems & applications.	12
03	**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.	10
04	**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.	06
05	**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	08
06	**Hydrogen Energy:** Methods of Hydrogen production, Hydrogen Storage, Fuel Cells and Types of Fuel Cells.	05

Reference Books:

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers
2. Renewable Energy:Power for a Sustainable Future, Edited by Godfrey Boyle, 3rd Edition, Oxford University Press
3. Solar Energy: Principles of Thermal Collection and Storage by SP Sukhatme and J K Nayak, TMH
4. Solar Energy: Fundamentals and Applications by H.P. Garg& Jai Prakash, Tata McGraw Hill.
5. Wind Power Technology, Joshua Earnest, PHI Learning, 2014
6. Renewable Energy Sources, J W Twidell& Anthony D. Weir. ELBS Pub.
7. Energy Conversion Systems, R D Begamudre, New Age International (P) Ltd., Publishers, New Delhi ,2000.
8. Solar Photovoltaics: Fundamentals, Technologies and Applications, C S Solanki, 2ndEdition, PHI Learning
9. Biomass Regenerable Energy, D. D. Hall and R. P. Grover, John Wiley, New York
10. Wind and Solar Power Systems, Mukund R Patel, CRC Press
11. Wind Energy Explained: Theory, Design and Application, J F Manwell, J.C.McGowan, A.L.Rogers, John Wiley and Sons
12. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison

BTECHME- 804 (iv) (ENERGY MANAGEMENT IN UTILITY SYSTEMS)

Module	Detailed Contents	Hrs.
01	**General Aspects of Energy Management**: Introduction to utility systems (Types) Current energy scenario: India and World, Current energy consumption pattern in global and Indian industry, Principles of Energy management, Energy policy, Energy action planning, Energy security and reliability, Energy and environment, Need of Renewable and energy efficiency, Energy Conservation Act	08
02	**Energy Auditing :** Need of Energy Audit, Types of energy audit, Components of energy audit, Energy audit methodology, Instruments, equipment used in energy audit, Analysis and recommendations of energy audit - examples for different applications, Energy audit reporting, Energy audit software. Material & Energy Balance	08
03	**Energy Economics:** Costing of Utilities - Determination of cost of steam, natural gas, compressed air and electricity. Financial Analysis Techniques - Simple payback, Time value of money, Net Present Value (NPV), Return on Investment (ROI), Internal Rate of Return (IRR), Risk and Sensitivity analysis	09
04	**Energy Efficiency in Thermal Utilities:** Energy performance assessment and efficiency improvement of Boilers, Furnaces, Heat exchangers, Fans and blowers, pumps, Compressors and HVAC systems. Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system	08
05	**Electrical Energy Management and Lighting:** Distribution and transformer losses. Electrical motors - types, efficiency and selection. Speed control, Energy efficient motors. Electricity Act 2003. **Lighting -** Lamp types and their features, recommended illumination levels, lighting system energy efficiency.	07
06	**Cogeneration and Waste Heat Recovery**, Cogeneration- Need, applications, advantages, classification, the cogeneration design process. Waste heat recovery- Classification and application, Potential for waste-heat recovery in Industry, Commercial WHR devices, saving potential. CDM projects and carbon credit calculations	08

References:

1. Energy engineering and management, AmlanChakrabarti, PHI Learning, New Delhi 2012
2. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, 7th Edition,The Fairmont Press Inc
3. Energy management Handbook, Wayne C. Turner, 5th Edition,The Fairmont Press Inc., Georgia.
4. Handbook on Energy Audit and Environment management, Abbi Y. A., Jain Shashank, TERI, New Delhi
5. Energy Performance assessment for equipment and Utility Systems Vol. 1 to 4, Bureau of Energy Efficiency, Govt. of India
6. General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency, Govt of India
7. Boiler Operators Guide,4th Edition, Anthony L Kohan, McGraw Hill
8. Energy Hand book, Robert L. Loftness,2nd Edition, Von Nostrand Reinhold Company
9. Sustainable Energy Management, MirjanaGolusin, SinisaDodic, Stevan Popov, Academic Press
10. Energy Management, Trivedi P R, Jolka K R, Commonwelth Publications, New Delhi
11. www.enrgymanagertraining.com
12. www.bee-india.nic.in

BTECHME- 805 (i) (PROJECT MANAGEMENT)

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects **6.2 Closing the Project:**	6
	Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management,Gido Clements, Cengage Learning
4. Project Management,Gopalan, Wiley India
5. Project Management,Dennis Lock, 9th Edition, Gower Publishing England

BTECHME- 805 (ii) (FINANCE MANAGEMENT)

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	05

	Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

BTECHME- 805 (iii) (ENTREPRENEURSHIP DEVELOPMENT & MANAGEMENT)

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

BTECHME- 805 (iv) (HUMAN RESOURCE MANAGEMENT)

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
02	**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning**	5

	• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods	
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	6
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

BTECHME- 805 (v) (PROFESSIONAL ETHICS & CORPORATE SOCIAL RESPONSIBILITY)

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

BTECHME- 805 (vi) (RESEARCH METHODOLOGY)

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3**. Descriptive Research **2.4**. Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	07
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	08
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached	04
	6.2 Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

BTECHME- 805 (vii) (IPR & PATENTING)

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR):** Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

BTECHME- 805 (viii) (DIGITAL BUSINESS MANAGEMENT)

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

BTECHME- 805 (ix) (ENVIRONMENTAL MANAGEMENT)

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

BTECHME- 851 (DESIGN OF MECHANICAL SYSTEMS LAB)

Term Work: Comprises a & b

a) Term work - Shall consist of

1. Design and detailed assembly drawing (computer aided drawing on **A3 size sheets**) of minimum two design problems, from the following:
   i)   Design of hoisting mechanisms
   ii) Design of belt conveyors
   iii) Design of pumps

2. **Course Project:** Students in a group of two to four should be able to apply and integrate the knowledge gained during the course. Design and preparation of working drawings of any system having minimum 5 to 6 components is expected.

b) Assignment: Exercises on following topics in the form of design calculations with sketches and / or drawings.
   1. Engine design
   2. Design of gearbox

BTECHME- 852 (POWER ENGINEERING LAB)

List of Experiments

1. Demonstration of Boilers
2. Demonstration of Boiler mountings and accessories
3. Trial on Impulse turbine
5. Trial on Reaction turbine
6. Trial on centrifugal pump (Single stage/Multistage)
7. Trail on receprocating pump
8. Visit to Thermal Power Plant/Hydroelectric Power Plant/Gas Turbine Power Plant

BTECHME- 853 (PROJECT I & II)

Guidelines for Project

Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor

Students should use multiple literatures and understand the problem.

Students should attempt solution to the problem by experimental/simulation methods.

The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

Project I should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

Project II should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation