Scheme and Syllabus
of
B. Tech. Automation & Robotics Engineering
(3rd to 8th Semester)

Batch 2011

By
Department of Academics

Punjab Technical University

B-Tech, Automation and Robotics Syllabus (3rd semester)

Code	Tittle of Course	Load Allocation			Maximum Marks		Total Marks	Credits
		L	T	P	Internal	External		
BTAR301	Mathematics- III	4	1	0	40	60	100	4
BTAR302	Electronic Devices and Digital Circuits.	4	1	0	40	60	100	4
BTAR303	Engineering Mechanics	4	1	0	40	60	100	4
BTAR304	Strength of Machine Elements	4	1	0	40	60	100	4
BTAR305	Kinematics of Machines	4	1	0	40	60	100	5
BTAR306	Kinematics of Machines Lab	0	0	2	30	20	50	2
BTAR307	Electronic Devices and Digital Circuits Lab.	0	0	2	30	20	50	1
BTAR308	Strength of Machine Elements Lab	0	0	2	30	20	50	1
BTAR309	Workshop Training				90	60	150	1
	Advisory Meeting			1				
	Total	**20**	**5**	**7**			**800**	26

Workshop Training will be imparted in the Institution at the end of 2nd semester for Four (04) weeks duration (Minimum 36 hours per week). Industrial tour will also form part of this training.

B-Tech, Automation and Robotics Syllabus (4th semester)

Course Code	Title of Courses	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTAR-401	Power Electronics & Motors	4	1	0	40	60	100	3
BTPE-401	Design of Machine Elements	4	1	0	40	60	100	3
BTEE-402	Linear Control Systems	4	1	0	40	60	100	3
BTCS-305	Object Oriented Programming using C++	4	1	0	40	60	100	3
PE- 408	Industrial Automation and Robotics	4	1	0	40	60	100	3
BTPE-406	Design of Machine Elements Practice	0	0	2	30	20	50	
BTAR-402	Lab Power Electronics and Motors	0	0	2	30	20	50	
BTCS-309	Lab- (Object Oriented Programming)	0	0	2	30	20	50	
PE- 414	Industrial Automation and Robotics lab	0	0	2	30	20	50	
	General Fitness				100		100	
	Advisory Meeting			1				
	Total	**20**	**5**	**9**			**800**	

B-Tech, Automation and Robotics Syllabus (5th semester)

Code	Title of the course	L	T	P	Maximum Marks		Total Marks	Duration of Theory Examination (in Hours)
					Internal	External		
BTEC-404	Electronic Measurement and Instrumentation	3	1	0	40	60	100	3
BTEEE-501	Communication System	3	1	0	40	60	100	3
BTEC-504	Microprocessors & Microcontrollers	3	1	0	40	60	100	3
BTAR-501	Hydraulic and Pneumatics	3	1	0	40	60	100	3
ME-309	Numerical Methods in Engineering	3	1	0	40	60	100	3
BTEC-407	Electronics Measurement and Instrumentation Lab	0	0	2	30	20	50	
BTAR-502	Microprocessor & Microcontroller Lab	0	0	2	30	20	50	
BTAR-503	Hydraulic & Pneumatic Lab	0	0	2	30	20	50	
	Industrial Training				60	40	100	
	Total	**15**	**5**	**6**			**750**	

B-Tech, Automation and Robotics Syllabus (6th semester)

Course Code	Course Name	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
EE-202	Electromechanical Energy conversion and DC Machines	3	1	0	40	60	100	4
BTEE-604	Microcontroller and PLC	3	1	0	40	60	100	4
BTAR-604	Computer Aided Design and Manufacturing	4	0	0	40	60	100	4
BTAR-601	Advanced Robotics	4	1	0	40	60	100	5
BTAR-DE	Departmental Elective-I	3	1	0	40	60	100	4
BTAR-602	Advanced Robotics Lab.	0	0	2	30	20	50	1
BTME-506	Computer Aided Design and Manufacturing Lab	0	0	2	30	20	50	1
BTAR-603	Motor Control and PLC Lab.	0	0	2	30	20	50	1
	General Fitness						100	-
	Advisory Meet			1				
	Total	**17**	**4**	**7**	**290**	**360**	**750**	**24**

The project work will be carried out in parts as minor project in 6th semester and major project in 7/8th semester. The literature survey, problem formulation, assessment for viability of the project, objectives and methodology for the project shall be decided in 6th semester. The same project problem is to be extended in the major project in $7^{th}/8^{th}$ semester. The minor project may be carried out by a group of students (2 to 4)

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Scheme of Automation and Robotics Engineering 7th/8th Semester

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal Marks	External Marks		
BATR-701	Sensors and Signal Processing	3	1	0	40	60	100	4
BTAR-702	Programming Industrial Automation Systems	3	1	0	40	60	100	4
BTME-803	Mechanical Vibrations	4	1	0	40	60	100	5
ME-402	Industrial Safety and Environment	3	1	0	40	60	100	4
BTAR (DE-II)	Departmental Elective-II	3	1	0	40	60	100	4
BTME-805	Mechanical Vibration Lab	0	0	2	30	20	50	1
	Major Project	0	0	6	120	80	200	3
	General Fitness						100	
	Advisory Meeting			1				
	Total	**16**	**5**	**9**	**350**	**400**	**850**	**25**

The problem of the minor project “formulated" during 6th Semester is to extended and executed in major project by the same group of students. The design/construction/fabrication/computer modeling/experimentation etc. is to be carried out. The results and analysis followed by discussion regarding suitability /non suitability of the project or any positive gain in the project made with conclusions and recomrnendations for future extension of the project must be covered.

Scheme of Automation and Robotics Engineering 7th/8th Semester

Course Code	Course Name	Maximum Marks		Total Marks	Credits
		Internal Marks	External Marks		
BTAR-IT	Software Training	150	100	250	8
	Industrial Oriented Project Training	300	200	500	10
	Total	450	300	750	18

- Industrial Training in reputed industries will be arranged for complete one semester

Departmental Elective – I

BTEC 901 Relational Data Base Management System

DE/ME-2.5 Total Quality Management

BTEC 904 Digital System Design

BTEC 906 Intelligent Instrumentation

DE/PE-3.0 Product Design and Development

Departmental Elective –II

DE/ME-1.3 Non-Conventional Energy Resources

DE/PE-2.2 Modeling and Simulation

DE/ME-2.7 Material Management

BTEC 913 Human Resource Management

BTEC 914 Computer organization and Architecture

BTAR-301 Mathematics-III

1. Laplace Transforms

Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function, periodic functions, applications to solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations.

2. Special Functions

Power series solution of differential equations, Frobenius method, Legendre's equation, Legendre polynomial, Bessel's equation, Bessel functions of the first and second kind. Recurrence relations, equations reducible to Bessel's equation, Error function and its properties.

3. Functions of Complex Variable

Limits, continuity, derivative of complex functions, analytic function, Cauchy-Riemann equation, conjugate functions, harmonic functions; Conformal Mapping: Mapping of a complex function, conformal mapping, standard transforms, mapping of standard elementary transformations, complex potential, applications to fluid flow problems.

4. Complex Integration

Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions, singular points, poles, residue, complex integration using the method of residues, evaluation of real integrals by contour integration.

SUGGESTED READING/ BOOKS:

1. Kreyszing Erwin, **Advanced Engineering Mathematics**, Wiley Eastern Ltd.
2. BS Grewal, **Higher Engineering Mathematics,** Khanna Publishers.
3. NK Jain, **Numerical Solutions of Differential Equations**, Prentice Hall.
4. Sharma and Gupta, **Differential Equations**, Krishna Prakashan Media (P) Ltd.
5.B V Ramana, **Higher Engineering Mathematics**, Tata McGraw Hill.

BTAR-302 Electronic Devices and Digital Circuits

1. Semiconductor devices

H parameters equivalent circuit, Common emitter amplifier, DC behavior: the load slope and the Q point, AC behaviour, Emitter follower amplifier, Field effect transistors: JFET and MOSFET.

2. Power supplies

Review of Rectification with and without filters, Linear regulators. 78XX and 79XX family. Switching regulators.

3. Operational amplifiers Fundamentals & Applications

Basic opamp circuit, Opamp parameters, Opamps as DC Amplifiers, Voltage followers, Non-Inverting and Inverting Amplifier, Summing and Difference Amplifier, Opamp as AC Amplifier, Opamp Frequency Response, Opamp Applications as Voltage Source, Current Source, Current Amplifiers, Instrument Amplifiers, Precision Half Wave and Full Wave Rectifier, Limiters, Clampers, Peak Detectors, Sample and Hold Circuits, V-I and I-V converter, Schmitt Trigger.

4. Opamp applications as Voltage Regulator, Timer and Data Converters

IC 555 Timer used as Astable and Monostable Multivibrator, PLL,VCO, D-A and A-D Converter

5. Digital Techniques: combinational circuits and sequential circuits

Truth tables. Karnaugh's diagram. Miniterm addition. Maxiterm product. Synthesis of combinational circuits. Logic comparators. Codifiers. Decodifiers. Multiplexers, de-multiplexers. Basic Bistable Element, Latches, A SR Latch, Application of SR Latch, The SR Latch, The gated SR Latch, The gated D Latch, The Master-Slave Flip-Flops (Pulse-Triggered Flip-Flops): The Master-Slave SR Flip-Flops, The Master-Slave JK Flip-Flop, Edge Triggered Flip-Flop: The Positive Edge-Triggered D Flip-Flop, Negative-Edge Triggered D Flip-Flop.

6. Analysis of Sequential Circuits

Registers and Counters, Binary Ripple Counters, Synchronous Binary counters, Ring and Johnson Counters, Design of a Synchronous counters, Design of a Synchronous Mod-n Counter using clocked JK Flip-Flops Design of a Synchronous Mod-n Counter.

7. Bistable, Monostable and Astable Multivibrator

A fixed bias binary, self biased binary, commutating capacitors, a direct connected binary, Schmitt trigger, emitter coupled binary. Monostable multivibrator, emitter coupled monostable multivibrator, astable emitter coupled multivibrator.

SUGGESTED READING/ BOOKS:

1. Ronald J Tocci, **Fundamentals of Pulse & Digital Circuits**, TMH.
2. David A Bell, **Analog Electronics**, PHI.
3. John M Yarbrough, **Digital Logic Applications and Design**, Thomson Learning, 2001.
4. Millman and Taub, **Pulse Digital and Switching Waveforms ,** McGraw Hill Edition.
5. Millman- Halkias, **Electronic Devices & Circuits**, Tata Mcgraw Hill.
6 Boylestad, **Electronic Devices & Circuits Theory**, PHI Learning Pvt Ltd.

BTAR-303 Engineering Mechanics

1. Basics of Engineering Mechanics

Introduction, Laws of Mechanics (First, second and third), Law of Gravitation:Weight of bodies, Vectors, Vectorial representation of forces and moments, Vector operations: addition, subtraction, dot product, cross product, Force and moment concept, Force fields: Linear, Plane and Spatial, Distributed force field, Force system acting on a body: Resultant of a parallel force system, concurrent force system, coplanar force system, spatial force system and gravitational force system.

2. Equilibrium Analysis of Static Systems

Equilibrium concepts in mechanics, Free body diagram in statics, Reactions by supports, Equilibrium of a particle, Lami's theorem, Triangular Law of Equilibrium, Equilibrium of Rigid body: Concurrent force system, Parallel force system, Coplanar force system, Spatial force system.

3. Friction

Introduction: nature of friction, effect of Friction, Types of friction: dry friction, fluid friction, Mechanism of dry friction, Laws of Coloum friction, Belt friction, Rolling resistance.

4. Kinematics of Particles

A kinematics concept, Motion Referred to fixed Rectangular coordinates, Rectilinear motion of a point, Motion Referred to cylindrical polar coordinates, Motion Referred to path coordinates, Plane motion of a point: Gravitational field, Motion referred to moving frames of reference (Relative motion of two points, Translation of moving frame, Rotation of moving frames, Derivatives of moving unit vectors, Derivative of constant vector in a moving frame, derivative of a position vector for different reference, velocity of a point, Acceleration of a point), Rectangular motion of a point, Plane motion of a point.

5. Dynamics of Particles

Introduction, Equation of motion, D'alembert Principle: inertia force, Work, Power and Energy, Work energy principle, Conservation of mechanical energy, Impulse of force, Impulse momentum principle, Conservation of momentum, Moment of momentum, Moment of momentum equation, Conservation of moment of momentum.

6. Simple Lifting machine

Introduction, Types of lifting machine, Simple wheel and axle, Differential wheel and axle, Weston's pulley Block, Gear pulley Block, worm and worm wheel, Worm Geared pulley Block, Single purchase crab winch, Double purchase crab winch, simple pulley, first, second and third system of pulleys, simple screw jack, differential screw jack, worm geared screw jack.

SUGGESTED READING/ BOOKS

1. K L Kumar**, Engineering Mechanics**, Tata McGraw-Hill, Third Edition 2009.
2. Jaykumar V. & Kumar M, **Engineering Mechanics**, PHI 2012.
3. Khurmi, R.S, **Engineering Mechanics 20th Edition**, S. Chand & Company Ltd.
4. Irving H. Shames, **Engineering Mechanics - Statics and Dynamics IV Edition**, Pearson Education Asia Pvt. Ltd., 2003.
5. Arlhm P.Boresi Richard J Schmidt, **Engineering Mechanics and Dynamics**, Cengage Learning .

BTAR-304 Strength of Machine Elements

1. Simple stresses and strains

Revision of Concept of stress and strain (linear, lateral,, shear,thermal & volumetric);Hooke's law, Modulus of rigidity, Young's modulus, Bulk modulus. Poisson ratio, Stress strains diagram for ductile and brittle materials. Stress at a point, stress and strains in bars subjected to axial loading. Various strengths of material-Yield strength, Ultimate tensile strength etc.Axial force diagram, stress and strain in determinate and indeterminate homogeneous & composite bar under concentrated loads & self weight. Temperature stresses in simple & composite members. Strain energy due to axial load. Compound stress and strains, the two dimensional system; stress at a point on a plane, principal stresses and principal planes; Mohr's circle of stress; ellipse of stress and their applications.

2. Shear force & Bending moment diagram

Shear force & Bending moment definitions. BM and SF diagrams for cantilevers, simply supported beams with or without overhangs and calculation of maximum BM and SF and the point of contraflexure under the concentrated loads, Uniform distributed load, Combination of Concentrated load & UDL, Uniformity varying load.

3. Stresses in machine elements

Theory of simple bending ,assumptions in bending theory, derivation of formula, its application to beams of rectangular, circular and channel, I & T- sections,: Combined direct and bending stresses in aforementioned sections, composite / flitched beams.

4. Torsion

Derivation of torsion equation and its assumptions.Applications of the equation to the hollow and solid circular shafts, torsional rigidity, combined torsion and bending of circular shafts principal stress and maximum shear stresses under combined loading of bending and torsion, analysis of close-coiled-helical springs.

5. Theories of Failure

Maximum principal stress theory, maximum shear stress theory, Total strain energy theory, shear strain energy theory.

6. Buckling of columns

Concept of buckling of coloumn, Columns and failure of columns : Euler's formulas; Rankine- Gordon's formula, Johnson's empirical formula for axially loaded columns and their applications.

7. Slope and deflection

Relationship between moment, slope and deflection, Moment area method; method of integration; Macaulay's method: Use of all these methods to calculate slope and deflection for the following :

a) Cantilevers

b) Simply supported beams with or without overhang

c) Under concentrated loads, uniformly distributed loads or combination of Concentrated and uniformly distributed loads

SUGGESTED READING/ BOOKS

1. EP Popov, **Mechanics of Materials-(SI Version)**, Prentice Hall India.
2. Ramamurtham , **Solid of Mechanics**, Dhanpat Rai.
3. R S Khurmi, **Strength of Materials,** S Chand Publisher.
4 .S.S. Ratan, **Strength of Materials,** Tata McGraw Hill.
5. R.S Lehri and A.S Lehri, **Strength Of Material**, Kataria and sons

BTAR-305 Kinematics of machines

1. Introduction to kinematics

Introduction, Mechanisms, kinematics, kinematic inversion, four bar mechanism, slider crank mechanism, analysis of mechanism.

2. Position analysis

Vector algebra and analysis, position, displacement, position analysis(analytical) applications to simple mechanisms.

3. Velocity analysis

Velocity of point and link, linear and angular velocities, relative velocity, analytical velocity analysis; relative velocity method, solutions for common mechanisms, instantaneous method of rotation.

4. Acceleration analysis

Acceleration of point and link, normal and tangential acceleration, relative acceleration, relative acceleration analysis; analytical method, solutions for common mechanisms, acceleration of a point on a floating link, coriolis acceleration, equivalent linkages, acceleration curves.

5. Dynamic force analysis

Forces and torques, mass and weight, mass moment of inertia, laws of motion, static forces, dynamic forces, dynamic forces in mechanisms; analytical analysis, static balancing, dynamic balancing.

6. Kinmatic analysis of gears

Introduction to gears, types of gears, spur gear terminology, involute tooth profiles, spur gear kinematics, rack and pinion kinematics, gear trains, planetary gear trains.

7. Spatial linkages

Spatial mechanisms, velocity and acceleration relationships, robotic mechanisms.

SUGGESTED READING/ BOOKS

1 .Kenneth J Waldron, **Kinematics, Dynamics & Design of Machinery**, Gary L. Kinzel, John Wiley & Sons, India.

2. David H Myszka, **Machines and Mechanisms,** Prentice Hall.

3. S. S. Rattan, **Theory of Machines**, Tata McGraw Hill.

4. Shigley, **Theory of Machines,** Tata McGraw Hill.

5. R L Norton**, Kinematics and Dynamics of Machinery**,Tata McGraw Hill.

BTAR-306 Kinematics of machines Lab

1. Velocity and acceleration analysis of mechanisms (graphical method). Velocity and acceleration analysis of reciprocating engine mechanism, four bar mechanism and quick return motion mechanism by relative velocity method, instantaneous centre method and klein's construction methods.
2. Computer aided modeling, analysis and simulation of mechanisms using any analysis software.

   Modeling and simulation of simple mechanisms.

   - Slider crank mechanism
   - Crank slider mechanism
   - Dynamic forces in simple mechanisms.
3. Balancing of rotating masses.
4. Determination of gyroscopic couple (graphical method).
5. To Study Whirling of shaft.

BTAR-307 Electronic Devices and Digital Circuits Lab

1. Implementation of half and full wave rectifier with C filter and (78XX) voltage regulator.
2. Implementation of full wave rectifier with C filter and voltage regulator (78xx)
3. Input and output characteristics of BJT and FET/MOSFETs.
4. Frequency response of BJT CE amplifier.
5. Opamp as Inverting and NonInverting Amplifier,
6. Opamp as Instrumentation amplifier, Schmitt Trigger/Wave Generating Circuits.
7. IC 555 Timer applications.
8. Study of ADC/DAC.
9. Realization of given Boolean expression using basic gates and universal gates.
10. Realization of adder and subtractor using logic gates.
11. Realization of 4:1 Mux, 1:4 Demux, 8 to 3 encoder, 3 to 8 decoder using ICs.
12. Shift left; shift right, SIPO, SISO, PISO, and PIPO operations using D Flip flop.
13. Realization of asynchronous and synchronous 3-bit counters.
14. Realization of decade counter and Mod-5 counter using 7490.

(BTAR-308) Strength of Machine Elements Lab

1. To perform tensile test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2. To perform compression test on C.I. and to determine ultimate compressive strength.
3. To perform shear test on different materials and determine ultimate shear strength.
4. To perform any one hardness test (Rockwell, Brinell & Vicker's test) and determine hardness of materials.
5. To perform impact test to determine impact strength.
6. To perform torsion test and to determine various mechanical properties.
7. Study of performance of Fatigue & Creep tests
8. To perform bending test on beam (wooden or any other material) and to determine the Young's modulus and Modulus of rupture
9. To perform Torsion test and close coiled helical spring in tension and compression and to determine modulus of rigidity/stiffness
10. Determination of Bucking loads of long columns with different end conditions.

Fourth Semester

BTAR-401 Power Electronics & Motors

Thyristors and their characteristics :

Introduction to thyristor family V-I characteristics of SCR, SUS, PUT, SCS, GTO, LASCR, DIAC and TRIAC. Principle of operation of SCR. Two transistor analogy. Turn on methods of a thyristor Switching characteristics of thyristors during turn-on and turn-off. Gate characteristics. Firing of thyristors. Gate triggering circuits. Series and parallel, operation of SCRs and their triggering circuits. Thyristor specifications; such as latching current and bolding current, dv/dt and di/dt, PTV etc. Protection of SCR from over voltage and over current. Snubber circuits. Power dissipation.

Thyristor commutation Techniques :
Load commutation (Class A), Resonant-Pulse commutation (class B), impulse commutation (class D), Line commutation (class F).

Phase controlled Techniques :
Introduction to phase angle control. Single phase half wave controlled rectifiers. Single phase half controlled and full controlled bridge rectifiers. Three phase full controlled bridge rectifiers. Effect of resistive, inductive and resistive connductive loads. Basic circuit and principle of operation of Dual Converter, circulating current mode and non-circulating current mode of operation. Applications of rectifiers and dual converters to speed control of DC motor drives.

Choppers
Introduction and principle of chopper operations. Control strategies, two quadrant chopper, Four quadrant chopper. Regenerative chopper. Steady state time domain analysis of type A-chopper, voltage commutated chopper or classical Jones chopper.

Cyclo converters
Basic circuit and operation of single phase cyclo converter. Single phase bridge cyclo converter. Three phase to single phase to single phase cyclo converter. Advantages disadvantages of cyclo converters.

Inverters
Introduction to inverter. Operating principle and already state analysis of single phase, voltage source, bridge inverter. Modified Mcmurray half-bridge and full bridge inverter. Three phase bridge inverter. Voltage control (PWM control etc.) and reduction of harmonics in the inverter output voltage. Series inverter.

SUGGESTED READING/ BOOKS

1. P.S. Bimbhra, **Power Electronics**, Khanna Publishers.
2. M.D. Singh, K.B. Khanchandani, **Power Electronics**, Tata Mc Graw Hill Publishing company limited.
3. M.H. Rashid, **Power Electronics**, PHI.
4. P.C. Sen**, Power Electronics**, Tata Mc Graw Hill Publishing company limited.

BTPE-401 Design of Machine Elements

1. Scope and meaning of machine design. Sources of design data. Design considerations from economics, manufacturing, aesthetics and ergonomics aspects. Design Process, Selection of Materials.
2. **Screwed Joints**
   Design of Bolted joints, Bolted Joints under eccentric Loading. Welded Joints: - Design of Fillet Welded Joints, Butt Joints, Un-symmetric Welded sections, Eccentrically loaded welded joints.
3. **Riveted Joints**
   Design of Lap Joints, Butt Joints, Diamond Riveting, Eccentrically loaded riveted joints, Design of Cotter and Knuckle Joints.
4. **Shafts**
   Design of shafts under different types of loading conditions.
5. **Keys & Couplings**
   Design of rectangular and square keys, muff coupling, split muff coupling, flange coupling, bushed-pin flexible coupling.
6. **Levers**
   Design of straight levers, Bell - Crank levers, foot levers, hand levers.
7. **Brakes and Clutches**
   Design of friction plate and cone clutches, simple type brakes.
8. Introduction to Design for Manufacturing and Assembly.

Suggested Readings / Books:

1. Design J.E. Shigley, **Mechanical Engineering,** McGraw-Hill Education (India) Pvt Ltd.
2. Dr. Sadhu Singh, **Machine Design**, Khanna Publishers.
3. R.S.Khurmi & J.K.Gupta, **A text book of machine design,** S. Chand & Co.
4. D.K.Aggarwal & P.C.Sharma, **Machine Design,** S.K Kataria and Sons.
5. Krishnamurthi, **Design and Manufacturing** S.K. Kataria and Sons.

NOTE: Design data book is NOT allowed in the examination.

BTEE-402 Linear Control System

Introductory Concepts
Plant, Systems Servomechanism, regulating systems, disturbances, Open loop control system, closed loop systems, linear and non-linear systems, time variant & invariant, continuous and sampled data control systems, Block diagrams, some illustrative examples.

Modeling
Formulation of equation of Linear electrical, mechanical, thermal Pneumatic and hydraulic system, electrical and Mechanical analogies. Use of Laplace transform, Transfer function, concepts of state variable modeling. Block diagram representation signal flow graphs and associated algebra, characteristics equation.

Time Domain Analysis
Typical test - input signal, Dominant closed loop poles of higher order systems. Steady state error and coefficients. Pole-zero location and stability. Routh-Hurwitz Criterion.

Root Locus Technique
The extreme points of the root loci for positive gain. Asymptotes to the loci, breakaway points, intersection with imaginary axis, location of roots with given gain & sketch of the root locus plot.

Frequency Domain Analysis
Closed loop frequency response, bode plots, stability and loop transfer function. Frequency response specification relative stability, Polar plots, Nyquist criterion.

Compensation
Necessity of compensation series and parallel compensators, Compensating network, application of lag and lead compensation.
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Control Components
Error detectors: Potentiometers and synchronous, servo motor A.C. and D.C. techogenerators. Stepping motors and their control.

Digital control systems
State description of sampled continuous –time plants, state description of systems with dead time, controllability & observability, Multivariable system.

SUGGESTED READING/ BOOKS

1. B.S. Manke, **Linear Control system,** Khanna Publications.
2. I.J. Nagrath & Gopal, **Control System Engineering**, Wiley Eastern Ltd.
3. K. Ogata, **Modern Control Engg**, Prentice Hall.
4. J.F. Gibsen, **Control System Components**, Mcgraw Hill.
5. B.C. Kuo, **Automatic Control System,** Prentice Hall.

BTCS-305 Object Oriented Programming using C++

Introduction to C++
Procedural programming, Object based programming, Object Oriented Programming, Concepts in C++, Comparison of C++ with C, Console input/output in C++, Variables in C++, Data types in C++, operators in C++ , Statements-IF, ELSE, IF-ELSE, SWITCH, BREAK, CONTINUE, GOTO, Loops- WHILE.

Object Based Programming
Introduction to Classes and Objects, Member functions and member data, Objects and functions, Objects and arrays, Implicit this pointer, Class scope, Constructors and Destructors in Class, Copy constructor, Friend Class, Static Class members, Static Member functions, Nested Class.

Function, Arrays, Structure and Union
Function declaration, call, definition, recursion, one dimensional arrays, two dimensional arrays, searching and sorting, strings, structure & union.

Function Overloading and Operator Overloading
Overloading and scope, Function matching and argument conversions, three steps in overload resolution, argument type conversion, pointer to functions. Overloading Operators-Operator Overloading, Friend functions, Operator =, Operator [ ], Operator (), Operator ->, Operators ++ and --, Operators new and delete.

Object Oriented Programming
Inheritance-Base class and derived class pointers, function overriding, base class initialization, protected access specifiers, different kinds of inheritance, Virtual functions-Need for virtual functions, Mechanism of virtual functions, Pure virtual functions.

SUGGESTED READING/ BOOKS

1. Herbert Schildt, **C++ The Complete reference**, 4th Edition, TMH.
2. E. Balaguruswami, **Object oriented programming using C++,** TMH.
3. Bjarne Stroustroup, **The C++ Programming language**, Pearson Education.
4. Robert C Lafore, **Turbo C++,** Galgotia Publications.
5. E. Balaguruswami, **Ansi C,** TMH.

PE-408 INDUSTRIAL AUTOMATION AND ROBOTICS

1. **Introduction**
   Concept and scope of automation, Socio economic consideration, Low cost automation.
2. **Fluid Power Control**
   Fluid power control elements and standard graphical symbols, Construction and performance of fluid power generators, Hydraulic and pneumatic cylinders - construction, design and mounting; Hydraulic and pneumatic valves for pressure, flow and direction control: Servo valves and simple servo systems with mechanical feedback, governing differential equation and its solution for step position input, Basic hydraulic and pneumatic circuits.
3. **Pneumatic Logic Circuits**
   Design of pneumatic logic circuits for a given time displacement diagram or sequence of operations.
4. **Fluidics**
   Boolean algebra, Truth tables, Conda effect, Fluidic elements - their construction working and performance characteristics: Elementary fluidic circuits.
5. **Transfer Devices and Feeders**
   Their Classification: Construction details and application of transfer devices and feeders (Vibratory bowl feeder, reciprocating tube feeder and centrifugal hopper feeder).
6. **Electrical and Electronic Controls**
   Introduction to electrical and electronic controls such as electromagnetic controllers - transducers and sensors, microprocessors, programmable logic controllers (PLC), Integration of mechanical systems with electrical, electronic and computer systems.
7. **Robotics**
   Introduction, classification based on geometry, devices, control and path movement, End effectors - types and applications, Sensors - types and applications, Concept of Robotic/Machine vision, Teach pendent.
8. **Industrial Applications** of Robots for material transfer, machine loading / unloading, welding, assembly and spray painting operations.

SUGGESTED READING/ BOOKS

1. Anthony Esposito, **Fluid Power with applications**, Pearson.
2. S.R. Majumdar, **Pneumatic Control,** Tata Mc Graw Hill.
3. S.R. Deb, **Robotics and Flexible Automation**, Tata mc Graw Hill
4. A.K Gupta, S.K. Arora, **Industrial Automation and Robotics,** Laxmi Pubilaction (P) Ltd.

BTPE-406 Design of Machine Elements Practice

1. Select a daily use product and design the conceptual design by applying the design process talking the controlling parameters

2. Make a list of mechanical components and know their materials and suggest some alternative materials for the each one of them.

3. Design a wall bracket, which is being used in real life by actual measurement of load.

a. Welded joints

b. Riveted and bolted joints

c. And justify your findings

4. Find a flange coupling in the college laboratory and justify its design by actual measurements.

5. Design a shaft used in some practical application, by actual working and loading conditions.

6. Select a braking system lever (both hand and foot lever) and justify the design parameters.

7. Justify the design of single plate clutch of a engine assembly

8. Design of software in some high level language or excel sheets for design of a component.

BTAR-402 POWER ELECTRONICS AND MOTORS LAB

1. To study principle of operation of SCR, plot V-I characteristics and study the effect of gate triggering on turning on of SCR.
2. To draw V-I characteristics of an UJT and to use UJT as relaxation oscillator.
3. To study the effect of free-wheeling diode on power factor for single phase half-wave rectifier with R-L load.
4. To plot waveforms for output voltage and current, for single phase full-wave, fully controlled bridge rectifier, for resistive and resistive cum inductive loads.
5. Study of the microprocessor based firing control of a bridge converter.
6. To study three phase fully controlled bridge converter and plot waveforms of output voltage, for different firing angles.
7. Study of Jones chopper or any chopper circuit to check the performance.
8. Thyristorised speed control of a D.C. Motor.
9. Speed Control of induction motor using thyristors.
10. Study of series inverter circuit and to check its performance.
11. Study of a single-phase cycloconverter.
12. To check the performance of a Mc Murray half-bridge inverter.

BTCS 309 Object Oriented Programming Using C++ Lab

1.[Classes and Objects] Write a program that uses a class where the member functions are defined inside a class.
2. [Classes and Objects] Write a program that uses a class where the member functions are defined outside a class.
3. [Classes and Objects] Write a program to demonstrate the use of static data members.
4. [Classes and Objects] Write a program to demonstrate the use of const data members.
5. [Constructors and Destructors] Write a program to demonstrate the use of zero argument and parameterized constructors.
6.[Constructors and Destructors] Write a program to demonstrate the use of dynamic constructor.
7. [Constructors and Destructors] Write a program to demonstrate the use of explicit constructor.
8. [Initializer Lists] Write a program to demonstrate the use of initializer list.
9. [Operator Overloading] Write a program to demonstrate the overloading of increment and decrement operators.
10. [Operator Overloading] Write a program to demonstrate the overloading of binary arithmetic operators.
11. [Operator Overloading] Write a program to demonstrate the overloading of memory management operators.
12. [Typecasting] Write a program to demonstrate the typecasting of basic type to class type.
13. [Typecasting] Write a program to demonstrate the typecasting of class type to basic type.
14. [Typecasting] Write a program to demonstrate the typecasting of class type to class type.
15. [Inheritance] Write a program to demonstrate the multilevel inheritance.
16. [Inheritance] Write a program to demonstrate the multiple inheritance.
17. [Inheritance] Write a program to demonstrate the virtual derivation of a class.
18. [Polymorphism] Write a program to demonstrate the runtime polymorphism.
19. [Exception Handling] Write a program to demonstrate the exception handling.
20. [Templates and Generic Programming] Write a program to demonstrate the use of function template.
21. [Templates and Generic Programming] Write a program to demonstrate the use of class template.13
22. [File Handling] Write a program to copy the contents of a file to another file byte by byte. The name of the source file and destination file should be taken as command-line arguments,
23. [File Handling] Write a program to demonstrate the reading and writing of mixed type of data.

PE-414 INDUSTRIAL AUTOMATION AND ROBOTICS LAB

1. Design and assembly of hydraulic / pneumatic circuit.
2. Study of power steering mechanism using cut piece model
3. Study of reciprocating movement of double acting cylinder using pneumatic direction control valves
4. Use of direction control valve and pressure control valves clamping devices for jig and fixture
5. Study of robotic arm and its configuration
6. Study the robotic end effectors
7. Study of different types of hydraulic and pneumatic valves

Fifth Semester

BTEC-404 (Electronic Measurement and Instrumentation)

Internal Marks: 40	**L T P**
External Marks: 60	**3 1 0**
Total Marks: 100	

Unit I Fundamentals
Generalized instrumentation system – Units and Standards, Calibration Methods, Standards of measurements, Classification of errors, error analysis. Static Characteristics- Accuracy, Precision, sensitivity, linearity, resolution, hysteresis, threshold, input impedance, loading effects etc. Dynamic Characteristics.

Unit II Electronic Meters
Electronic Analog voltmeter: DC voltmeters-Choppers type-DC amplifier, solid state voltmeter, Differential voltmeter, peak responding voltmeter, True RMS voltmeter, calibration of DC voltmeters. Digital Voltmeter:- Introduction, Ramp Techniques, dual slope, integrating type DVM, Successive approximation type DVM, Resolution and sensitivity of digital meters, general specification of a DVM. CRO's study of various stages in brief, measurement of voltage, current phase and frequency, special purpose oscilloscope.

Unit III Measuring Instruments
Principle of operation of galvanometer, PMMC, Moving Iron instruments, Resistance measurements using Wheatstone bridge, Kelvin Double Bridge, Ohm meter, AC bridges: Maxwell bridge, Maxwell wein bridge, Hey's Bridge, Schering Bridge, Anderson Bridge, Campbell Bridge.

Unit IV Instrumentation for Generation and Analysis of Waveforms
Signal generators: Fixed and variable AF oscillators, AF sine and square wave generator, Function generator: Square and pulse generator, Sweep generator, wave analyzer, harmonic distortion analyzer, spectrum analyzer, spectrum analysis.

Unit V Storage and Display Devices
Necessity of recorders, recording requirements, graphic recorders, strip chart recorders, magnetic tape recorders, digital tape recorders. Electronic indicating instruments, seven segment display, fourteen segmental display Nixie tube.

Unit VI Transducers and DATA Acquisition Systems
Strain gauge, LVDT, thermocouple, piezoelectric, crystal and photoelectric transducers and their applications. Data acquisition systems.

Unit VII Telemetry
Introduction, method of data transmission, types of telemetry systems and applications.

Suggested Books:

1. A.K. Sawhney , **Electrical and Electronic Measurements and Instrumentation,** Dhanpat Rai
2. D Cooper ,**Electronic Instrumentation and Measurement Techniques**.
3. H.S. Kalsi, **Electronic Instrumentation**, Tata McGraw Hill.
4. David Buchla, Wayne Melachlan **Applied Electronics Instrumentation and measurement**.
5. B.H and Cag J.M ,**Electronics Measurement and Instrumentation**,Tata McGrawHill.

BTEEE-501 (Communication Systems)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

Unit I Base Band Signals and Systems
Introduction, Elements of communication system, Noise and its types, Noise figure and Noise factor, Noise equipment temperature, Modulation & Demodulation, Mixing, Need of modulation, Types of modulation systems, AM, FM their sidebands, Comparison, Sampling theorem, Different Pulse Modulation techniques- PAM, PWM, PPM and PCM, FDM, TDM, Introduction to Fourier series and Fourier transform of periodic signals.

Unit II Analog Communication: Transmitters
Block diagram explanation of low and high level AM transmitter, AM broadcast transmitter, DSB transmitter, SSB transmitter, and Independent Sideband transmitter, Block diagram explanation of Reactance tube, and Armstrong FM transmitters, Stereophonic FM broadcast transmitter.

Unit III Analog Communication: Receivers
AM diode detector, characteristics of radio receiver, Sensitivity, Selectivity, Fidelity, and Image rejections, Classification of radio receivers, TRF receiver and Super Heterodyne receiver, Block diagram explanation of AM receiver, AM receiver using PLL, DSB and SSB receiver, Independent sideband receiver, AM broadcast receiver, Noise in AM systems, FM detection, Block diagram explanation of FM receiver and Stereophonic FM broadcast receiver, Noise in FM systems.

Unit IV Data Communication
Concepts Data representation, Data transmission, Modes of data transmission, Signals encoding, Transmission channel, Directional capability of data exchange.

Unit V Digital Communication
Wire pairs, Microwave, Coaxial cables, Satellite communication, Optical fibers, Modulation techniques AM, FM, PM, Digital modulation method ASK, FSK, PSK, Multilevel modulation, Synchronous and asynchronous modulation, Modems and Line Drivers, Data multiplexing techniques- FDM, TDM, STDM, Multiplexed common carrier system, Multiplexing satellite signals concentrations, Data compression Hoffman code Adaptive scanning, Facsimile Compression

Suggested Books:

1. Simon Haykin , **Analog communication system** , Prentice hall.
2. J.S Chitode ,**Communication Engineering**,Technical Publications.
3. A.P.Godse U.A.Bakshi ,**Communication Engineering** , Technical Publications.
4. Wayne Tomasi**, Electronic Communications System,** Pearson Education
5**.** George Kennedy **, Electronic Communication Systems,** Tata McGraw-Hill

BTEC-504 Microprocessors & Microcontrollers (Same as to be uploaded in ECE 5th sem)

BTAR-501 (Hydraulic & Pneumatics)

Internal Marks: 40	**L T P**
External Marks: 60	**3 1 0**
Total Marks: 100	

Unit-I Fluid Power Principles and Fundamentals
Introduction to fluid power, Advantages and applications, Fluid power systems, Types and Properties of Hydraulic fluids, Basics of hydraulics, Principles of flow, Work, Power and Torque, Reynolds number, Influence of temperature on viscosity, High water based fluid, Fluid preparation, Common fire resistant fluid**,** Biodegradable oils**.**

Unit-II Hydraulic Linear Actuators
Hydraulic cylinder, Construction of cylinders, Seals in cylinders, Cylinder reliability, Cylinder force, Acceleration and losses, Calculation of cylinder forces, Flow velocity, Cylinder efficiency, Sizing of cylinder tubes, Piston rod design, Mounting style of cylinders, Cushioning of hydraulic cylinder, Hydraulic cylinder and their characteristic application.

Unit-III Hydraulic motors
Vane Motor, Gear Motor, Piston motor, Selection of hydro motor, Hydraulic or electrical motor, Hydraulic motor in circuits, Types of hydraulic transmission, Pump motor combination, Open loop and close loop system, Application of hydrostatic transmission.

Unit-IV Filter and Filtration
Nature, effect and sources of contamination, Effect of dirt on hydraulic components, System failure, Contamination level and standardization, Filter rating, Terminology and Design types of filters and Filter construction, Location of filter, Magnetic filter, Optimum filtration, Automatic particle counter and its performance characteristics.

Unit-V Hydraulic Pumps
Pump classification-Gear Pump, Internal Gear pump, Gerotor Pump, Screw Pump, Vane Pump, Piston Pumps, Selecting and sizing of Hydraulic pumps, Pump ripple.

Unit-VI Hydraulic Reservoir and Accumulators
Common types of reservoirs- their mounting and construction, Reservoir shapes and size, Reservoir accessories, Integral reservoirs, Hydraulic accumulator, Accumulators in circuit, Accumulator selection.

Unit-VII Hydraulic Circuits
Hydraulic circuits, Manual or Automatic Hydraulic systems, Regenerative circuits, Use of check Valve in hydraulic circuits, Standards in circuit diagram representation, Speed variation in cylinder motion, Some basic circuits, Functional diagram, Application of functional diagram, Electrical control of hydraulic system.

Unit-VIII Hydro Pneumatic
Compressibility, Solution, Types of hydro Pneumatic systems, Hydraulic check unit, Hydro pneumatic cylinder, Parallel check unit, Integral air oil cylinder, Types of feed, Intensifier, Comparison of Hydro pneumatic, Hydraulic and pneumatic system.

Unit-IX Automation and Principal of Pneumatic Circuit Design
Pneumatic controls, Functional diagram in pneumatic circuit, Movement diagram, Cascade system of Pneumatic circuit design.

Unit-X Maintenance and Trouble Shooting of Pneumatic system
Maintenance need of Pneumatic systems, Common problems in Pneumatic system, Maintenance schedule of Pneumatic system, Trouble shooting, Maintenance tips, Flow resistance, Seal failures, Maintenance of air compressor, Instructions for removal of operating troubles of air compressor.

Suggested Books:

1. S.R. Majumdar, **Oil Hydraulic Systems-Principles and Maintenance**, Tata McGraw Hill.
2. S.R. Majumdar, **Pneumatic Systems-Principles and Maintenance**, Tata McGraw Hill.
3. Farel Bradbury, **Hydraulic Systems and Maintenance,** Butterworth & Co (Publishers) Ltd.
4. R. Srinivasan, **Hydraulic and Pneumatic Controls**, Vijay Nicole.
5. Anthony Esposito, **Fluid Power with Applications**, PHI/Pearson Education.

ME-309 (Numerical Methods in Engineering)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

Unit-I Errors in Numerical Calculations
Errors and their analysis, General error formula, Errors in a series approximation.

Unit-II Solution of algebraic and Transcendental equations
Bisection method, Iteration method, Method of false position, Newton-Raphson method, solution of systems of non linear equations, method of iteration

Unit-III Interpolation method
Errors in polynomial interpretation, Finite difference , forward, backward and central difference, Difference of a polynomial, Newtons formulae for interpolation, Central difference intepolation formulae, Interpolation with unevenly spaced points, Newton's general interpolation formula, interpolation by iteration

Unit-IV Curve Fitting
Cubic splines and approximation, Least square curve fitting Procedures -fitting a straight line, non linear curve fitting, curve fitting by a sum of exponentials, Data fitting with cubic splines-derivation of governing equation, End conditions.

Unit-V Numerical Differentiation and Integration
Numerical differentiation- cubic spline method: Maximum and minimum values of a tabulated function, Numerical Integration- trapezoidal rule, Simpson1/3 rule, Simpsons 3/8 rule, Newton-cots integration formulae, Euler-Meclaurin formula, Gaussian integration(One dimensional only)

Unit-VI Matrices and Linear systems of equations
Introduction, Inverse of Matrix, Solution of linear systems, Matrix inversion method, Gaussian Elimination method (fall and banded symmetric and unsymmetric systems), Eigen value problems

Unit-VII Numerical solution of ordinary differential equations:
Solution by Taylor's series, Prediction-correction method, Boundary value problems, Prediction corrector method, Euler's and modified Euler's method, Runge-Kutta method, finite difference methods

Unit-VIII Numerical solution of Partial differential equations
Finite difference approximation to derivatives, Solution to Laplaces equation- Jacobi's method, Gauss-Siedel method, S.O.R method, Parabolic equation and their solution using iterative methods

Suggested Books:

1. V. RajaRaman **, Computer Oriented Numerical Methods**
2. Mc Cromik and Salavadory, **Numerical Methods in Fortran**.
3. S.D. Conte, & Cari De Boor**, Elementary Numerical Analysis**, Mc Graw Hill.
4. Cornahn B., Et al, **Applied Numerical Methods**, John Wiley.

BTEC-407 (Electronic Measurement & Instrumentation Lab)

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 2**
Total Marks: 50

List of Experiments:

1. Measurement of Inductance by Maxwell's Bridge.
2. Measurement of small resistance by Kelvin's Bridge.
3. Measurement of Capacitance by Schering Bridge.
4. Measurement of Frequency by Wein Bridge.
5. Measurement of medium resistance by Wheat Stone's Bridge.
6. Determination of frequency & phase angle using C.R.O.
7. To find the Q of a coil using LCR-Q meter.
8. To determine output characteristic of a LVDT and determine its sensitivity.
9. Study characteristics of temperature transducer like Thermocouple, Thermistor and RTD with implementation of small project using signal conditioning circuit.
10. Study characteristics of Light transducer like Photovoltaic cell, Phototransistor and Pin Photodiode with implementation of small project using signal conditioning circuit.
11. To study input- output characteristics of a potentiometer and to use two potentiometers as an error detector.
12. To study transmitter- receiver characteristics of a synchro set to use the set as control component.
13. To study the operation of a d-c positional servo system and to investigate the effect of damping and supply voltage on its response.
14. To study the operation of an a.c. position servo-system and to obtain effects of supply voltage and system parameter on its transient response.
15. To study a stepper motor and control its direction speed and number of steps with the help of a microprocessor.

BTAR -502 (Microprocessor and Microcontroller Lab)

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 2**
Total Marks: 50

List of Experiments:

1. Study of 8085 Microprocessor Kit.
2. Write a program to add two 8-bit number using 8085 .
3. Write a program to add two 16-bit number using 8085 .
4. Write a program to subtract two 8-bit number using 8085 .
5. Write a program to subtract two 16-bit number using 8085 .
6. Write a program to multiply two 8 bit numbers by repetitive addition method using 8085.
7. Write a program to multiply two 8 bit numbers by rotation method using 8085
8. Write a program to multiply 16-bit number with 8-bit number using 8085.
9. Write a program to generate fibonacci series using 8085.
10. Write a program to sort series using bubble sort algorithm using 8085.
11. Study of 8051/8031 Micro controller kits.
12. Write a program to add two numbers lying at two memory locations and display the result.
13. Write a program for multiplication of two numbers lying at memory location and display the result.
14. Write a program to check a number for being ODD or EVEN and show the result on display.
15. Write a program to split a byte in two nibbles and show the two nibbles on display.
16. Write a Program to arrange 10 numbers stored in memory location in Ascending and Descending order.
17. Write a program to find a factorial of a given number.
18. Study of Interrupt structure of 8051/8031 micro controllers.

BTAR-503 (Hydraulic & Pneumatic Lab)

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 2**
Total Marks: 50

List of Experiments:

1. Design and testing of hydraulic circuits using-
   i. Pressure control
   ii. Flow control
   iii. Direction control
2. Design of circuit with programmed logic sequence, using an optional PLC in hydraulic Electro hydraulic Trainer.
3. Design and testing of pneumatic circuits using-
   i. Pressure control
   ii. Flow control
   iii. Direction control
   iv. Circuits with logic controls
   v. Circuits with timers
   vi. Circuits with multiple cylinder sequences in pneumatic electro pneumatic trainer.
4. Design of circuits using mechanical feedback systems.
5. Velocity control of single and double acting hydraulic and pneumatic cylinders.
6. Design of Pneumatic system using any commercially available simulation software.
7. Design of Hydraulic system using any commercially available simulation software.

Sixth Semester

EE-202 (Electromechanical Energy Conversion and D.C. Machines)

Internal Marks: 40	**L T P**
External Marks: 60	**3 1 0**
Total Marks: 100	

1. Electro-Mechanical Energy Conversion

Energy stored in electric and magnetic fields, energy conversion in singly and multiple excited systems, reluctance torque, reluctance and hystersis motors.

2. General Description Of Electrical Machines

Description of electric circuits in cylindrical rotor and salient pole machines, MMF of Single and multiple coils, harmonic analysis of induced voltages and armature MMF, Effect of slots, winding factors, Torque in terms of flux and mmf.

3. D.C. Machines

Armature windings, single and double layers, windings & winding diagrams, E.M.F. and torque equations, interaction of fields produced by excitation circuit and armature, effect of brush shift, compensating winding, commutation, causes of bad commutation, methods of improving commutation, methods of excitation of d.c. generators and their characteristics. D.C. motors: characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control, Ward Leonard method, Braking: plugging, dynamic and regenerative braking, Testing: Swinburn's test, Hopkinson test, Field test. Estimation of losses and efficiency.

4. Cross-Field Machines

Principle of working, analysis of cross-field generator, typical characteristics with different compensations. Applications.

Suggested Books:

1. Fitzgerald Kingsley & Kusko, Electric Machinery, Tata McGraw-Hill
2. Langsdorff , Principles of D.C. machines, Tata McGraw-Hill
3. Nagrath & Kothari , Electrical Machines, Tata McGraw-Hill Education, Jun 1, 2004
4. P.S. Bhimbhra , Electrical Machinery, Khanna Publishers

BTEE-604 (Microcontroller and PLC)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. **Introduction**
   Microprocessor, Microcontrollers and their comparison. The 8051 Architecture: Introduction, 8051 microcontroller hardware, input/ output, pins, ports and circuits, external memory, counters and timers, serial data input/ output, interrupts.

2. **8051 Assembly Language Programming**
   The mechanics of programming, assembly language programming process, programming tools and techniques, instruction set (data moving, logical operations, arithmetic operations, jump and call instructions)

3. **8051 Microcontroller Design**
   Microcontroller specification, external memory and memory space decoding, reset and clock circuits, expanding input and output (I/O), memory mapped I/O, memory address decoding, memory access times, testing the design, timing subroutines, lookup tables for the 8051, serial data transmission

4. **Microcontroller Applications**
   Interfacing keyboards, displays, Digital-to-Analog (D/A) and Analog-to-Digital (A/D), multiple interrupts, serial data communications, introduction to the use of assemblers and simulators Embedded Systems: Introduction to PLDs and FPGA-architecture, technology and design issues, implementation of 8051 core.

5. **Programmable Logic Controllers (PLC)**
   Introduction, operation of PLC, difference between PLC and Hardwired system, difference between PLC and Computer, relay logic and ladder logic, ladder commands and examples of PLC ladder diagram realization, PLC timers, PLC counters, PLC classification.

Suggested Books:

1. Kenneth J Ayola, The 8051 Micro Controller -Architecture, Programming and Application , Penram International Publication
2. John B Peatman, Design with Micro Controller, Tata McGraw Hill
3. Ray A.K and Bhurchand K.M., Advanced Microprocessors and Peripherals; Architecture, Programming and Interfacing , Tata McGraw Hill
4. Mazidi M.A. and Mazidi J.G., The 8051 Micro-controller and Embedded System, Pearson Education.
5. Udayashank ara V. and Mallikarjunaswamy M.S., 8051 Micro controller Hardware, Software and Applications , TataMcGraw Hill Education Pvt. Ltd., (2010)

BTAR-604 (Computer Aided Design and Manufacturing)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Fundamentals of CAD

Design process with and without computer; CAD/CAM system and its evaluation criteria, brief treatment of input and output devices, Display devices, Functions of a graphics package and Graphics standard GKS, IGES and STEP .Geometric Transformations: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation. Geometric Modeling: Wire frame Model, Solid Modeling, Boundary Representation (B-rep), Conductive Solid Geometry(CSG), Introduction to Parametric and Non Parametric representation of Curves.

2. NC/CNC Machine Tools

NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system.

3. Group Technology (GT)

Part families; part classification and coding system: Group technology machine cells: Advantages of GT.

4. Computer Aided Process Planning

Introduction and benefits of CAPP. Types of CAPP systems, machinability, data selection systems in CAPP.

5. Computer Integrated Manufacturing Systems

Basic Concepts of CIM: CIM Definition, The meaning of Manufacturing, Types of Manufacturing systems; Need, Elements, Evolution of CIM; Benefits of CIM; Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations; FMS benefits.

6. Automated Material-Handling and Storage Systems

Introduction to Material handling system, principles of material handling, material handling equipment, automated guided vehicle systems (AGVS), components of an AGVS, types of AGVS, AGVS guidance system, advantages of AGVSs over other Material handling systems, automated storage and retrieval systems, functions of storage systems, AS/RS components and terminology used, types of AS/RS, conveyer systems. ***Classification of feeders, parts of feeding devices, different types of feeders***

Books:

1. Mikell P. Groover, Emory W. Zimmers, CAD/CAM, PHI
2. Automation, Production systems and Computer Integrated Manufacturing :- Groover M. P.
   PHI
3. Zeid Ibraham, CAD/CAM - theory and Practice, Tata McGraw Hill
4. P. N Rao, CAD/CAM, Tata McGraw Hill
5. Nanua Singh ,Approach to computer integrated design and manufacturing ,John Wiley and sons.

BTAR-601 (Advanced Robotics)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Robot Coordinate System

Position and orientation of objects, Object coordinate frames, Rotations matrix, Euler angles , Roll pitch and yaw angles coordinate, Transformations, Joint variables and position of end effecter, Dot and Cross products, coordinates frames, Rotations, Homogeneous coordinates.

2. Forward Kinematic

Introduction to Forward kinematic, Denavit-Hartenberg (D-H) representation (with examples), The arm equation, the arm matrix of serial link manipulators, forward/direct kinematic analysis for serial link manipulators.

3. Inverse Kinematic

Introduction to inverse kinematics, General properties of inverse kinematic solution, Tool configuration vector, Tool configuration of serial link manipulators with examples of five axis. Articulated robot and four-axis SCARA Robot. Inverse kinematics of a serial link manipulator.

4. Velocity and Static Analysis of robotic manipulators

Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom, Statics of serial manipulators, work space analysis of serial link manipulators

5. Dynamics of serial manipulators

Mass and inertial of links, Lagrangian formulation for equations of motion for serial manipulators, Kinetic and potential energy, Lagrangian-Euller dynamic mode., Direct and inverse dynamics, Recursive dynamics using Newton-Euler formulation

6. Motion Planning and Control

Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non linear model based control schemes.

7. Robot programming

On line programming, teach pendant control, Lead through programming, Walk through programming, off line programming, Task programming.

Suggested Books:

1. Schilling, R. J., Fundamentals of Robotics Analysis & Control, Prentice Hall of India
2. Fu, K. S., Gonzalez, R. C. and Lee, C. S., Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill
3. Craig, J. J., Introduction to Robotics: Mechanics and Control, Pearson Education
4. Deb, S. R., Robotics and Flexible Automation, McGraw Hill.
5. Saha, S. K., Introduction to Robotics, McGraw Hill

BTAR-602 (Advance Robotics Lab)

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 2**
Total Marks: 50

List of Experiments

1. Study of different actuators and end effector for robot.
2. Robot Programming with Computer Simulation Softwares.
3. Programming of robots by manual, lead through and off-line methods, use of robot programming languages to pick and place, stacking of objects in increasing or decreasing size, palletizing operations, assembly and inspection operation etc.
4. Solving Robot Arm Kinematics with Matlab
   a) Matrix multiplication and Concatenation of matrices in matlab, inverse of a matrix
   To solve different transformation matrices, To find the homogeneous transformation matrix of robotic manipulator, To find the joint angles when the end effector position is given.
   b) Robot workspace: Plot of end effector position vector in three dimensional space.

BTME-506 (Computer Aided Design and Manufacturing Lab)

Internal Marks: 30
External Marks: 20
Total Marks: 50

I. Introduction to modeling (using any CAD software):

1. 2D drawing using sketcher – 2 Drawings
2. 3D modeling using 3D features (Modeling of Crane Hook, Bench Vice, Screw Jack components)
3. Assembling and drafting (any 2 above mentioned assemblies) with proper mating conditions and interference checking
4. Surface modeling – (Computer mouse, Plastic bottles with spraying Nozzle)

II. Computer Aided Manufacturing:

1. Manual part programming on CNC Lathe and CNC Milling – (4 programs, 2 for each)

2. Computer Aided Part programming for CNC Lathe and CNC Milling to generate tool path, NC code, and Optimization of tool path (to reduce machining time) using any CAM software.

BTAR-603 (Motor Control and PLC Lab)

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 2**
Total Marks: 50

List of Experiments:

1. Load test on D.C. shunt motor.
2. Speed control of D.C. shunt motor.
3. Swinburne's test.29
4. Load test on three phase induction motor.
5. No load and blocked rotor tests on three – phase induction motor.
6. Load test on single phase induction motor.
7. No load and blocked rotor tests on single phase induction motor.
8. Load test on Synchronous motors.
9. Performance characteristics of Stepper motor.
10. Performance characteristics of single phase transformer.
11. Implementation of different gates using PLC.
12. Implementation of DOL and star delta starter using PLC.
13. Implement basic logic operations, motor start and stop operation using
(i) Timers
(ii) Counters
14. Motor forward and reverse direction control using PLC.

BTEC-901 (Relational Database Management System)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. **Introduction to Database Systems**
   File Systems Versus a DBMS, Advantages of a DBMS, Describing and Storing Data in a DBMS, Database System Architecture, DBMS Layers, Data independence.
2. **Physical Data organization**
   File Organization and Indexing, Index Data Structures, Hashing, B-trees, Clustered Index, Sparse Index, Dense Index, Fixed length and Variable length Records.
3. **Data Models**
   Relational Model, Network Model, Hierarchical Model, ER Model: Entities, Attributes and Entity Sets, Relationships and Relationship Sets, Constraints, Weak Entities, Class Hierarchies, Aggregation, Conceptual Database Design with ER Model, Comparison of Models.
4. **The Relational Model**
   Introduction to the Relational Model, ER to Relational Model Conversion, Integrity Constraints over Relations, Enforcing Integrity Constraints, Relational Algebra, Relational Calculus. querying Relational Data.
5. **Relational Query Languages**
   SQL: Basic SQL Query, Creating Table and Views, SQL as DML, DDL and DCL, SQL algebraic Operations, Nested Queries, Aggregate Operations, Cursors, Dynamic SQL, Integrity Constraints in SQL,Triggers and Active Database, Relational Completeness, Basic query Optimization Strategies. Algebric Manipulation and Equivalences.
6. **Database Design**
   Functional Dependencies, Reasoning about Functional Dependencies, Normal Forms, Schema Refinement, First, Second and Third Normal Forms, BCNF, Multivalued Dependency, Join Dependency, Fourth and Fifth Normal Forms, Domain Key Normal Forms, Decompositions.
7. **Transaction Management**
   ACID properties, Serializability, Two-phase Commit protocol, Concurrency Control, Lock Management, Lost Update Problem, Inconsistent Read problem , Read-Write Locks, Deadlocks Handling. 2PL protocol.

8. **Database Protection**
   Threats, Access Control Mechanisms, Discretionary Access Control, Grant and Revoke, Mandatory Access Control, Bell-la-Padula Model, Role Based Security, Firewalls, Encryption and Digital Signatures.

Suggested Books:

1. Ramez Elmasri, Shamkant Navathe ,Fundamentals of Database Systems, Fifth Edition, Pearson education, 2007.
2. C.J. Date , An Introduction to Database Systems, Eighth Edition, Pearson Education
3. Alexis leon, Mathews Leon , Database Management Systems, Leon Press.
4. S. K. Singh, Database Systems Concepts, Design and Applications, Pearson Education.

DE/ME-2.5 (Total Quality Management)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Quality and Total Quality Management
Excellence in manufacturing/service, factors of excellence, relevance of TQM.

2. Concept and definition of quality
Total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality Management Models, benefits of TQM.

3. Just-in-time (JIT)
Definition: Elements, benefits, equipment layout for JIT system, Kanban system MRP (Material Requirement planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation.

4. Customer
Satisfaction, data collection and complaint, redressal mechanism.

5. Planning Process
Policy development and implementation; plan formulation and implementation.

6. Process Management
Factors affecting process management, Quality function development (QFD), and quality assurance system.

7. Total Employees Involvement (TEI)
Empowering employees: team building; quality circles; reward and Recognition; education and training, Suggestion schemes.

8. Problems solving
Defining problem, Problem identification and solving process, QC tools.

9. Benchmarking
Definition, concept, process and types of benchmarking.

10. Quality Systems:
Concept of quality system standards: relevance and origin of ISO 9000; Benefits; Elements of ISO 9001, ISO 9002, ISO 9003.

11. Advanced techniques of TQM:
Design of experiments: failure mode effect analysis: Taguchi methods.

Suggested Books:

1. Sunder Raju, Total Quality Management , Tata McGraw Hill.
2. M.Zairi, TQM for engineers, Aditya Books.
3. J.L. Hradeskym, Total Quality Management Handbook, McGraw Hill.
4. Dalela and Saurabh, ISO 9000 quality System, Standard Publishers.

BTEC-904 (Digital System Design)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Combinational Logic
Review of adders, Subtractor, Multipliers, Multiplexers, ROM, PLA, PAL and PLD.

2. Synchronous Sequential Logic
Flip-flops, Triggering of flip-flops, Analysis of clocked sequential circuits, State reduction and assignment, Flip-flop excitation tables, Design procedure, Design of counters,

3. Finite State Machines
Finite state model, Memory elements and their excitation functions, Synthesis of Synchronous sequential circuits, Capabilities and limitations of FSM, Design, Modeling and Simulation of Moore and Mealy machines.

4. Algorithmic State Machines
ASM chart, Timing considerations, Control implementation, Control Design with multiplexers, PLAs, etc.

5. Asynchronous Sequential Logic
Analysis Procedure, Circuits with latches, Design procedure, Reduction of state and flow tables, Race-free state assignment, Hazards, Design examples.

6. Designing with Programmable Logic Devices and Programmable Gate Arrays
Read only memories, Programmable logic arrays, Programmable array logic, Designing with FPGAs, Xilinx series FPGAs

Suggested Books:

1. VHDL – 3rd Edition – Douglas Perry – TMH
2. Fundamentals of Digital Logic with VHDL design – Stephen Brown, Zvonko Vranesic – TMH.
3. Digital Design Principles – William I Fletcher.
4. Digital System Design Using VHDL – Chales H. Roth.
5. Digital System Design – John Wakerley.

BTEC-906 (Intelligent Instrumentation)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Instrumentation

Introduction about Instrumentation systems, Types of Instrumentation systems, Data acquisition system (DAS) and its uses in intelligent Instrumentation system, Detailed study of each block involved in making of DAS, Signal Conditioners: as DA, IA, Signal Converters (ADC & DAC), Sample and hold, Designing of Pressure, Temperature measuring instrumentation system using DAS, Data logger.

2. Automation

Introduction about Automation system, Concepts of Control Schemes, Types of Controllers, Components involved in implementation of Automation system i.e., DAS, DOS, Converter (I to P) and Actuators: Pneumatic cylinder, Relay, Solenoid (Final Control Element), Computer Supervisory Control System (SCADA), Direct Digital Control's Structure and Software.

3. PLC

Introduction of Programmable logic controller, Principles of operation, Architecture of Programmable controllers, Programming the Programmable controller.

4. Intelligent Controller

Introduction to Intelligent Controllers, Model based controllers, Predictive control, Artificial Intelligent Based Systems, Experts Controller, Fuzzy Logic System and Controller, Artificial Neural Networks, Neuro-Fuzzy Controller system.

Suggested Books:

1. "Process Control Instrumentation Technology" 6/e, by Curtis D Johnson, Pearson Ed.
2. "Electrical and Electronics Measurement and Instrumentation" by A. K. Swahney.
3. "Electronics instrumentation" by H. S. Kalsi [TMH]
4. "Computer-Based Industrial Control", by Krishna Kant, PHI.
5. "Process Control Instrumentation Technology", by Curtis D Johnson, Pearson Ed

DE/PE-3.0 (Product Design and Development)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Visual Design

Basic elements and concept of visual design-line color, Balance proportion, Size shape mass, unity and variety, Special relationships and composition in two and three dimensions.

2. Form and Color

Elementary forms their characteristics and significance in design. Form transition, Form in relation to ergonomics, material and manufacturing process, color as an element of design, color clarification dynamics, interrelation of colors, colors and traditions; Psychological use of color form and material.

3. Product Graphics

Meaning and objectives of product graphics. Basic principles of graphic design, Visual communication aspects of product graphics, Graphics of displays and control panels,

4. Product Detailing

Standard fastening and joining details in different materials; Temporary and permanent joints: Detailing for plastic products, Detailing for fabricated products in sheet metal.

5. Products Development

Definition and objective, Role of designer in product development. Manufacturing and economic aspects of product development, Product promotions, product developments.

Suggested Books:

1. W.H. Mayal, Industrial Design for Engineers, London Liifee Books Ltd.
2. Huchingson R. Dale, New Horizons for Human Factors in Design, McGraw Hill.
3. N.L. Svensson, Engineering Design.
4. R. Matousek, Engineering Design.
5. K. J. Mccormick (Ed), Human Factor Engineering, McGraw Hill.

Seventh/Eighth Semester

BTAR-701 (Sensors and Signal Processing)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Smart Sensors

Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors – applications -Automobile, Aerospace, Home appliances, Manufacturing, Medical diagnostics, Environmental monitoring.

2. Signal Conditioning And Data Acquisition

Amplification – Filtering – Sample and Hold circuits –Data Acquisition: Single channel and multichannel data acquisition – Data logging.

3. Signal Processing

Introduction, Z-Transform, Region of convergence; Inverse Z Transform methods, properties of Z transform.

4. Design of Digital Filters

Structures of realization of discrete time system, direct form, Cascade form, parallel form and lattice structure of FIR and IIR systems. Linear Phase FIR filters; Design methods for FIR filters; IIR filter design by Impulse Invariance, Bilinear Transformation, Matched Z-Transformation, Analog and Digital Transformation in the Frequency Domain. Finite Precision Effects**:** Fixed point and Floating point representations

5. PID Controller

Process Control, Introduction to Process Control, P-I-D Control, Controller Tuning, Implementation of P-I-D Controllers.

Suggested Books:

1. E. O. Doebelin, Measurement Systems – Applications and Design , Tata McGraw Hill, edition 1992.
2. A. K. Sawhney, A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co (P) Ltd, 2004.
3. Beckwith, Marangoni and Lienhard, Mechanical Measurements, Addison – Wesley, 5th Edition, 2000.
4. D. Roy Choudry, Sheil Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
5. Patranabis. D, Sensors and Transducers, 2nd edition PHI, New Delhi, 2003.

BTAR-702 (Programming Industrial Automation Systems)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks:100

1. Nature of Industrial Process: continuous & discrete state sequential process, process variables and their classification.

2. Introduction to Process Control Philosophies: type of relays, ladder logic methodology, ladder symbols.

3. Introduction to Programmable Logic Controllers: advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC.

4. PLC programming methodologies: ladder diagram, STL, functional block diagram, creating ladder diagram from process control descriptions, introduction to IEC61131 international standard for PLC.

5.PLC functions: bit logic instructions, ladder diagram examples, interlocking, latching, inter dependency and logical functions, PLC Timer & Counter functions on-delay timer, off-delay timers, retentive on-delay timers, pulse timers, timer examples, up-counter, down-counter and up-down counter, counter examples, register basics.

6. PLC Data Handling: data move instructions, table and register moves, PLC FIFO & LIFO functions**.**

7. PLC arithmetic and logical functions: addition, subtraction, multiplication, division instructions, increment decrement, trigonometric and log functions, AND, OR, XOR, NOT functions, PLC compare and convert functions.

Suggested Books:

1. John Webb, Programmable Logic Controllers Principles & applications, PHI
2. T. A. Hughes, Programmable Controllers
3. C. D. Johnson, Process Control Instrumentation

BTME-803 (Mechanical Vibrations)

Internal Marks: 40	**L T P**
External Marks: 60	**3 1 0**
Total Marks: 100	

1. Introduction:

Basic concepts, Types of vibration, Periodic & Harmonic vibrations, Methods of vibration analysis

2. Vibration of Single Degree of Freedom System:

Undamped free vibrations, damped free vibrations and damped force vibration system, Modelling of stiffness and damping (both viscous and coulomb), estimation of damping by decay plots, vibration isolation transmissibility, vibration measuring instruments.

3. Two degrees of Freedom systems:

a) Principal modes of vibrations, natural frequencies, amplitude ratio, undamped free, damped free, forced harmonic vibration, semi-definite systems, combined rectilinear & angular modes; Lagrange's equation.

b) Application to un-damped and damped absorbers: Vibration absorber – principle; centrifugal pendulum vibration absorber, torsional vibration damper, untuned dry friction and viscous vibration damper, torsional vibration abosrber.

4. Multi-degree of freedom systems:

Undamped free vibrations, influence coefficients, Generalised coordinates, orthogonality principal, matrix iteration method, Rayleigh and Dunkerley, Holzer's , Stodola method, Eigen values and eigen vectors

5. Continuous systems:

Lateral vibrations of a string, longitudinal vibrations of bars, transverse vibrations of beams,Euler's equation of motion for beam vibration, natural frequencies for various end conditions,torsional vibration of circular shafts

Suggested Books:

1. G.K. Grover, Mechanical Vibrations Hem Chand and Bros
2. K.K. Purjara, Mechanical Vibrations, Dhanpat Rai and Sons, Delhi
3. V.P.Singh, Mechanical Vibrations Dhanpat Rai and Sons, Delhi
4. Debabrata Nag, Mechanical Vibration, John Wiley India
5. Thomson, Mechanical Vibration, Prentice Hall

ME-402 (Industrial Safety and Enviorement)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Safety
Meaning & need for safety, Relationship of safety with plant design, Equipment design and work environment, Industrial accidents, Natures, Types and causes.

2. Assessment of Accident Costs
Prevention of accidents, Industrial hazards, Hazard identification techniques, Accident investigation, Reporting and analysis.

3. Planning for Safety
Definition, Purpose, Nature, Scope and procedure, Range of planning, Variety of plans, Policy formulation and implementation of safety policies, Safety measures in a manufacturing organization, Safety, Economics, Safety and productivity, Employees participation in safety, Safety standards and legislation.

4. Meaning of Environment and Need for Environmental Control
F-factors in industry, Effect of temperature, Illumination, Humidity, Noise and vibrations on human body and mind. Measurement and mitigation of physical and mental "fatigue", Basics of environment design for improved efficiency and accuracy at work.

5. Ventilation and Heat
Control Purpose of ventilation, Physiology of heat regulation, Thermal environment and its measurement, Thermal comfort, Indices of heat stress, Thermal limits for comfort, Efficiency and freedom from health risk, Natural ventilation and mechanical ventilation, Air conditioning Process ventilation, Control of heat exposures, Control at source, Insulation and local exhaust ventilation, Control of radiant heat, Dilution ventilation, Local relief.

6. Industrial Lighting
Purpose of lighting, Benefits of good illumination, Phenomenon of lighting and safety, Lighting at work, Sources and types of artificial lighting, Principles of good illumination, Recommended optimum standards of illumination, Design of lighting installation, Maintenance standards relating to lighting and colour.

7. Noise & Vibrations
Continuous and impulse noise, Effect of noise on man, Noise measurement and evaluation of noise, Noise isolation. Noise absorption techniques, Silencers vibrations: Effect, Measurement and control measures.

8. Environment Standards
Introduction to ISO-14000, Environment standards for representative industries

Suggested Books:

1. Joselin, Ventilation, Edward Arnold.
2. Beranek, Noise Reduction, McGraw Hill.
3. Reamer D.C., Modern Safety and health Technology, R. Wiley.
4.Heinrich H.W, Industrial Accident Prevention, McGraw Hill.
5.Firenze, The process of Hazard Control, R.J. Kendale.

BTME-805 (Mechanical Vibration Lab)

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 2**
Total Marks: 50

List of Experiments:

1. Determine the viscosity of given fluid by single wire torsional pendulum.
2. Determine the natural frequencies of a coupled pendulum.
3. Find out the fundamental natural frequency of a cantilever beam.
4. Determine the modulas of elasticity from free vibration test.
5. Study of forced vibration of a two degree of freedom system under harmonic excitation.
6. Study of a dynamic absorber.
7. Determine coefficient of dry friction from measurement of natural frequency ofvibration of a bar resting on two disks rotating in opposite direction.

DE/ME-1.3 (Non-Conventional Energy Resources)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Introduction
Renewable and non-renewable energy sources, their availability and growth in India; energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements.

2. Solar Energy
Solar radiation - beam and diffuse radiation; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles, general description and design procedures of flat Platte and concentrating collectors; Performance analysis of cylindrical and parabolic collectors; Solar energy storage systems - their types, characteristics and capacity; solar ponds. Applications of solar energy in water, space and process heating, solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar cells and batteries; economic analysis of solar systems.

3. 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 acco-dynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

4. Direct energy conversion systems
i) Magnetic Hydrodynamic (MHD) Generator: gas conductivity and MHD equations; operating principle, types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields.
ii) Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration.
iii) Thermionic generators: thermoionic emission and materials; working principle of thermionic convertors.
iv) Fuel Cells: thermodynamic aspects; types, components and working of fuel cells.
v) Performance, applications and economic aspects of above mentioned direct energy conversions systems.

5. Miscellaneous Non-Conventional energy Systems
i) Bio-mass: Concept of bio-mass conversion, photo-synthesis and bio-gasification; Bio gas generators and plants - their types constructional features and functioning; digesters and their design; Fuel properties of bio gas and community bio gas plants
ii) Geothermal: Sources of geothermal energy - types, constructional features and associated prime movers.
iii) Tidal and wave energy: Basic principles and components of tidal and wave energy plants;single basin and double basin tidal power plants; conversion devices Advantages/disadvantages and applications of above mentioned energy systems.

Suggested Books:

1. H.P. Garg and Jai Prakash, Solar Energy : Fundamentals and Applications, Tata McGraw Hill.
2. S.P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill.
3. John A. Duffic and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley.
4. S. L. Sheldon, Chang, Energy Conversion, Prentice Hall.
5. O. M. Bockris and S. Srinivasan, Fuel Cells, McGraw Hill.

DE/PE-2.2 (Modeling and Simulation)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Modeling
Need for system modeling, systems approach to modeling, open and feedback systems, combination of simple feedback systems, feedback time lag effects, feedback and managerial systems

2. Production and Operations Management
Principle of analytical modeling, kinds of analytical methods, measures of effectiveness, cost analysis large systems

3. Simulation
Monte Carlo simulation, generation of stochastic variates, continuous and discrete probability distributions, application of Monte Carlo methods for production systems, computer simulation models, Macro Dynamic models, examples from business and industry, design of management game, Simulation languages SIMULA, SIMSCRIPT, GPSS etc. Statistical output analysis.

4. Analog computer simulation;
Basic analog computer components and operations; amplitude and time scaling; solution of linear and non-linear partial differential equations, formulation of model for a dynamic system and its simulation on analog computer.

Suggested Books:

1. Narsingh Deo, System Simulation with Digital Computer, PHI Learning.
2 G. Gordon, System Simulation, PHI Learning.
3. Jackson A.S, Analog Computation, McGraw-Hill.
4. Naylor T.H. et. al, Computer Simulation Techniques, John Wiley.
5. S. Buffa, Modern Production Management, John Wiley .

DE/ME-2.7 (Material Management)

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

1. Introduction
Meaning, definition, functions of materials management, Concept of integrated material management, Relationship of material management with other Organizational functions.

2. Material Planning & Budgeting
Need for material planning, Factors affecting material planning, Techniques of material planning, Material classification, codification and standardization, Material budgeting – meaning and need, techniques of material budgeting.

3. Inventory Control
Need and meaning of inventory, types of inventory, functions of inventory control, Inventory costs, Inventory control tool - ABC, VED, XYZ and FSN: Economic order Quantity and replenishment of stocks. Physical control of inventory: Fixed order, Two bin and Kardex systems - Material requirement planning (MRP-I) Spare parts control for maintenance purposes. Evaluation of inventory control performance. Concept of Just-in-Time(JIT). Use of computers for inventory control

4. Purchasing
Purchasing principles, procedures and systems, Functions of purchasing, Make-or-buy decision, Vendor development and vendor rating. Factors affecting purchase decisions, Legal aspects of purchasing, Documentation and procedure for import.

5.Storage
Functions and importance of store keeping, types of stores, store accounting and store verification, Legal aspects of store keeping, Management of surplus, scrap and obsolete items. Importance of material handling in store keeping, handling equipment.

Suggested Books:

1. M.M. Verma, Materials Management, S. Chand and Co.
2. Gopal Krishnan and Sundaresan, Material Management - An Integrated Approach, Prentice Hall
3. Dobbler and Burt, Purchasing and materials management, Tata McGraw Hill
4. M. Starr and D. Miller, Inventory control, Prentice Hall.

BTEC 913 Human Resource Management
(Same as to be uploaded in ECE 2011 batch)

BTEC 914 Computer organization and Architecture
(Same as to be uploaded in ECE 2011 batch)