COURSES SCHEME

&

SYLLABUS

FOR

B.E.

MECHATRONICS

ENGINEERING

2014

COURSES SCHEME & SYLLABUS FOR B.E.

MECHATRONICS ENGINEERING

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UMA031	OPTIMIZATION TECHNIQUES	3	1	0	3.5
2	UHU031	ORGANIZATIONAL BEHAVIOUR	3	1	0	3.5
3	UES032	MATERIAL SCIENCE AND ENGINEERING	3	1	2	4.5
4	UEC303	SIGNALS AND SYSTEMS	3	1	2	4.5
5	UME	KINEMATICS OF MACHINES	3	1	0	3.5
6	UEC	ELECTRONIC DEVICES AND CIRCUITS	3	1	2	4.5
	UEI	MECHATRONICS MEASUREMENT SYSTEM	3	1	0	3.5
TOTAL			**21**	**7**	**6**	**27.5**

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UMA032	NUMERICAL AND STATISTICAL METHODS	3	1	2	4.5
2	UHU003	HUMAN VALUES, HUMAN RIGHTS AND IPR	2	1	0	2.5
3	UEN001	ENVIRONMENTAL STUDIES	3	0	0	3.0
4	UEE201	ELECTRICAL MACHINES	3	1	2	4.5
5	UME	DYNAMICS OF MACHINES	3	1	0	3.5
6	UEC	DIGITAL ELECTRONICS AND MICROPROCESSORS	3	1	2	4.5
7	UME	COMPUTER AIDED DESIGN AND ANALYSIS	3	4	0	5.0
TOTAL			**20**	**9**	**6**	**27.5**

SEMESTER – V

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEI	SENSORS AND TRANSDUCERS	3	1	2	4.5
2	UME	MACHINE DESIGN	3	1	0	3.5
3	UEC722	DIGITAL SIGNAL PROCESSING	3	1	2	4.5
4	UEC	BASICS OF COMMUNICATION ENGINEERING	3	1	2	4.5
5	UEI501	CONTROL SYSTEMS	3	1	2	4.5
6	UEI	SIGNAL CONDITIONING AND DATA ACQUISITION SYSTEM	3	0	2	4.0
7		DESIGN PROJECT (WITH 8 SELF-EFFORT HOURS)	0	0	2	5.0
TOTAL			**18**	**5**	**12**	**30.5**

SEMESTER – VI

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UME	PROJECT SEMESTER*	-	-	-	12.0
TOTAL			**-**	**-**	**-**	**12.0**

OR (ALTERNATE SEMESTER)

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UME	PROJECT	-	-	-	2.0
2	UME	PRODUCT DESIGN AND DEVELOPMENT	3	1	0	3.5
3	UME	PRODUCTION AND INVENTORY CONTROL	3	1	0	3.5
4		ELECTIVE-II	3	0	0	3.0
TOTAL			**9**	**2**	**0**	**12.0**

* TO BE CARRIED OUT IN INDUSTRY/RESEARCH INSTITUTION.

SEMESTER – VII

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UME	COMPUTER AIDED MANUFACTURING	3	0	2	4.0
2	UME	AUTOMOBILE ENGINEERING	3	0	2	4.0
3	UEC	MEMS AND SENSOR TECHNOLOGY	3	0	0	3.0
4	UEE504	POWER ELECTRONICS	3	1	2	4.5
5	UME	INDUSTRIAL AUTOMATION	3	1	0	3.5
6		CAPSTON PROJECT PART-I (START)	0	0	4	0.0
TOTAL			**15**	**2**	**10**	**19.0**

SEMESTER – VIII

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UME	ROBOTICS ENGINEERING	3	1	0	3.5
2	UEE701	ELECTRIC DRIVES	3	1	2	4.5
3	UEC	MICROCONTROLLERS AND EMBEDDED SYSTEMS	3	1	2	4.5
4	UEI841	ADVANCED CONTROL SYSTEM	3	1	0	3.5
5	UHU081	ENGINEERING ECONOMICS	3	1	0	3.5
6		CAPSTON PROJECT PART-II (CONTINUED)	0	0	6	8.0
TOTAL			**15**	**5**	**10**	**27.5**

ELECTIVE-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1		WORK STUDY AND METHODS ENGINEERING	3	0	0	3
2		LEAN MANUFACTURING	3	0	0	3
3		FACILITY PLANNING	3	0	0	3
4		ERGONOMICS ENGINEERING	3	0	0	3

UMA031 OPTIMIZATION TECHNIQUES

L	T	P	Cr
3	1	0	3.5

Course Objective: The main objective of the course is to formulate mathematical models and to understand solution methods for real life optimal decision problems. The emphasis will be on basic study of linear programming problem, Integer programming problem, Transportation problem, Two person zero sum games with economic applications and project management techniques using PERT and CPM.

Scope of Operations Research: Introduction to linear and non-linear programming formulation of different models.

Linear Programming: Geometry of linear programming, Graphical method, Linear programming (LP) in standard form, Solution of LP by simplex method, Exceptional cases in LP, Duality theory, Dual simplex method, Sensitivity analysis, Parametric linear programming.

Integer Programming: Branch and bound technique.

Transportation and Assignment Problem: Initial basic feasible solutions of balanced and unbalanced transportation/assignment problems, Optimal solutions.

Network Analysis: Shortest path problem, Dijkastra's algorithm, Minimum spanning tree problem, Maximum flow problem.

Project Management: Construction of networks, Network computations, Floats (free floats and total floats), Red flagging rule, Critical path method (CPM), Crashing.

Nonlinear Programming: Concept of convexity and concavity, Maxima and minima of functions of n-variables, Lagrange multipliers, Kuhn-Tucker conditions for constrained optimization, One dimensional search methods, Fibonacci, Gradient methods for unconstrained problems.

Course Learning Outcomes (CLO):

After Completion of this course, the students would be able to:

1. Formulate and solve linear programming problems.
2. Solve the problems on networks models such as Transportation, Assignment, Shortest path, minimal spanning tree, and Maximal flow.
3. Solve the problems of Project Management using CPM.

Text Books:

1. *Chandra, S., Jayadeva, Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, (2013).*
2. *Taha H.A., Operations Research-An Introduction, PHI (2007).*

Recommended Books:

1. *Bazaarra Mokhtar S., Jarvis John J. and Shirali Hanif D., Linear Programming and Network flows, John Wiley and Sons (1990).*
2. *Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).*
3. *Pant J. C., Introduction to optimization: Operations Research, Jain Brothers (2004).*

UHU 031-ORGANIZATIONAL BEHAVIOR

L	T	P	Cr
3	1	0	3.5

Course Objective: To understand the complexity of human behavior and factors affecting individual differences and their relevance in the global world**.** To learn the dynamics of leadership and motivation for effective functioning in the organization.

Introduction to Organizational Behavior, Today's Organizations, Contemporary Challenges, Foundations of Organizational Behavior, and Individual Behavior: Personality, Values, Attitudes, and Motivation Theories. Employees Motivation in Organization. Management by Objectives, Learning Processes, Reward and Punishment, Shaping Behavior.

Foundations of Group Behavior: Group Development Process, Group Decision Making Techniques, Leadership, Power & Politics, Conflict Process, Negotiations, Inter- Group Relations, Team Working, and Stress Management.

A Macro perspective of Organizational Behavior, Organizational Structure: Key Elements, Types and Basic Models, Work Designs, Organizational Change and Learning Organizations.

Organizational Behavior: Future Challenges, Gender Diversity at Work Place, Changing World Scenario, Role of external Environment.

Achieving Competitive Advantage Management of change, International issues in Organizational Behavior.

Current issues in Organizational Behavior: Techno-stress, Combating stress, Role of Positive Psychology.

Course Learning Outcomes (CLO):

After completing the course, the students will be able to:

1. Understand the basics of Organizational Behavior as an interdisciplinary Course.
2. Understand the different levels of analysis: Individual, Group, Organization.
3. Understand the effect of personality, Learning, Attitudes of an individual in an Organization.
4. Understand the role of Motivation and Leadership in an organization and how an individual as a leader can motivate his/her employees and utilize Group dynamics in Organization.
5. Understand the concept of Power and Politics, and Conflict management and its relevance.
6. Understand how organization functions as whole, Organizational Culture, Organizational Design, and Organizational Change.

Text Books:

1. *Robbins, S.P. Organizational Behavior, PHI, New Delhi.*
2. *Luthans, F. Organizational Behavior, Irwin McGraw Hill.*
3. *Susan Nolen-Hoeksema,S; Geoffrey Loftus ,G,& Wagenaar,W Atkinson & Hilgard's Introduction to Psychology Wadsworth Cengage learning.*

UES032: MATERIALS SCIENCE AND ENGINEERING

L	T	P	Cr
3	1	2	4.5

Crystal Structure and Chemical Bonding: Materials and their classification, Mechanical, Chemical, Electrical properties, Structure-property relationship in engineering materials, Miller Indices, Crystal planes and directions, Determination of crystal structure using X-rays, Chemical bonding in solids, Primary and Secondary bonds.

Structure of Solids: Crystalline and non-crystalline materials, Inorganic solids, Silicate structures and its applications.

Crystal Imperfections: Point defects, Line defects, Surface defects, Movement of Dislocation, Dislocation energy.

Diffusion: Laws of diffusion, Temperature dependence of diffusion coefficient, Determination of activation energy.

Mechanical Properties of Materials: Elastic, Anelastic and Viscoelastic behaviour, Plastic behaviour of solids, Critical shear stress, Twinning and slipping phenomenon, Creep.

Equilibrium Diagram: Solids solutions and alloys, Gibbs phase rule, Isomorphous and eutectic phase diagrams and their construction, Lever arm rule, Application of phase diagrams, Zone refining.

Corrosion Process: Corrosion, Cause of corrosion, Types of corrosion, Protection against corrosion.

Conducting and Resistor Materials: Conducting and resister materials, Coefficient of thermal expansion, Matthiessen and Nordheim rules for alloys and their engineering application.

Semiconductors: Semiconducting materials, Element and compound semiconductors their properties and applications.

Magnetic Materials: Magnetic materials, Soft and hard magnetic materials their properties and applications.

Dielectric Materials: Dielectric materials, Polarization, Dielectric loss and dielectric breakdown, Ferro, Piezo-and Pyroelectric materials, their properties and applications.

Biomaterials and Applications: Biomaterials with reference to biopolymer and bioceramics.

Modern Materials: Introduction and application to nanomaterials, Smart materials and structures, Optical materials, Superconducting materials, Materials for nuclear and space applications.

Laboratory Work:

1. To determine Curie temperature of a ferrite sample and to study temperature dependence of permeability in the vicinity of curie temperature.
2. To study cooling curve of a binary alloy.
3. Determination of the Young's modulus and Ultimate strength of a given fiber strand.
4. To determine the dielectric constant of PCB laminate.
5. Detection of flaws using ultrasonic Flaw Detector (UFD).
6. To study the intensity response of L.D.R and voltage response of a V.D.R.
7. To prepare two metallic specimens for metallographic examination and measure their grain size.
8. Estimation of band-gap energy of Germanium.
9. To determine the light intensity response of a Silicon Solar Cell.
10. To determine the resistivity of a given sample using four probe method.

11. To determine Fiber and void fraction of a glass fiber reinforced composite specimen.
12. To investigate creep of a given wire at room temperature.
13. To estimate the Hall coefficient, carrier concentration and their mobility in Ge Crystal using Hall Effect.
14. To estimate the Band-gap of energy of Ge Crystal using Four Probe Technique.
15. To Study the Corrosion behavior of metallic materials.

Text Books:

1. *Smith, W.F., Principles of Materials Science and Engineering: An Introduction, Tata Mc-Graw Hill (2008).*
2. *Raghavan, V., Introduction to Materials Science and Engineering, PHI, Delhi (2005).*
3. *Callister, W.D., Materials Science and Engineering, John Wiley & Sons, Singapore (2002).*

Reference Books:

1. *Kasap, S. O., Principles of Electronic Engineering Materials, Tata-Mc-Graw Hill (2007).*
2. *Van Vlack, L H., Elements of Material Science and Engineering, Thomas Press, India (1998).*

UEC303: SIGNALS AND SYSTEMS

L	T	P	Cr
3	1	2	4.5

Course Objective: Aim of this subject is to develop analytical capability of students, by which they would be able to handle real-time signal processing related problems and projects. The knowledge of various transforms will help students to work in multi-disciplinary fields of engineering in group activities.

Representation of Signals and Systems: Signals, Basic continuous time signals, Energy and power signals, System modeling concepts, Linear time invariant systems, Representation of signals in terms of impulses, Discrete time LTI systems continuous time LTI systems, Properties of LTI systems, Systems described by differential and difference equations, Introduction to Sampling theorem of sinusoidal and random signals, Quantization.

Fourier Analysis: Continuous and discrete time Fourier series, Trigonometric & exponential Fourier series, Properties of Fourier series, Parseval's theorem, Line spectrum, Rate of conversion of Fourier spectra, Continuous and discrete time Fourier transforms and its properties, Analysis of discrete time signals and systems, Correlation, Autocorrelation, Relation to Laplace transform.

The Z-Transform: Definition of Z-transform and Z-transform theorems, Relation between Z.T. and F.T., Transfer function, Inverse Z-transform, Discrete time convolution, Stability, Time domain and frequency domain analysis, Solution of difference equation.

Introduction to Fast Fourier Transforms: Discrete Fourier transform, Properties of DFT, Fast Fourier transforms, Divide and Conquer Approach, Decimation in time and decimation infrequency, Radix-4 FFT, Linear Convolution, Circular Convolution, Power spectrum and correlation with FFT.

Random Signals: Probability, Random variables, Gaussian distribution, Transformation of random variables, Random processes, Stationary processes, Correlation and Covariance Functions, Regularity and Ergodicity, Gaussian Process, Transmission of deterministic and undeterministic signals through a linear time invariant system, Spectral density.

Laboratory Work:
Signal generation, Solving difference equation, Calculating Z-transform, Linear and Circular convolution, Correlation, DFT/IDFT, FFT algorithms using Matlab.

Course Learning Outcomes (CLO):
The students will be able to:

1. development of analog as well as discrete signal generation and applications; and to learn the physical significance of random signals and its applications in the emerging field of communication engineering
2. development of linear as well as nonlinear techniques for the conversion of discrete-time signals and systems to digital signals and systems
3. application of fourier series and fourier transform in the field of communication and signal processing
4. application of z-transform in the field of communication and signal processing

5. application of laplace transform in the field of control system engineering
6. application of laplace transform in the field of control system engineering
7. ability to use fft/ifft for implementation in vlsi signal processing

Text Books:

1. *Oppenheim, A.V. and Willsky, A.S., Signal & Systems, Prentice Hall of India (1997).*
2. *Proakis, J.G. and Manolakis, D.G., Digital Signal Processing Principles Algorithm & Applications, Prentice Hall (2007).*

Reference Books:

1. *Lathi, B.P., Modern Digital and Analog Communication Systems, Oxford Univ. Press (1998).*
2. *Papoulis, A., Probability Random Variables and Stochastic Processes, McGraw Hill (2008).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

KINEMATICS OF MACHINES

L	T	P	Cr
3	1	0	3.5

Course Objectives: To learn actual mechanisms and their kinematic characteristics (displacement, velocity and acceleration) used in the analysis, design and development of machines and to study existing machines for better understanding.

Motion Analysis: Kinematics links, Pairs and chains, Type of motions, Type of mechanisms, Inversion of mechanisms, Velocity analysis of different mechanism by vector and instantaneous method, Acceleration analysis of different mechanism, Coriolis acceleration.

Gear Drives: Law of Gearing, Types of gears, Types of Profiles, Gear terminology, Gear Trains, Types and applications of gear trains, Train value, Analysis of Simple, Compound, Inverted and Epicyclical gear trains.

Cam Mechanism: Types of Cams and Followers, Types of follower motions, Construction of cam profiles, Analysis of motion of follower, Operating different types of cam.

Steering Mechanism, Hook's Joint.

Synthesis: Introduction to Synthesis of mechanisms.

Course Learning Outcomes (CLO):
The students will be able to:

1. Select appropriate combination of mechanism to analyze and design new machines and to study existing machines for improvements.

Text Books:

1. *Rattan, S. S., Theory of Machines, Tata McGraw Hill (2009).*
2. *Bevan, T., Theory of Machines, CBS Publisher (2005).*

Reference Books:

1. *Ghosh, A. and Malik, A.K., Theory of Mechanism and Machines, East West Press (2009).*
2. *Shigley, J. E., Kinematics Analysis of Mechanism, McGraw-Hill (1995).*
3. *Myszka, D. S., Machines & Mechanisms: Applied Kinematic Analysis, Pearson Education (2004).*

UEC ELECTRONIC DEVICES AND CIRCUITS

L	T	P	Cr
3	1	2	4.5

Course Objectives: The basic objective of this course is to introduce the concept of semiconductor physics for intrinsic and extrinsic materials, basics of semiconductor diodes, BJTs, FETs on the basis of their operation and working. The objective of this course is to impart basic knowledge about rectifier, amplifier, wave shaping and operation amplifiers circuits.

Semiconductor Physics: Energy bands In solids (metals, semiconductor, insulators), intrinsic, extrinsic semiconductor, mass action law, charge densities, conductivity of metals and semiconductors, concept of fermi levels in intrinsic and extrinsic semiconductor.

Semiconductor Devices: P-N junction and its V-I characteristics, ideal diode, P-N junction as rectifier, diode as a circuit element, load line concept, half-wave and full-wave rectifiers, diode switching characteristics; Zener diode, LED, photo diode.

Bipolar Junction Transistor: Operation of transistor and its current components; transistor circuit configurations - CB, CE, CC (relationship between α, β, γ), input-output characteristics, concept of Q point and load line, switching characteristics of transistor, h-parameter model of a transistor, biasing of BJT.

Field Effect Transistors: JFET, pinch-off voltage, volt-ampere characteristics, small signal model, MOSFET-enhancement & depletion mode, V-MOSFET, JFET & MOSFET amplifiers, biasing of JFETS and MOSFETS. JFET and MOSFET, their construction, operation and characteristics, biasing of FET.

Feedback Oscillators and Power Amplifiers: Feedback in amplifiers: basic feedback topologies. Oscillators: Barkhausen's criterion, sinusoidal oscillators, phase shift oscillators, resonant circuit oscillator, a general form of oscillator, the Wein Bridge oscillator, crystal oscillator. Introduction to power amplifiers and its various types with applications.

Wave Shaping Circuits: Multi-vibrators (astable, mono-stable, bi-Stable), high pass and low pass filters using R-C Circuits and R-L, R-L-C circuits & their response to step input, pulse input and ramp Input, clipping and clamping circuits, Schmitt trigger.

Operational Amplifier: Introduction to operational amplifier, characteristics of ideal operational amplifier, differential and common mode operation, applications of operational amplifier, voltage summing, integrator, differentiator etc.

Practical/Laboratory Work:
Experiments will be conducted covering the problems related to diodes, transistors, JFET, MOSFET, single-stage amplifiers, operational amplifier, oscillators, clippers, clampers.

Course Learning Outcomes (CLO):

The students will be able to:

1. Understand the physics of semiconductor and its types.
2. Understand the physics and working of semiconductor devices, i.e., diode, bipolar junction transistor, junction field effect transistor, etc.
3. Understand the concept of feedback oscillators and power amplifiers, their types and applications.
4. Understand in detail the different types of wave shaping circuits.
5. Learn the concept and working of operational amplifiers and their applications as voltage summer, differentiator, integrator, etc.

Text Books:

1. *Milliman, J. and Halkias, C.C., Integrated Electronics, Tata McGraw Hill (2007).*
2. *D.A. Neamen; Electronic circuit analysis and design (Second Edition): TMH (2009).*

Reference Books:

1. *Boylestad & Nashelsky, Electronics Devices & Circuits, Pearson Education (2008).*
2. *David A Bell, Electronic Devices and Circuits, Prentice Hall of India (2003).*
3. *Thomas L. Floyd, Electronic devices, Pearson Education (2006).*
4. *R.A. Gayakward , OP-amps and Linear Integrated circuits (2007).*

UEI - MECHATRONICS MEASUREMENT SYSTEM

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective of this course is to impart knowledge on the basic concepts of measurement, static and dynamic characteristics of measurement systems, accuracy, loading effect, reliability, choice and economics of measurement systems.

General Concept of Measurement Systems: Introduction, purpose, structure, generalized elements of a measurement system.

Static Characteristics of Measurement System Elements: Systematic characteristics, generalized model of system element, static characteristics, accuracy, precision, sensitivity, resolution, linearity, hysteresis etc.

Accuracy of Measurement Systems: Measurement error of a system of ideal elements, error probability density function of a system of non-ideal elements, types of error and reduction techniques, statistical analysis of errors, normal distribution, confidence level, significance test.

Dynamic Characteristics of Measurement Systems: Transfer function of some typical system elements, zero order, first order and second order systems, identification of the dynamics of an element, step and frequency response, dynamic errors in measurement systems: definitions and calculations, techniques for dynamic compensation.

Loading Effects: Generalized stiffness and input impedance, electrical loading: Thevenin and Norton's equivalents.

Reliability, Measurement Systems: Reliability of measurement systems: principles, data, design and maintenance, choice of measurement systems, specifications, total lifetime operating cost.

Course Learning Outcomes (CLO):

The students will be able to:

1. Demonstrate the concepts of measurement systems
2. Implement static and dynamic characteristics for analysing measurement systems
3. Learn about the accuracy of the measurement system and statistical analysis of errors
4. Select appropriate measurement system based on characteristics, loading effect, reliability and economic issues.

Text Books:

1. *Doeblin, E.O., Measurement systems, Tata McGraw Hill (2007).*
2. *Nakra, B.C. and Chaudhry, K.K., Instrumentation Measurement and Analysis, Tata McGraw□Hill (2009).*

Reference Books:

1. *Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India (2008).*
2. *Sawhney, A.K. and Sawhney, P., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai (2008).*

UMA032 NUMERICAL AND STATISTICAL METHODS

L	T	P	Cr
3	1	2	4.5

Course Objective: The main objective of this course is to motivate the students to understand and learn various numerical and statistical techniques to solve mathematical problems representing various engineering, physical and real life problems.

Floating-Point Numbers: Floating-point representation, Rounding, Chopping, Error analysis, Condition and instability.

Non-Linear Equations: Bisection, Secant, Fixed-point iteration and Newton-Raphson methods, Order of convergence.

Linear Systems and Eigen-Values: Gauss elimination method (using Pivoting strategies), Gauss-Seidel iteration method and its convergence, Rayleigh's power method for eigen values and eigen vectors.

Interpolation: Newton form of polynomials, Finite differences, Newton's forward, Lagrange and Newton's divided difference interpolation formula with error analysis.

Numerical Integration: Newton cotes quadrature formulae (with error) and Gauss - Legendre quadrature formulae.

Differential Equations: Solution of initial value problems using Taylor series, Euler's and Runge Kutta (up to fourth order) methods.

Random Variables: Basic concepts of probability, Discrete and continuous random variables, Probability mass/density functions, Cumulative distribution functions, Mathematical expectation, Variance and covariance.

Probability Distributions: Introduction to binomial and poisson distribution, Geometric, Uniform, Normal and exponential distribution.

Linear Regression and Correlation: Linear regression, Least square principle and the fitted model, Correlation and regression (two variables only).

Sampling Distribution: Sampling distribution of mean and variance, Chi square distribution and F distribution.

Hypothesis Testing: General concepts, Testing a statistical hypothesis.

Laboratory Work:

Laboratory experiments will be set in consonance with the materials covered in theory.

Course Learning Outcomes (CLO):

Upon completion of this course, the students will be able to:

1. understand error, source of error and its affect on any numerical computation and also analyzing the efficiency of any numerical algorithm.
2. learn how to obtain numerical solution of nonlinear equations using Bisection, Newton – Raphson and fixed-point iteration methods.
3. solve system of linear equations numerically using direct and iterative methods.
4. understand the methods to construct interpolating polynomials with practical exposure and also the various approaches dealing with the data using theory of probability.
5. analyze the different samples of data at different level of significance using various hypothesis testing.

Text Books:

1. *Conte, S.D. and Boor, C.D., Elementary Numerical Analysis: An Algorithmic approach, (Third Edition), Tata McGraw Hill, New York (2006).*
2. *Jain, M.K., Iyengar, S. R. K. and Jain, R. K., Numerical Methods for Scientific and Engineering Computation, New Age International Publishers (2008).*
3. *Johnson, R.A., Miller and Freund's Probability and Statistics for Engineers, Pearson Education (2006).*
4. *Meyer P.L., Introduction to Probability and Statistical Applications, Oxford & IBH (2007).*

Reference Books:

1. *Atkinson, A.E., An Introduction to Numerical Analysis, Wiley Publication, Second Edition (2011).*
2. *Chapra, S.C. and Caule, R.P., Numerical Methods for Engineers, McGraw-Hill, (1989).*
3. *Walpole E Ronald, Myers H. Raymond, Myers L. Sharon, Keying Ye, Probability and Statistics for Engineers and Scientists, Pearson Education (2005).*

UHU003: HUMAN VALUES, HUMAN RIGHTS AND IPR

L	T	P	Cr.
2	1	0	2.5

Course Objectives: The course has been designed to enable students to understand the concept of values and different types of values, and to establish the theoretical foundation for the study of important values and their major dimensions. It will also help in understanding the meaning of moral and ethical values and need for ethics in professional life. The course also covers the concept and classification of human rights and their significance in the modern-day world. The course will also enable them to understand the nature and character of IPRs and their role in economic development.

Values: Concept, Types, Rokeach Value Survey.

Different Kinds of Values: Individual, Societal, Material, Psychological, Cultural, Moral And Ethical, Spiritual; The Burgeoning Crises at Each of these levels.

Modern Approach to the Study of Values: Analyzing Individual Human Values such as Creativity, Freedom, Wisdom and Love; Value Spectrum for a Good Life; The Indian Concept of Values, Comparison of eastern and western concept of values.

Ethics: Values, Morals and Ethics; Need for Ethics in Professional Life; Kohlberg's Theory of Moral Development and Its Applicability to Engineers.

Professional Ethics: Values in Work Life; Professional Ethics and Ethos; Codes of Conduct, Whistle-Blowing, Corporate Social Responsibility, Case Studies on Ethics in Business.

Human Rights: Meaning and concept of Human Rights; Notion and Classification of Rights: Natural, Moral and Legal Rights; Three Generations of Human Rights; Civil and Political Rights; Economic, Social and Cultural Rights; Collective/Solidarity Rights.

Introduction to IPR: Nature and Enforcement, International Character of IPRs, Role of IPRs in Economic Development.

Patents: Introduction To Patents, Object of Patent Law, Inventions not Patentable, Obtaining Patents, Rights and Obligations of a Patentee.

Copyrights: Introduction to Copyrights, Subject-Matters of Copyright, Rights Conferred by Copyright, Infringement, Assignment and Licensing Of Copyrights, Copyright Societies, International Copyright, Performers' Rights.

Trademarks: Functions, Significance and Types of Trademarks, Distinctiveness and Deceptive Similarity, Registration Procedure, Trademark Registry, Grounds for Refusal of Registration of Trademarks, Concurrent Use, Character Merchandising.

Trade Secrets: Meaning, Types of Trade Secrets, Statutory Position of Trade Secrets in India, Proofs Required in Trade Secret Litigation Case.

Some Other Types of Intellectual Properties: Role and Significance, Current Status of GIs as Intellectual Property Rights, Nature and Significance of Industrial designs.

Course Learning Outcomes (CLO):
The students after studying this course will be able to appreciate the significance of values and ethics in both personal and professional life, and to be able to respect and uphold human rights. Additionally, they will be able to appreciate the significance of Intellectual Property as a very important driver of growth and development in today's world and be able to statutorily acquire and use different types of intellectual property in their professional life.

Text Books:

1. *Narayanan, P., Intellectual Property Law, Eastern Law House (2007).*
2. *Tripathi A.N., Human Values, New Age International (P) Ltd (2008).*
3. *Rhona K. M. Smith: Textbook on International Human Rights: Oxford University Press (2011).*

Reference Books/Journals:

1. *Robbins, S.P., Organizational Behavior, Prentice Hall of India (2007).*
2. *Journal of Intellectual Property Rights, published by National Institute of Science Communication, CSIR.*

UEN001 ENVIRONMENTAL STUDIES

L	T	P	Cr
3	0	0	3.0

Definition and Scope: Importance, Public awareness and education.

Natural Resources: Introduction, Renewable and non-renewable, Forest, water, mineral, food, energy and land resources, Individual and conservation of resources, equitable use of resources.

Ecosystems: Concept, Structure, Function, Energy flow, Ecological succession, Forest, grassland, desert and aquatic ecosystems - Introduction, characteristic features, structure and function.

Biodiversity: Genetic, Species and ecological diversity, Bio-geographical classification of India, Value and hot spots, Biodiversity at global, national and local levels, India as mega-biodiversity nation, Threats to biodiversity, Endangered and endemic species of India, Conservation of Biodiversity, Endangered and endemic species, Conservation of biodiversity.

Pollution: Definition, Causes, effects and control measures of the pollution – Air, soil, Noise, Water, Marine and Thermal and Nuclear Pollution, Solid waste management, Role of Individual in Prevention of Pollution, Pollution case studies, Disaster management.

Social Issues: Sustainable development, Water conservation, Environmental ethics, Climatic change, Wasteland reclamation, Environmental protection acts and issues.

Human Population and the Environment: Population growth, Environment and human health, Human rights, HIV/AIDS, Value education, Women and child welfare, IT in human health and environment, Case studies.

Text Books:

1. *Bharucha, E., Textbook of Environmental Studies for undergraduate courses, Universities Press (2005).*
2. *Chapman, J.L. and Reiss, M.J., Ecology - Principles and Application, Cambridge University Press (LPE) (1999).*
3. *Joseph, B., Environmental Studies, Tata McGraw Hill (2005).*

Reference Books:

1. *Miller, G.T., Environmental Science - Working with the Earth, Thomson (2006).*
2. *Wright, R.T., Environmental Science -Towards a sustainable Future, Prentice Hall of India (2008).*

UEE201 ELECTRICAL MACHINES

L	T	P	Cr
3	1	2	4.5

Course objective: To introduce the fundamentals of transformer, dc machines and ac machines.

Energy Conversion Principle: Magnetic field, Field energy, Mechanical forces and torques in singly-excited and doubly-excited systems, Electric field.

Rotating Machines: Concepts of reluctance and electromagnetic torques, Concept of transformer and speed e.m.f`s. and torque in round-rotor machines.

Transformers: Theory and operation, Phasor diagram, Equivalent circuit, Open circuit and short circuit tests, Regulation, Performance estimation, Auto-transformers, Parallel operation, Three phase transformer connections, Instrument transformers: Current Transformer (CT) and potential transformer (PT); Pulse transformers.

DC Machines: Methods of excitation, Magnetization and operating characteristics of generators, Starters, Speed-torque characteristics of DC motors. Speed control, Losses and efficiency. PM motors.

Induction Machine: Induction motor principle and applications as stepper and brushless motors, Induction motor equivalent circuit, Torque-slip characteristics, Methods of starting, Speed control of 3-phase induction motor.

Polyphase Synchronous Machines: MMF and EMF phasor, Concept of synchronous reactance, Regulation by EMF and MMF methods, Synchronous motor starting and V-curves.

Induction Machines: No load and Blocked rotor tests, Starters. Synchronous Machines: Regulation calculation by EMF method.

Laboratory Work: DC machines: Constructional features, Characteristics of generators and motors, Speed control, Efficiency. Transformers: Open and short circuit tests, Parallel operation, Harmonics in no-load current.

Course Learning Outcome (CLO):
After the completion of the course the students will be able to:

1. Test the transformer and calculate its efficiency and performance in distribution system.
2. Scrutinize three-phase transformer connections and use special purpose transformer for measurement and protection.
3. Select appropriate DC motor for specific purpose and can compute their steady performance.
4. Thoughtfully select the speed control and starting method of DC motor.
5. Test the induction motor and compute its parameters.
6. Test the synchronous motor to compute voltage regulation.

Text Books:

1. *Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).*
2. *Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai and Co. (P) Ltd. (2004).*
3. *Nagrath, I.J and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).*

Reference Books:

1. *Bimbhra, P.S., Generalized Theory of Electrical Machines, Khanna Publishers (2007).*
2. *Toro, Vincert, Electromechanical Devices for Energy Conversion, Prentice Hall of India (2004).*
3. *Fitzgerald, A.E., Kingsley, C. Jr, and Umans, Stephen, Electric Machinery, McGraw Hill (2002).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

DYNAMICS OF MACHINES

L	T	P	Cr
3	1	0	3.5

Course Objectives: To learn different parameters and principles needed to calculate forces and torques in friction devices (belts, pulleys, bearings, brakes, clutches), balancing of rotating and reciprocating masses, and some important devices like gyroscope, gears and gear trains etc. in totality.

Force Analysis: Static and dynamic force analysis of mechanisms.

Flywheel: Turning moment diagrams, Fluctuation of energy, Coefficient of fluctuation of energy and speed, Application in engines and punching presses.

Governors: Function, Types, Force analysis and their Characteristics.

Friction Devices: Fundamentals of friction, Pivots and Collars, Plate and Cone Clutches, Centrifugal Clutches, Friction in mechanism.

Belts Ropes and Chain Drives: Types of belt drives, Velocity ratio, Slip, belt length, Crowning of pulleys, V-belts, Condition for transmission of maximum power, Centrifugal tension, Chain drive, Types of chains, Merits and demerits of chain drive over belt drive.

Brakes and Dynamometers: Short shoe brakes, Pivoted shoe brakes, Long shoe brakes, Band brakes, Different types of Dynamometers.

Gears: Interference, Minimum number of teeth on gear and pinion to avoid interference, Path of contact and arc of contact.

Balancing: Balancing of rotating and reciprocating masses, Balancing of inline and v-engines.

Gyroscope: Gyroscopic effect, Application in ships, Vehicles etc.

Course Learning Outcomes (CLO):
The students will be able to:

1. Integrate kinematics with dynamics to study, analyze and design new machines, and performance enhancement of existing machines.

Text Books:

1. *Rattan, S. S., Theory of Machines, Tata McGraw Hill (2009).*
2. *Bevan, T., Theory of Machines, CBS Publisher (2005).*

Reference Books:

1. *Ghosh, A. and Malik, A.K., Theory of Mechanism and Machines, East West Press (2009).*
2. *Shigley, J. E., Kinematics Analysis of Mechanism, McGraw Hill (1995).*

UEC - DIGITAL ELECTRONICS & MICROPROCESSORS

L	T	P	Cr
3	1	2	4.5

Course Objectives: The basic objective of this course is to introduce the concept of digital electronics, logic gates, number systems, simplification and implementation of Boolean expressions, sequential circuits and logic families. The objective of this course is to impart basic knowledge about INTEL 8085 microprocessor, instruction set, peripheral controllers, main memory design and concept of advanced microprocessors.

Fundamentals of Digital Techniques: Digital signal, Number systems, logic gates: AND. OR, NOT. NAND. NOR- EX-OR, EX-NOR, Boolean algebra and Theorems, Binary codes: BCD, Gray codes, Logic Simplification, Karnaugh map, Design using gates.

Combinational Design Using MSI Devices: Multiplexers, Demultiplexers, Decoders, Encoders, Adders /Subtracters, and their applications.

Sequential Circuits: Latches and flip flops, their types and conversions, Characteristic Table and Equations, Excitation tables, Shift registers, Asynchronous and Synchronous Counters, Design of Synchronous counters.

Logic Families: DTL, TTL, CMOS logic families, their characteristics and comparison, basic gates in TTL and CMOS, Tristate Logic, Interfacing of TTL & CMOS logic families.

INTEL 8085 Microprocessor: Pin Functions, Architecture, Addressing Modes, Instruction Set, Timing Diagrams, Interrupts, Programming Examples.

Basic Input/Output Techniques: Serial I/O, Parallel I/O, Programmed I/O, Interrupt Driven I/O, Direct Memory Access.

Peripheral Controllers: Programmable Peripheral Interface (8255), Programmable Interrupt Controller (8259), Programmable Timer (8253/8254), Programmable Keyboard and Display Interface.

Main Memory System Design: Types of Main Memories, Memory Organization, CPU Read/Write Timing Diagrams, RAM and ROM Interface Requirements, DRAM Interfacing.

Advanced Microprocessors: Main features, Comparison of 8086, 80186, 80286, 80386, 80486 and Pentium processors.

Practical/Laboratory Work:

Experiments will be conducted covering the problems related to Logic Gates, K-Map, Encoder, Decoders, MUX, DEMUX, Flip-flops, Counters, Registers, Introduction to INTEL kit, Programming examples of 8085, Interfacing using 8085, 8086 kits, Interfacing of LED seven segment display, ADC, DAC.

Course Learning Outcomes (CLO):

The students will be able to:

1. Understand the number systems, logic gates and their types.
2. Understand the various combinational circuits such as multiplexer, demultiplexer, decoder, encoder, etc.
3. Understand the concept of logic families.
4. Understand in detail the different types of peripheral controllers.
5. Learn the concept of various kinds of microprocessors, i.e., 8085, 8086, 80186, 80286, 80386, 80486, etc.

Text Books:

1. *Modem Digital Electronics (Edition III): R. P. Jain; TMH (2002).*
2. *Gaonkar, Ramesh., Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing India Pvt Ltd. (2005).*
3. *Morris Mano, Digital Design, PHI (2007).*

Reference Books:

1. *Floyd Thomas, Digital Fundamentals, Pearson Education India (2002).*
2. *Malvino & Leach, Digital Principles and Applications, McGraw Hill (2004).*
3. *Rafiquzzaman, M., Microprocessors and. Microcomputer-Based System Design, CRC Press, (1995).*

UME - COMPUTER AIDED DESIGN AND ANALYSIS

L	T	P	Cr
3	4	0	5.0

Course Objectives: Introduction to Mechanical drawing standards, symbols, conventions and rules. Introduce standards, types, working, uses and design variations of components and assemblies used in machines. Impart knowledge related to principles, methods and techniques of 3D modelling in parametric CAD software for further use in mechatronics engineering. Assemble mechanical systems given only component drawings and interpret its working.Exposure to CAD tools for use in mechanical design conceptualisation, geometric modelling, communication, analysis and optimization. Exposure to mechanical design, evaluation and optimization using CAD, CAE software.

Study of mechanical machine components and assemblies in part A is to be done in lectures along with the use of CAD CAE software for their modeling, assembly, analysis and drawing creation in part B.

Mechanical Drawing: Classification of drawings views, principles of drawing, conventions according to is, sectional views and rules of sectioning, machining and surface finish symbols and tolerances in dimensioning.

Standards, types, applications and working of:
Machine Components: Screw fasteners, riveted joints, keys, cotters and joints, shaft couplings, pipe joints and fittings, welded joints.

Assemblies: Bearings, hangers and brackets, steam and IC engine parts, valves, machine components and assemblies.

CAD: Introduction to CAD, CAM, CAE software in product life cycle.

Geometric Modeling: Parametric sketching and modeling, constrained model dimensioning, relating dimensions. feature and sequence of feature editing. Material addition and removal for extrude, revolve, blend, helical sweep, swept blend, variable section sweep. References and construction features of points, axis, curves, planes, surfaces. Cosmetic features, draft and ribs features, chamfers, rounds, standard holes. Assembly modeling. Automatic drawing creation and detailing.

Productivity Enhancement Tools in CAD Software: Feature patterns, duplication, grouping, suppression. Simplified views. Top-down vs. bottom-up design. Software automation and customization tools. Colors and rendering. File formats for data transfer.

CAE: Part and assembly mass property analysis. Customized analysis features. Sensitivity analysis of dimension and parameters, automatic feasibility study and shape optimization.

Mechanism Motion Analysis: Kinematic joints used in mechanism assembly. Motion of kinematic chains, plot coupler curve. Analysis of Mechanisms for interference, position, velocity, acceleration and bearing reactions.

Use of software like 'ProMechanica', 'SolidWorksSimulation' as a black-box for stress, deflection, temperature, flow etc. Analysis of mechanical parts and assemblies, using shells, beams and 2D for Plane strain/ plane stress or axisymmetric simplifications.

Course Learning Outcomes (CLO):

The students will be able to:

1. use standards used in machine drawing of machine components and assemblies.
2. read production drawings for mechanical components and systems and deduce their functions
3. use parametric CAD software tools for geometric modeling and making drawings of machine components and assemblies.
4. evaluate design and optimize it using CAD, CAE software.
5. use CAD in future courses like project work in summer training, project semester, mechatronic system design etc.

Text Books:

1. *Gill, P.S., Machine Drawing, S.K.Kataria and Sons (2005).*
2. *Kelley David S., Pro/ENGINEER Wildfire 5.0 Instructor, Tata McGraw Hill (2011).*

Reference Books:

1. *Dhawan, R.K., Machine Drawing, S.Chand& Company Limited (2011).*
2. *Shyam Tikku and Prabhakar Singh, Pro/ENGINEER (Creo Parametric 2.0) for Engineers and Designers, Dreamtech press (2013).*
3. *Guide books in software help and online books at ptc.com*

UIE - SENSORS AND TRANSDUCERS

L	T	P	Cr
3	1	2	4.5

Course Objectives: To introduce the concept, classification and calibration of different types of sensors. The objective of this course is to impart basic knowledge about the different sensors and their applications in robotics.

Principles of Sensors: Sensor classification, characteristics and calibration of mechanical, electrical, optical, thermal, magnetic, chemical and biological sensors, sensor reliability.

Displacement Sensors: principles of variable resistance, variable inductance, variable reluctance, synchros and resolver, variable capacitance, hall effect device, digital displacement sensors.

Force, Torque, Tactile and Pressure Sensors and Transducers: Different types of load cells, digital force transducer, pressure transducer, transmission type, driving type and absorption type dynamometer, tactile sensors using contact closure, magnetic, piezoelectric, photoelectric, capacitive and ultrasonic methods, manometer, elastic elements, electrical and piezoelectric pressure transducers, Pirani gage.

Flow Sensors: Head type flow meter, electromagnetic flow meter, rotameter, anemometer, ultrasonic flow meter.

Temperature Sensors: Resistance and mechanical type temperature sensors, thermocouples, thermistor, optical pyrometer.

Sensors in Robotics: Potentiometers, synchros and resolvers, optical encoders, tactile and proximity sensors, non-contact ranging sensors, ultrasonic transducers, opto-electric sensors, gyroscopes.

Laboratory Work:
Speed measurement using inductive pickup/proximity sensor, measurement to temperature using thermocouple, thermistor and RTD, measurement of displacement using LVDT & Capacitive transducer, position and velocity measurement using encoders, flow measurement using rotameter.

Course Learning Outcomes (CLO):
The students will be able to:

1. study the classification, characteristics and calibration of mechanical, electrical, optical, thermal, magnetic, chemical and biological sensors.
2. get exposure to displacement, force, torque, tactile, pressure, flow and temperature sensors.
3. learn the applications of different sensors in robotics.

Text Books:

1. *Doeblin, E.O., Measurement systems, Applications and Design, McGraw Hill (2011).*
2. *Nakra, B. C. and Chaudhry, K. K., Instrumentation Measurement and Analysis, Tata McGraw Hill (2008).*

Reference Books:

1. *Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India Private Limited (2003).*
2. *Sawhney, A.K., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Co. (P) Ltd. (2007).*

MACHINE DESIGN

L	T	P	Cr
3	1	0	3.5

Course Objectives: To present the basic knowledge of design procedure for simple components like keys, cotters, shafts, pipe joints, pulleys, seals and gaskets under static and fatigue loading.

Design Processes: Introduction, standards and preferred numbers, stress-concentration, endurance limit, fatigue and reliability considerations, factor of safety and its selection, selection of materials, review of theories of failure, tolerance, type of fits, selection of fits, limits.

Design of Shaft: Shafts subject to combined loading; subjected to fatigue loading.

Analysis and Design of Fasteners and Joints: Key and keyed joints, cotter and knuckle joints, riveted joints, boiler joints, structural joints, welded joints, bolts and bolted joints with and without initial tightening loads; Bolted, riveted and welded joint under eccentric loading.

Couplings: Rigid and Flexible types.

Design of other Mechanical Components: Power screws, pipe joints: circular, oval and square flanged pipe joints, seals and gaskets, pulleys and flywheels.

Assignments related to design and drawings of the above components.
Machine Design data issued by Mechanical Engineering Department is only to be used.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the principles, process and requirements for design of machine elements.
2. select the suitable materials.
3. design simple components like fasteners, shafts, couplings etc.

Text Books:

1. *Bhandari, V. B., Design of Machine Elements, Tata McGraw Hill, New Delhi (2007).*
2. *Shigley, J., Mechanical Engineering Design, McGraw Hill Book Company Inc., New York (2003).*

Reference Books:

1. *Spotts, M. F. and Shoup, T. E., Design of Machine Elements, Pearson Education, New Delhi (2003).*
2. *Juvinall, R. C. and Marshek, K. M., Fundamental of Machine Component Design, John Wiley & Sons, New York (2005).*
3. *Norton, R.L., Machine Design: An Integrated Approach, Pearson Education, New Delhi (2006).*
4. *Sharma, C. S. and Purohil, K., Design of Machine Elements, Prentice Hall, New Delhi (2003).*

UEC 722 DIGITAL SIGNAL PROCESSORS

L	T	P	Cr
3	1	2	4.5

Course Objective: This course will prepare the students to work professionally in the area of digital signal processing. The students will be able to present a comprehensive introduction to important DSP processors with focus on architectures, addressing modes and instruction set. The focus of course is a series of Lab experiments, which provide practical knowledge in filters and DSP processors.

An Introduction to DSP Processors: Advantages of DSP, characteristics of DSP systems, classes of DSP applications, DSP processor embodiment and alternatives, Fixed and floating point number representation, IEEE 754 format representation Fixed Vs Floating point processors,.

DSP Architecture: An introduction to Harvard Architecture, Differentiation between Von-Neumann and Harvard Architecture, Quantization and finite word length effects, Bus Structure, Central Processing Unit, ALU, Accumulators, Barrel Shifters, MAC unit, compare, select, and store unit (CSSU), data addressing and program memory addressing.

Memory Architecture: Memory structures, features for reducing memory access required, wait states, external memory interfaces, memory mapping, data memory, program memory and I/O memory, memory mapped registers.

Addressing and Instruction Set: Various addressing modes - implied addressing, immediate data addressing, memory direct addressing, register direct and indirect addressing, and short addressing modes, Instruction types, various types registers, orthogonality, assembly language and application development.

Interrupts and Pipelining: Interrupts, pipelining and performance, pipelining depth, interlocking, interrupt effects, instruction pipelining.

Processors: Architecture and instruction set of TMS320C3X, TMS320C5X, TMS320C67XX, some example programs. Development tools for Programmable DSPs, An introduction to Code Composer Studio.

Laboratory Work:

Introduction to code composer studio, Using CCS write a program to compute factorial, dot product of two arrays, Generate Sine, Square and Ramp wave of varying frequency and amplitude, Design various FIR and IIR filters, Interfacing of LED, LCD, Audio and Video Devices with the DSP processor.

Course Learning Outcomes (CLO):

The students will be able to:

1. acquire knowledge about DSP processors
2. understand fundamentals of DSP processor architecture
3. understand fundamentals of memory interface and pipeline structures
4. design programs using Addressing and Instruction Set of DSP processors
5. understand the various industry standards DSP processors

Text Books:

1. *Lapsley, P., Bier, J., Shoham, A. and Lee, E.A., DSP Processor Fundamentals: Architecture and Features, IEEE Press Series on Signal Processing, IEEE (2000).*
2. *Venkataramani, B. and Bhaskar, M., Digital Signal Processor: Architecture, Programming and Applications, Tata McGraw Hill (2003).*

Reference Books:

1. *Padmanabhan, K., Ananthi, S. and Vijayarajeswaran, R., A practical Approach to Digital Signal Processing, New Age International Pvt. Ltd (2001).*
2. *Babast, J., Digital Signal Processing Applications using the ADSP-2100 family, PHI (1992).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC BASICS OF COMMUNICATION ENGINEERING

L	T	P	Cr
3	1	2	4.5

Course Objectives: The basic objective of this course is to introduce the concept of electronic communication systems with amplitude modulation (AM), frequency modulation (FM) and pulse modulation (PM). The objective of this course is to impart basic knowledge about digital Modulation Techniques such as BPSK, BFSK, ASK, QPSK, QAM.

Introduction to Electronic Communication: Evolution of communication system, elements of communication systems, types of electronic communications, baseband signals and baseband transmission, modulation techniques, bandwidth requirements.

Amplitude Modulation: Introduction, Equation of AM signal, modulation index and percentage of modulation for sinusoidal AM, frequency spectrum of the AM wave, representation of AM wave, average power for sinusoidal AM wave, effective voltage and current for sinusoidal AM, modulation.

Single Sideband Modulation: Introduction, suppression of carrier, suppression of unwanted sideband, extensions.

AM Receivers: Functions of receivers, types of receivers, characteristics of radio receiver, AM receivers.

Frequency Modulation: Frequency modulation theory, characteristic of frequency modulation, Mathematical representation of frequency modulated wave, frequency modulators, pre□emphasis, de□emphasis, directly modulated FM transmitter, phase modulation, indirect method of FM modulation, wide and narrow band FM transmission, advantages and disadvantages of FM.

FM Receiver: FM receiver, basic FM demodulators, noise triangle in FM, capture effect, FM stereo system.

Pulse Modulation: Introduction, Classification of pulse modulation, continuous vs discrete time signals, sampling process, pulse amplitude modulation, pulse time modulation, pulse position modulation, quantization, pulse code modulation, TDM, delta modulation, adaptive delta modulation,

Digital Modulation Techniques: Introduction to BPSK, BFSK, ASK, QPSK, QAM. transmitter & receiver block diagram, constellation diagram, MPSK, MSK (minimum shift keying), basics of remote sensing.

Laboratory Work:
Study of amplitude modulation and demodulation, study of ring modulator, frequency modulation and demodulation, frequency conversion**,** assembly of AM superhetrodyne receivers, study of AM communication system, assembly of FM communication system, assembly of FM superhetrodyne receivers with automatic frequency control, Study of AM transmitter, familiarization of PLL.

Course Learning Outcomes (CLO):

The students will be able to:

1. Study and understand the concepts of electronic communication system.
2. Understand the concepts related to the various modulation techniques.
3. Understand the concepts of AM & FM receivers to be used in mechatronics circuit design.
4. Learn the basic fundamentals of digital modulation techniques.

Text Books:

1. *Blake, R., Electronic Communication Systems, Thomson Business Information (2008).*
2. *Lathi, B.P., Modern Analog and Digital Communication, Oxford University Press (2007).*

Reference Books:

1. *Kennedy, G., Electronic Communication Systems, McGraw Hill (2002).*
2. *Schweber, W., Electronic Communication Systems, Prentice Hall of India Private Limited (2002).*

UEI501 CONTROL SYSTEMS

L	T	P	Cr
3	1	2	4.5

Basic Concepts: Historical review, Definitions, Classification, Relative merits and demerits of open and closed loop systems

Mathematical Models of Physical Systems: Linear and non-linear systems, Transfer function, Mathematical modeling of electrical, Mechanical, Thermal, Hydraulic and pneumatic systems, Analogies, Block diagrams and signal flow graphs.

Components: AC and DC servomotors and tachogenerators, Potentiometers, Synchros, Stepper motors.

Analysis: Time and frequency domain analysis, Transient and frequency response of first and second order systems, Correlationship between time and frequency domain specifications, Steady-state errors and error constants, Concepts and applications of P, PD, PI and PID types of control.

Stability: Definition, Routh-Hurwitz criterion, Root locus techniques, Nyquist criterion, Bode plots, Relative stability, Gain margin and phase margins, M and N circles, Nichol's charts

MATLAB: Introduction, Applications in solution of control system problems.

Compensation: Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance.

Components: D.C. and A.C. Servomotors, D.C. and A.C. Tachogenerators, Potentiometers and optical encoders, Synchros and stepper motors, Introduction to PLCs, their hardware and ladder diagram programme.

State Space Analysis: Concepts of state, State variables and state models, State space equations, Transfer function, Transfer model, State space representation of dynamic systems, State transition matrix, Decomposition of transfer function , Controllability and observability.

Laboratory Work:
Linear system simulator, Compensation design, D.C. position control and speed control, Synchro characteristics, Servo demonstration, Stepper motor, Potentiometer error detector, Rate control system, Series control system, Temperature control system.

Text Books:

1. *Gopal, M., Digital Control System, Wiley Eastern (1986).*
2. *Nagrath, I.J. and Gopal, M., Control System Engineering, New Age International (P) Limited, Publishers (2003).*
3. *Ogata, K., Modern Control Engineering, Prentice–Hall of India Private Limited (2001).*

Reference Books:

1. *Kuo, B.C., Automatic Control System, Prentice–Hall of India Private Limited (2002).*
2. *Sinha, N.K., Control System, New Age International (P) Limited, Publishers (2002).*

UEI SIGNAL CONDITIONING AND DATA ACQUISITION SYSTEM

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to impart basic knowledge about analog and digital signal conditioning and data acquisition techniques.

Analog Signal Conditioning: Principles of analog signal conditioning, signal-level changing, linearization, conversions, zero adjustment, span adjustment, filtering and impedance matching, passive circuits, divider circuit, bridge circuits, RC filters, operational amplifier characteristics, OpAmp circuits in instrumentation, voltage follower, differential amplifier, instrumentation amplifier, active filters, voltage-to-current converter, current-to-voltage converter.

Digital Signal Conditioning: Busses and tri-state buffers, converters, comparators, digital-to-analog converters (DAC), analog-to-digital converters (ADCs), sample and hold, multiplexer and de-multiplexer, decoder and encoder, pulse modulations.

Data Acquisition System: Introduction to analog and digital data acquisition systems, block diagram, components, CPU, memory, input / output, sensors, ADC, DAC, sample and hold, multiplexing, de-multiplexing, modulation, display, recording, alarm, programming, voltage, current, frequency, temperature, displacement, pressure measurement using data acquisition system (DAS), application of data acquisition system in power plant, process control plant and automation, data logger.

Practical/Laboratory Work:
Familiarity with CRO and electronic components, different types of OpAmp circuits, application of instrumentation amplifier, design of filters, A/D and D/A converters, data acquisition using Lab View.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the concepts of analog signal conditioning and learn the various techniques namely signal-level changing, linearization, zero and span adjustment, filtering, impedance matching etc.
2. get an exposure to digital signal conditioning through the knowledge of A/D and D/A converters, comparators, sample and hold circuits, multiplexer and de-multiplexer, decoder and encoder and pulse modulation techniques.
3. know about the data acquisition system through display systems, recorders, alarms and also measurement of voltage, current, frequency, temperature, displacement and pressure and its applications in process control industries.

Text Books:

1. *Curtis D. Johnson, Process Control Instrumentation Technology, Prentice Hall, (2006).*
2. *Bruce W.G. Newby, Electronic Signal Conditioning, Butterworth-Heinemann Limited, (1984).*

Reference Books:

1. *R.A. Gayakwad, Opamps & Linear Integrated Circuits, Prentice Hall of India, (2000).*
2. *Kalsi, H.S., Electronic Instrumentation, Tata McGraw-Hill (2002).*
3. *Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice-Hall of India Private Limited (2007).*
4. *John Park and Steve Mackay, Practical Data Acquisition for Instrumentation and Control Systems, Newnes, (2003).*

UMEXXX DESIGN PROJECT

L	T	P	Cr
0	0	2	5.0

Course Objectives: To develop design skills according to a Conceive-Design-Implement-Operate (CDIO) compliant methodology. To implement engineering skill and knowledge to complete the identified project work while encouraging creativity and innovation. To develop spirit of team work, communication skills through group-based activity and foster self-directing learning and critical evaluation.

For this course groups of the students shall be formulated in the fourth semester. Students shall be encouraged for self-learning. During summer break after second year students are expected to identify the problem of their choice through interactions with industry, R&D labs and other reputed institutions. Students shall make presentation of their effort of problem formulation in first fortnight of the fifth semester and shall complete project. Students shall be making periodic presentation during fifth semester for continuous evaluation and monitoring.
At the end of this project each group shall be required to submit a detailed technical report, presentations related to the project undertaken.

Course Learning Outcomes (CLO):
The students will be able to:

1. design and analyze the given mechanical engineering system/ component.
2. work individually or in a design team.
3. create production drawings for mechanical components and systems using manual drafting and CAD tools.

PRODUCT DESIGN AND DEVELOPMENT

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the basis of product design along with the requirements of a good product design.

General: Product design objectives, concept, terminology, principles, requirements of a good product design, product types and design considerations for engineering, product life cycle, product specification and range, safety, liability and warranty aspects, patents and copyrights.

Product Development – Technical and Business Concerns: Technology forecasting and technology S-Curve (Technology Stage), mission statement and technical questioning, economic analysis of product, customer needs and satisfaction, customer population and market segmentation, customer needs-types and models, gathering customer needs information, analysis of gathered information.

Designing for Specific Requirements: Design features and requirements with regard to manufacturing and assembly, safety, ergonomics, energy conservation, storage, transportation and maintence, quality and reliability as a factor in product design, quality v/s cost, packaging design, role of national and international standards.

Visual Design: Objectives, form, function, material and process, relationship, product graphics, role of color.

Product Detailing: Need and objectives, considerations affecting detailing decisions, illustration of detailing.

Product Development: Concepts and objectives, information sources, role of innovation in product development and competitiveness, part approval process, advanced product quality planning, design failure mode and effect analysis, use of computers in product design and development, introduction to reverse engineering and rapid prototype development, the CAD-CAM link.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the basic product design objectives and requirements.
2. understand the different design principles like designing for manufacturing and assembly, maintenance, storage, transportation etc.
3. understand the visual design with respect to form, function, material, process, colour etc.

Text Books:

1. *Neibel and Draper, Product Design and Process, McGraw Hill, New York (2004).*
2. *Mayal, Industrial Design, McGraw Hill, New York (1999).*
3. *Trott, Innovation Management and New Product Development, Pearson Education Asia, New Delhi (2007).*

Reference Books:

1. *Asimov, M., Fundamentals of Engineering Design, PHI, New Delhi (2000).*
2. *Chitale and Gupta, Product Design and Manufacturing, PHI, New Delhi (2007).*

PRODUCTION AND INVENTORY CONTROL

L	T	P	Cr
3	1	0	3.5

Course Objectives: To expose the students to the various broad functions under production planning and control. To study the role of process planning especially routing, scheduling functions etc. in effective operations management.

Production Control: Necessity of planning and control, functions of production control department; various functions under production control, factors determining control procedure, types of control.

Short term and long term trends in business, financial aspects of planning, analysis of machine capacity, capacity and manpower requirement planning.

Process Planning: Routing, routing procedures, progress reporting and expediting methods; Shop floor control.

Scheduling: Loading, departmental and shop schedule charts, Gantt charts, multiple-dimension rule, employee scheduling, and various priority rules.

Inventory Management and Control: Importance of inventory control, methods of inventory control, ordering quantity to order, economic run lengths.

Applications of Computers in production control and inventory control activities.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the necessity and functions under production control.
2. understand the role of inventory management and control.

Text Books:

1 *Monks, J. G., Operations Management: Theory and Problems, McGraw Hill, New York (1987).*

2 *Krajewski, L. J., Ritzman, L. P. and Malhotra, M. K., Operations Management, Prentice Hall of India, New Delhi (2009).*

Reference Books:

1 *Ebert, J and Adams, D.J., Production/Operations Management, Prentice Hall of India, New Delhi (2007).*

2 *Chase, R. B., Aquilano, N. J. and Jacob, F. R., Production and Operations Management: manufacturing and services, Tata McGraw Hill, New Delhi (1999).*

COMPUTER AIDED MANUFACTURING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To expose the students to the basics of NC, CNC, DNC machines. To make them understand the concept of writing the manual part program on CNC milling and lathe machines. To introduce the students to the different components of Computer Integrated Manufacturing systems.

Fundamentals of CAM: Programmable automation, automation and CAM. Numerical control of machine tools. Adaptive control of machine tools, Industrial robots, programming methods, applications. CNC design features to improve accuracy and productivity. Manual part programming.

Computer Aided Part Programming: Introduction and demonstration of use of Pro/E CAM Software or equivalent in: Computer Aided Part Programming, machining simulation, process planning, route sheet development and Post processing.

Computer Integrated Manufacturing Systems & Integrated CAD/CAM System: Components of CIMS, types of CIMS, CAD/CAM integration, FMS and CIMS, Group Technology.

Automated Material Handling & Storage: AGVs, ASRS, Carousel.

Computer Aided Manufacturing Planning Systems: CAPP, computer aided production management, inventory management, MRP-I and MRP-II, shop floor control, computer aided process monitoring and control, computer aided quality control and inspection.

Laboratory Work:

Exercises on manual part programming of CNC machines: Lathe- Complete machining of a part with: Taper, concave and convex arc, grooving, central drilling and threading. Milling- Complete machining of a part with: Taper, concave and convex arc, pocketing and drilling, radius compensation. Robot programming: Programs for pick place, welding path, manufacturing, and assembly operations. Practical setup and programming exercise using CNC milling, CNC lathe and robotic arm. Practical on the machines to be conducted as per lab instructions and guidance of the teacher incharge of practical.

Course Learning Outcomes (CLO):
The students will be able to:

1. write a manual part program for a given component on CNC milling and lathe machine.
2. understand the basics of CNC machines and robotic arm.
3. understand the use of computers in group technology, process planning, manufacturing, inventory, shop floor control, quality control, material handling and storage system.

Text Books:

1 Groover, M. P., Automation, Production Systems, and Computer Integrated Manufacturing, Pearson Education Asia, New Delhi (2008).

2 Koren, Y., Computer Control of Manufacturing Systems, McGraw Hill, New York (2005).

Reference Books:

1 *Groover, M. P. and Zimmers, E. W., CAD/CAM, Pearson Education Asia, New Delhi (2005).*

2 *Koren, Y. and Joseph, B. U., Numerical Control of Machine Tools, Khanna Publishers , New Delhi (1999).*

3 *Kundra, T. K., Rao, P. N. and Tewari, N. K., Numerical Control and Computer Aided Manufacture, Tata McGraw Hill, New Delhi (2003).*

AUTOMOBILE ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To deliver basic knowledge of different components of automobiles.

Introduction: Conventional motor vehicle, vehicle classification, frame and frameless construction, vehicle dimensions, power requirements, vehicle performance, gear ratio for maximum acceleration, stability of two wheel drive and four wheel drive vehicles.
Clutch and Transmission: Single-Plate clutch, multi-plate clutch, dry clutch, wet clutch, centrifugal, semi-centrifugal clutch, servo clutch mechanism, requirements for manual and automatic transmission, their type and constructional detail.
Steering and Suspension: Steering mechanisms and steering system including power steering, steering geometry, suspension principle, rigid axle suspension and independent suspension, suspension system elements, hydraulic suspension, pneumatic suspension, leaf spring, Mc-pherson strut.
Drive Line: Propeller shaft, universal joint, constant velocity joint, slip joint, differential, axle and hub.
Braking System: Introduction to braking system and their types, ABS, brake compensation.
Wheel and Tyres: Disc pressed wheels, alloy wheels, multi-piece wheels, tyre description, types and manufacturing, tubed and tubeless tyres, radial tyres , tyre specifications and coding, tread pattern, aqua-planing.
Emission control devices: Catalytic convertor and its types, EGR.
Vehicle Electronics: Electrical and electronic systems in automobiles, starting motor drives,
automotive accessories and safety features in automobile.
Trouble shooting in various components.
Trends in automobile sector: Hybrid, solar powered vehicles.

Laboratory Work:
Study of vehicle chassis and construction, study of single plate and multi-plate clutch in an automobile, construction and working of following gear boxes: Contact mesh gear box; synchronous gear box, parts of automatic transmission system, components of suspension system of automobile (2 wheel, 4 wheel), steering system of an automobile, electric system, starting system, braking system of an automobile, study of radiator, study of turbocharger and supercharger, study of differential, axles, study of propeller shaft, universal joints and slip joint, study of catalytic convertor; Visit to automobile service station for troubleshooting exercises; Group assignments on above topics.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the performance parameters and power requirements of a vehicle.
2. understand the concept of manual and automatic working of different components of automobiles.
3. understand the fundamental knowledge of mechanisms used to transfer energy from engine to the wheels.

Text Books:

1 *Hiller, V. A. W., Fundamentals of Motor Vehicle Technology, Nelson Thornes, UK (2012).*
2 *Giri, N. K., Automobile Mechanics, Khanna Publishers, New Delhi (2011).*

Reference Books:

1 *Garrett, T. K., Newton, K. and Steeds, W., The Motor Vehicle, Butterworth-Heinemann, Great Britain, London (2001).*
2 *Norton, A. A., Book of the Car, Automobile Association, London (1977).*
3 *Heinz, H., Advance Vehicle Technology, Arnold Publishers, Butterworth-Heinemann, London (1999).*
4 *Crouse, W. and Anglin, D., Automotive Mechanics, Tata McGraw Hill, New Delhi (2006).*
5 *Heinz, H, Engine and Vehicle Technology, Arnold Publishers, Butterworth-Heinemann, London (2002).*

UEE504: POWER ELECTRONICS

L	T	P	Cr.
3	1	2	4.5

Course Objective: To understand the concept of power electronic devices, phase controlled converters, dc choppers, inverters, ac voltage controllers and cycloconverter.

Introduction: Introduction to Thyristors and its family, static and dynamic characteristics, turn-on and turn - off methods and firing circuits, Ratings and protection of SCR'S, series and parallel operation.

Phase Controlled Converters: Principle of phase control, Single phase and three phase converter circuits with different types of loads, continuous and discontinuous conduction, effect of source inductance, Dual converters and their operation

DC Choppers: Principle of chopper operation, control strategies, types of choppers, step up and step down choppers, steady state time domain analysis with R, L, and E type loads, voltage, current and load commutated choppers.

Inverters: Single phase voltage source bridge inverters and their steady state analysis, modified Mc murray half bridge inverter, series inverters, three phase bridge inverters with 180^0 and 120^0 modes. single-phase PWM inverters, current source inverters, CSI with R load (qualitative approach).

AC Voltage Controllers: Types of single-phase voltage controllers, single-phase voltage controller with R and RL type of loads.

Cycloconverters: Principles of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase cycloconverters, output voltage equation for a cycloconverter.

Course learning outcome (CLO):
After the completion of the course the students will be able to:

1. Identify the power – electronic devices and inference their usage as switch for energy conversion and control
2. Select and design appropriate converter configuration / topology for typical power application such as DC drive, AC drive, HVDC and FACTS.
3. Design the firing and commutation circuit for different converter configurations.
4. Use power converters for harmonic mitigation, voltage and frequency control

Text Books:

1. *Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.M.K., Thyristorised Power Controllers, New Age International (P) Limited, Publishers (2004).*
2. *Rashid, M., Power Electronics, Prentice–Hall of India (2006).*
3. *Bimbhra,P.S., Power Electronics, Khanna Publishers(2012).*

Reference Books:

1. *Mohan, N., Underland, T. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley (2007).*
2. *Bose, B.K., Handbook of Power Electronics, IEEE Publications*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

INDUSTRIAL AUTOMATION

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the need, evolution, and motivation for Industrial Automation. Familiarization with basic concepts and different automation strategies being used in practice worldwide.

Introduction to Factory Automation and Integration: Basic concepts and scope of industrial automation, socio-economic considerations, modern developments in automation in manufacturing and its effect on global competitiveness. Need and implications of automation in manufacturing. Different types of production systems and automation. Hard/fixed automation.

Introduction to Hydraulics/Pneumatics: Basic elements of hydraulics/pneumatics, electro-pneumatic controls and devices, electro-pneumatic systems, fluid power control elements and standard graphical symbols for them, construction and performance of fluid power generators, hydraulic and pneumatic actuators, their design and control devices. Sequence operation of hydraulic /pneumatic actuators. Applications in manufacturing. Hydraulic & pneumatic valves for pressure, flow & direction control, servo valves and simple servo systems with mechanical feedback, solenoid. Different sensors for hydraulic, pneumatic & electro-pneumatic systems.

Design of Pneumatic and Electro-pneumatic Logic Circuits: Logic circuits to be designed for a given time displacement diagram or sequence of operation. Pneumatic safety and control circuits and their applications to clamping, traversing and releasing operations.

Programmable Logic Controllers (PLC): PLC for design demonstration, programming and interface the hardware with software for modern manufacturing applications.

Automatic Transfer Machines: Classifications, analysis of automated transfer lines, without and with buffer storage, group technology and flexible manufacturing system.

Assembly Automation: Types of assembly systems, assembly line balancing, performance and economics of assembly system.

Course Learning Outcomes (CLO):

The students will be able to:

1. measure the output of any physical system with the help of various sensors and transducers and able to evaluate the performance of any physical system.
2. understand the various components of Hydraulics/Pneumatics Electro-pneumatic systems and methods to design, construct and evaluate such systems.
3. study the design of pneumatic logic circuits for a given time displacement diagram for pneumatic safety and remote control circuits

Text Books:

1 Esposito, A., Fluid Power with Applications, Prentice Hal of India, New Delhi (2005).

2 Majumdar, S. R., Pneumatic Systems, Tata McGraw Hill, New Delhi (1995).

Reference Books:

1 *Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing, Prentice Hall Inc., New Jersey (1996).*

2 *Deppert, W. and Stoll, K., Pneumatic Control, Vogel Verlag, Wurzburg, Germany (1987).*

3 *Herbert, E.M., Hydraulic Control System, John Wiley & Sons, New York (1991).*

4 *Hall, D.V., Microprocessors & Interfacing: Programming & Hardware, McGraw Hill, New York (2006).*

5 *Mukhopadhaya, A. K., Microprocessors, Microcomputers and their Applications, Wheeler Pub, New Delhi (2003).*

6 *Fitch, E.C and Surjaatmadja, J.B., Introduction to Fluid Logic, McGraw Hill, New York (1978).*

UME ROBOTICS ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the students to the basic terminologies, applications, design specifications, and mechanical design aspects both kinematics and dynamics of industrial robotics/ manipulators, sensors, actuators and image processing for robotic work cell control.

Introduction: Definition of a robot, types of robotic joints and motions, classifications of robot based on: Physical configurations, actuators and motion control; Terminologies used for robotics specification and selection for industrial applications; Types of end effectors; Applications of robotics.

Robot Kinematics: Homogeneous co-ordinates and co-ordinate transformations, kinematic parameters, use of Denavit-Hartenberg representation for finding arm equation of robotic arms, forward and inverse kinematics for basic industrial robotic configurations viz. Cartesian coordinate robot, SCARA configurations, and 5-axis and 6-axis articulated industrial robotic configurations.

Robot Dynamics: Introduction to Robot Dynamics.

Robot in Work Place: Work cell organization in robotics environment, function of work cell controller, robotic work cell design and control, introduction to robot trajectory planning.

Introduction to Robot Vision: Sensing and digitization of vision data, image processing: image data reduction, segmentation, feature extraction, object recognition, and training of vision system.

Methods of Robot Programming: Robot programing methods, introduction to basic robot programming languages, and various on-line and off-line robot programming methods.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the robot kinematics and trajectory planning.
2. work individually and/or with an interdisciplinary team for the purpose of manipulator design for a specific need using mechanical kinematic structure along with the understanding of requirements from robotic work cell controller and its programming, for enabling robotic manipulator to work in an integrated automated industrial environment.

Text Books:

1 Groover, M. P., Weiss, M., Nagel, R. N. and Odrey, N. G., Industrial Robotics: Technology, Programming and Applications, McGraw Hill, New York (1986).

2 Lee, C.S.G., Fu, K.S and Gonzalez, Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill, New York (1990).

Reference Books:

1 Asada, H. and Slotine, J. E., Robot Analysis and Control, John Wiley & Sons, New York (1986).

2 *Craig, J. J., Introduction to Robotics Mechanics and Control, Addison - Wesley Publishing Company, New York (1986).*
3 *Schilling, R.J., Fundamentals of Robotics Analysis & Control, Prentice Hall of India, New Delhi (1990).*

UEE701: ELECTRIC DRIVES

L	T	P	Cr.
3	1	2	4.5

Course Objective: To introduce the concept of electric drives and control strategies.

Definitions and Dynamics of Electric Drives: Concept of electric drive and its classifications, Types of loads, Four-quadrant drive, Dependence of load torque on various factors, Dynamics of motor-load combination, Steady state stability of an electric drive system, Load Equalization.

Drive Features of Importance: Multi-quadrant operations of DC and AC motors, Energy relations during starting and braking.

Static Control of Motors: Contactors and relays for electric drives, Control circuits for automatic starters of DC and AC motors.

Estimation of Motors Rating: Thermal modeling of motors, Types of duty cycles, Calculation of motor rating for duty cycles, Overload factor calculation for short and intermittent duty cycle, Use of load diagrams.

Solid State Controlled Drives: Control of DC drives fed through single-phase and three-phase semi converter and full-converter phase-controlled configurations. Their analysis, Regeneration and braking through static power converters.
Control of three phase induction motors by stator voltage and frequency control for speeds below and above synchronous speed. Static rotor resistance control, Static kramer and scherbius drives, V/f and Vector control
Energy efficient drives, Losses in electrical drive system, Energy conservation in electric drives.

Laboratory Work:
Starting and running characteristics of converter fed AC and DC motor control, Harmonic analysis of AC and DC Drives, V/f based drive, Microprocessor based Drive, PLC based drive. Project on drives using standard software.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:

1. Conceptualize the basic drive system and analyse it for different types of loads
2. Analyse the motor situation during starting and braking
3. Develop control circuitry and devices for control of motor
4. Estimate the motor rating for different condition of load
5. Design the converter circuit for control purpose along with its different configuration
6. Use PLC and converter control to drive on the basis of energy efficiency

Text Books:

1. *Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall Inc. (1989).*
2. *Pillai, S.K., A Course in Electric Drives, New Age International (P) Limited, Publishers (1989).*

Reference Books:

1. *Bose, B.K., Modern Power Electronics and AC Drives, Prentice-Hall of India Private Limited (2006).*
2. *Dubey, G.K., Fundamentals of Electric Drives, Narosa Publications (2001).*
3. *Sen, P.C., Thyristor DC Drives, John Wiley and Sons (1981).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC MICROCONTROLLERS & EMBEDDED SYSTEMS

L	T	P	Cr
3	1	2	4.5

Course Objectives: The basic objective of this course is to introduce the concept of microprocessors, microcontrollers, architecture and hardware of 8051 microcontroller, to study the programming language concepts and the techniques of interfacing external hardware to the 8051. The objective of this course is to impart basic knowledge about real time applications of microcontrollers, real time applications of the embedded systems and RTOS.

Microcontroller: Introduction to microcontrollers, evolution, microprocessors vs. microcontrollers, MCS-51 family overview, important features, architecture. 8051 pin functions, architecture, addressing modes, instruction set, instruction types.

Programming: Assembly programming, timer registers, timer modes, overflow flags, clocking sources, timer counter interrupts, baud rate generation, serial port register, modes of operation, initialization, accessing, multiprocessor communications, serial port baud rate.

Interrupts: Interrupt organization, processing interrupts, serial port interrupts, external interrupts, interrupt service routines, microcontroller specification, microcontroller design, testing, timing subroutines, look-up tables, serial data transmission.

Introduction to Embedded Systems: Background and history of embedded systems, definition and classification, programming languages for embedded systems: desirable characteristics of programming languages for embedded systems, low-level versus high-level languages, main language implementation issues: control, typing, major programming languages for embedded systems, Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits, concept of Real Time Operating Systems (RTOS).

Laboratory Work:
Familiarization with microcontroller kit, system specifications, facilities, hardware description and keyboard description, programs based on various addressing modes, data transfer techniques using Kiel software, testing all arithmetic and logical instructions and their effect on various flags (using Kiel software), programs on branch and loop, string instructions using Kiel software, programs of sorting, sum of natural numbers, multiplication, division, factorial etc. using Kiel software, programs to introduce delays, to generate square & rectangular waves at different frequencies using Kiel, interfacing experiments programs to introduce delays, to generate square & rectangular waves at different frequencies using MCS-51 microcontroller kit, interfacing experiments like LED, seven segment, LCD, stepper motor, DC motor etc. using MCS-51-microcontroller kit

Course Learning Outcomes (CLO):
The students will be able to:

1. Understand different types of architectures, their distinguishing features.
2. Understand the architecture and working of 8051, functions of constituting components and their applications.
3. Understand in detail the different types of instructions, the results produced by their execution and timing analysis.
4. Learn the interfacing of hardware components and their applications.
5. Study application oriented projects and difference between 8 bit and 16 bit embedded systems.

Text Books:

1. *Mckenzie, Scott, The 8051 Microcontroller, PHIs, (1995).*
2. *Simon, David E., An Embedded System Primer, Pearson Education, (2005).*

Reference Books:

1. *Ayala, Kenneth J., The 8051 Microcontroller: Architecture, Programming, and Application,*
2. *(2008).*
3. *Raj Kamal, Architecture, Programming, Interfacing and System Design, Pearson Education India, (2009).*
4. *Mazidi, Muhammad Ali, The 8051 Microcontroller and Embedded Systems Using Assembly and C (English), Pearson India.*

UEI841 ADVANCED CONTROL SYSTEMS

L	T	P	Cr
3	1	0	3.5

Nonlinear Control Systems: Introduction to Nonlinear systems, Liapounov's method for stability study, Phase plane method, Describing functions.

Optimal Control Theory: Introduction, Optimization by steepest decent method, Optimization with constraint gradient method, Minimization of functions by neumerical methods: Fletcher–Powell method, Newton–Raphson method; Optimal control problem: Characteristics of the plant, Requirements of the plant, Plant data supplied to the Controller; Mathematical procedures for optimal control design: Calculas of variations, Pontryagin's optimum policy, Bang–Bang Control, Hamilton–Jacobi Principle, Dynamic Programming; State regulator problem, Parameter optimization.

z–Plane Analysis of Discrete–Time Control Systems: Introduction, Impulse sampling and data hold, Obtaining the z–transform by the convolution integral method, Reconstructing original signal from sampled signals, The pulse transfer function, Realization of digital controllers and digital filters.

Design of Discrete–time Control Systems by Convolution Methods: Introduction, Stability analysis of closed–loop systems in the z–plane, Transient and steady state response analysis, Design based on the root–locus method, Design based on the frequency–response method, Analytical design method.

State–Space Analysis: Introduction, State–space representations of discrete–time systems, Solving discrete–time state–space equations, Pulse transfer function matrix, Discretization of continuous time state space equations, Liapunov stability analysis, Controllability, Useful transformations in state–space analysis and design, Design via pole placement, State observer, Servo systems.

Quadratic Optimal Control Systems: Introduction, Quadratic optimal control, Steady–state quadratic optimal control, Quadratic optimal control of a servo system.

Text Books:

1. *Bandyopadhyay, M.N., Control Engineering: Theory and Practice, Prentice–Hall of India Private Limited (2003).*
2. *Ogata, K., Discrete–time Control Systems, Pearson Education (2005).*

UHU-081: ENGINEERING ECONOMICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective of the course is to help students to understand the concepts of Economics, get awareness about the economic environment and possess an understanding of market competition and their pricing strategies. The course will enable them to know about Financial Markets, PNational Income Accounting, Inflation and Deflation. It will prepare Engineering students to analyze Cost/Revenue data and carry out economic analyses for decision making.

Engineering Economics: Definitions**,** Scope and Significance
Demand and Supply: Meaning of Demand and supply, Determinants of demand and Supply
Demand Forecasting: Purpose of Forecasting Demand, Determinants of demand forecasting, Methods of Demand Forecasting, Criteria for the good forecasting method.
Cost of Production: Explicit and Implicit costs, Marginal, Incremental and Sunk costs, Opportunity cost, Short-run cost function, Total Average and Marginal costs, Long-run costs, Break-even analysis.
Theory of Production: Law of Variable Proportions and Laws of returns to scale.
Markets Structures and Pricing Theory: Pricing in Different Markets: Perfect competition, Monopoly, Monopolistic competition and Oligopoly.
Investment Decision: Capital Budgeting, Methods of Project Appraisal (Payback Period, IRR, NPV, BCR).

National Accounting: Meaning, Methods and Current Trends.

Inflation &Deflation: Meaning, Measures and Impact on Indian economy.

Globalization and Foreign Direct Investment :Meaning, Recent Indian Policy Towards FDI and Globalization, Impact of FDI & Globalization on Indian Economy.

Exchange Rate: Meaning, Determinants of exchange rate, Measurement of Exchange Rate.

Overview of Financial Markets: Capital Market & Money Market.

Course Learning Outcomes (CLO):
The students after studying this course will:
1. Possess a deep understanding of the concepts and principles of Economics.
2. Be able to develop analytical skills essential for engineers to help to take decisions.
3. Better understand the markets and their pricing strategies
4. Possess an understanding of the pre-requisites of investing and will be able to carry out and evaluate benefit/cost, breakeven analyses on one or more economic alternatives.
5. Acquire an in-depth knowledge about Financial markets, Foreign Exchange Market, National Income Accounting, Inflation and Deflation.

Text Books:

1. *Salvatore, D. and Srivastav, R., Managerial Economics: Principles and Worldwide Applications, Oxford University Press, Sixth Edition (2008).*
2. *Peterson, H. Craig, Lewis, W. Chis. and Jain, Sudhir K. Managerial Economics, Prentice Hall of India (2006).*
3. *Robert Pindyck and Daniel Rubinfeld Microeconomics, Prentice Hall (2009).*

Reference Books:

1. *Pandey, I.M. Financial Management, Vikas Publication (2010).*
2. *Kishore, Ravi, M. Financial Management, Taxmann Publication (2009).*
3. *Dutt, R. and Sundaram, K.P.M., Indian Economy, S. Chand & Company Ltd. (2012).*

WORK STUDY AND METHOD ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objectives: To impart knowledge about the concept of productivity, basic work content, excess work content and total work content. To inculcate knowledge about method study, tools used for recording processes, path of movement and work place, procedure for critical examination of operations with the objective of developing a new method. To impart knowledge about work measurement techniques, equipment and its application in shop floor operations for productivity improvement. To educate the use of pre-determined motion time systems and standard data for pro-actively determining time standard of operations

Introduction: Definition, Scope, Historical review and areas of application of work study in industries, Inter-relation between method study and work measurement, Human aspects, Reaction of management and labor, Role in improving plant productivity and safety.

Method Study: Objectives and step-wise procedure for method analysis, Recording & evaluation techniques, Micro-motion and macro motion study, Therbligs and simo-charts, Principle of motion economy, Normal work areas and design of work places, Principles of work design, Multiple activity chart, Flow process chart, String diagram, Travel charts, Layout Design.

Work Measurement: Work measurement objectives, Techniques & criteria for selection of technique, Stop watch time study, Systems of performance ratings, Calculation of standard time, Introduction to allowances, Production study, Work sampling, MTM& work factor system, Standard data usage, Engineered time standard, Computers in work study, Predetermined motion time system (PMTS). Job evaluation & merit rating Wage payment plans, Incentive schemes.

Course Learning Outcomes (CLO):

The student will be able to:

1. Develop a case for productivity improvement in any manufacturing or service industry scenario
2. Independently conduct a method study in any organization with the objective of improving a process, material movement system or design of a work place
3. Develop time standards for operations, identify production bottlenecks and improvise operations
4. Develop methods of working and corresponding time standards for new operations

Text Books:

1. *Niebel, B.W., Motion & Time Study, McGraw Hill Higher education (1992).*
2. *Kanawaty, G., Work Study, ILO, Geneva, (1992).*

Reference Books:

1. *Mundel, M., and Danner, D. L., Motion & Time Study, Englewood Cliffs, NJ, Prentice Hall, (1994).*
2. *Curie, R., Introduction to Work Study, McGraw Hill (1992).*
3. *Barnes, R. M., Motion & Time Study, John Wiley & Sons (1980).*

LEAN MANUFACTURING

L	T	P	Cr
3	0	0	3.0

Course Objectives: To introduce the philosophy behind 'Lean Manufacturing' by giving a background of the Toyota Production System. Discussion of different 'lean' tools and their significance in improving the workplace. Highlighting the importance of employee involvement, training and culture.

Lean Production: Introduction, background, and lean thinking, importance of philosophy, strategy, culture, alignment, focus and systems view. Discussion of Toyota Production System.

Lean Production Preparation: System assessment, process and Value-stream mapping, sources of waste.

Lean Production Processes, Approaches and Techniques: importance of focusing upon flow. Tools include: Workplace organization – 5S, Stability, Just-In-Time – One piece flow – Pull, Cellular systems, Quick change and set-up reduction methods, Total productive maintenance, Poka-Yoke– mistake proofing, quality improvement, Standards, Leveling and Visual management, Six Sigma.

SMED: Single minute exchange of dies – theory and practice of the SMED system, the structure of production, Set-up operations, Fundamentals of SMED, Techniques for applying SMED, Basic examples of SMED.

Employee Involvement: Teams, Training, Supporting and encouraging involvement – Involving people in the change process; communication; importance of culture.

Concurrent Engineering: Obeya in Toyota's new product development process, cross-functional teams, use of computer technology, information management for simultaneous engineering.

Course Learning Outcomes (CLO):

The students will be able to

1. Identify and understand the key requirements and concepts in lean manufacturing to initiate a continuous improvement change program in a manufacturing organisation.
2. Apply the tools in lean manufacturing to analyse a manufacturing system and plan for its improvements.

Text Books:

1. *Liker, J, The Toyota Way, McGraw-Hill (2004).*
2. *Liker, J and Meier, D., The Toyota Way Fieldbook, McGraw-Hill (2006).*

Reference Books:

1. *Womack, J and Jones, D, Lean Thinking, Free Press (2003).*
2. *Womack, J and Jones, D and Roos, D., The Machine that Changed the World, Rawson Associates (1990).*
3. *Dennis, P., Lean Production Simplified, Productivity Press (2007).*
4. *Shingo, S., A Revolution in Manufacturing: The SMED System, Productivity Press (1985).*

FACILITIES PLANNING

L	T	P	Cr
3	0	0	3.0

Course Objectives: Provide students with the ability to apply plant layout design procedure to design a new facility and ability to select a suitable location for new facility with the use of different techniques.

Facilities Planning: Need for facilities planning, Importance of plant layout in plant design, Classifications of production process structures, Types of layout.

Plant Location: Factors affecting plant location, Optimum decision on choice of plant location, Quantitative techniques for making plant location decision.

Planning Design And Presentation: Principles of plant layout design, Procedure for plant layout design, Evaluate alternative layouts, Characteristic features suitability and applications of different types of layout installation of layout, Quantitative techniques for developing alternative layouts, Design of process and product layouts, Line balancing techniques.

Material Handling: Principles of material handling, Classification of material handling systems, different forms and sizes of materials, Characteristic features of key material handling equipment, Concept of unit load, safety aspects in material handling system.

Course Learning Outcomes (CLO):
The student will be able to:

1. To select a suitable location amongst the available locations for setting up a new facility
2. To decide about the particular production process flow strategy
3. To design a layout for the new facility to suit the company's production process structure
4. To select proper type of equipment for storage and movement of material

Text Books:

1. *Tompkins, J. A., White, J. A., Bozer, Y.A. and Tanchoco, J.M.A., Facilities Planning, John Wiley (2003).*
2. *Muther, R., Practical Plant Layout, McGraw Hill Book Company (1995).*

Reference Books:

1. *Sheth, V., Facilities Planning and Materials Handling, Marcel Decker (1995).*
2. *Agarwal, G.K., Plant Layout and Material Handling, Jain Publishers (1997).*

ERGONOMICS ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course is dedicated to making the students understand the ergonomic principles in workplace design and work organisation. It is aimed at enabling the students to identify and evaluate the impact of various human factors to design of safe workplace environment.

General: Man in industrial work environments, Ergonomics as multidisciplinary fields, Importance and justification and ergonomics problems, Man-machine-environment system.

Anthropometry: Significance of human body measurement in design of equipment, Facilities, Work place and operation, Static and dynamic anthropometry, Anthropometric data.

Task Analysis: Task description, Posture measurement, RULA & REBA analysis and evaluation, Lifting & lowering tasks, Lifting index, Lifting & carrying tasks, NIOSH lifting equation.

Biomechanics: Introduction to levers of Human Body, Ligaments & Tendons, Joints. Kinetics to include forces producing motion.

Man-Environment Interface: Environmental factors of temperature, Humidity, Lighting and noise in industry, Effect of environmental factors on human performance, Measurement and mitigation of physical and mental fatigue, Basics of environment design for improved efficiency.

Design of Display and Control: Need for information display, Elements of information theory, Reaction time, Methods and types of displays, Design of audio and visual displays, Design of hand and foot operated control device, Design of human-computer interface.

Course Learning Outcomes (CLO):

The students will be able to:

1. identify, explain and evaluate the impact of various personal attributes (anatomical, physiological and anthropometric) on proper, safe working practice.
2. assess the effect of physical environment factors on comfort and performance.
3. apply principles of good ergonomic design to work areas and equipment.
4. apply various task analysis tools to posture measurement, lifting, lowering and carrying tasks.
5. comprehend the need for information display and the ergonomic design of different display and control devices.

Text Books:

1. *Bridger, R.S., Introduction to Ergonomics, McGraw Hill (2008).*
2. *Sanders, M. and McCormick E., Human Factors in Engineering & Design, McGraw Hill (1993).*

Reference Books:

1. *Maynard, H. B., Industrial Engineering Hand Book, McGraw Hill (1992).*
2. *David, A., Practice & Management of Industrial Ergonomics, Prentice Hall (1986).*
3. *Singleton, W. T., Introduction to Ergonomics, WHO, Geneva (1972).*