B.Tech/ B,Des

Semester-I

Subject Code	NS1001	**Course Title**	Mathematics-I
Contact Hours	L-3, T-1, P-0	**Credit**	4
Programme	B.Tech	**Semester**	I
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid term (30%), Quiz II (15%), End term (40%)		

Module 1: Calculus of Functions of One Variable:

Real Numbers, Functions, Sequences, Limit and Continuity, Differentiation : Review, Successive differentiation, Chain rule and Libnitz Theorem, Rolle's and Mean Value Theorems, Maxima/Minima, Linear and Quadratic approximations, Error estimates, Taylor's Theorem, The Riemann Integrals, Improper Integrals, Infinite series, Tests of convergence, Absolute and Conditional convergence, Taylor and Maclaurin series. **[21H]**

Module 2: Calculus of Functions of Several Variables:

Scalar fields, Limit and Continuity, Partial derivatives, Chain rules, Implicit differentiation, Directional derivatives, Total differential, Tangent planes and Normals, directional derivative, Maxima/Minima and Saddle points, Constrained maxima and minima, Double Integrals, Change of variables. **[14H]**

Module 3: Vector Calculus:

Vector fields, Divergence and Curl, Line Integrals, Green's Theorem, Surface Integrals, Divergence Theorem, Stoke's Theorem and applications. **[07H]**

Text/Reference books:

1. Calculus and Analytic Geometry by G.B. Thomas and R.L. Finney,
2. Introduction to Real Analysis by R. G. Bartle and D. R. Sherbert.

Subject Code	NS1002	**Course Title**	Engineering Mechanics
Contact Hours	L-2, T-1, P-2	**Credit**	4
Programme	B.Tech	**Semester**	I
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%),Lab (20%) End term (40%)		

Scalars and Vectors, Cartesian and curvilinear coordinate system, Newtons law: statics and dynamics, centre of mass and variable mass problem, work and energy, stable and unstable equilibrium, collisions in two dimension: Laboratory and COM frame **[07H]**

Double and triple integrals, Line, surface & volume integrals, Gradient, Divergence & Curl (in Cartesian and curvilinear coordinates), Line, surface, volume integrals, Guass's and Stoke's theorem (problems and physical significance) **[07H]**

Rotational motion, Torque, Angular momentum, Moments of Inertia, pure rotation and center of percussion (example), combined translation and rotation & the role of centre of mass, Chasles' Theorem, Moments of Inertia. **[07H]**

Moment of inertia tensor, Principal Axes of Inertia, Finding the Principal Axes; Eigenvalue Equations, Precession of a Top due to a Weak Torque & gyroscopic motion **[07H]**

Lab experiments:

1. Introduction to error analysis
2. Spring oscillation apparatus
3. Simple pendulum
4. Moment of inertia of a flywheel
5. Determine g by Bar pendulum
6. Tortional pendulum
7. Sonometer
8. Stoke's law
9. Newton's law of cooling

Text/Reference books:

1. Introduction to mechanics: Daniel Kleppner , Robert J. Kolenkow
2. Mathematical Methods in the Physical Sciences: Mary L. Boas

Subject Code	DS1002	**Course Title**	Design Fundamentals 1
Contact Hours	L-2, T-0 P-2	**Credit**	3
Programme	B. Des	**Semester**	1
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Introduction to design – Nature of design, Aesthetic sense, Role of perception, Gestalt principle, Inspiration, concepts, problem solving Product integrity (consistency between a product's function With its structure and customer expectations) **[07H Lecture,+3H Lab]**

Originality (originality in technology and form; plagiarism) Craftsmanship required transforming an idea to a product etc. An introduction to basic elements of Design: Point, Line – Line as Expression, Quality of lines, Symbolic Lines, Line as form etc. Space – Pictorial space, implied space, space illusion, actual space etc**.** **[07H Lecture,+3H Lab]**

Shape & Form– Natural shapes, geometric shapes, abstract shapes, non-representational shapes; Natural forms, geometric forms, abstract forms, non-objective forms**.** **[07H Lecture,+3H Lab]**

Color – color theory, color properties, color relationships, color harmony, color interaction. Texture - tactile texture, visual texture, texture and pattern, constructed textures, symbolic textures. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Bervin, M. E. (1984). Design Through Discovery: The Element and Principles. Holt, Rinehart and Winston, Washington.
2. Wong, W. (1972). Principles of two-dimensional design. John Wiley & Sons. Sherwin, D. (2010). Creative workshop: 80 challenges to sharpen your design skills. How Books.
3. Brommer, G. F. (1994). Collage techniques: A guide for artists and illustrators. Watson-Guptill Publications. Kelley, T., & Kelley, D. (2013). Creative confidence: Unleashing the creative potential within us all. Crown Business.

Subject Code	DS1003	**Course Title**	Design Drawing
Contact Hours	L-1, T-0, P-3	**Credit**	2
Programme	B.Des	**Semester**	1
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Including a combination of engineering and artistic drawing skills**.** **[07H Lecture,+3H Lab]**

Free hand drawing from natural or manmade environment develops the skill of coordination of mind and hand during the process of representation**.** **[07H Lecture,+3H Lab]**

Free hand drawing of Isometric (30-30), Diametric (15-15), Trimetric (45-15) and One point. **[07H Lecture,+3H Lab]**

Two point and Three point perspective in real location. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Nicolaides, K. (1990). The natural way to draw: A working plan for art study. Houghton Mifflin Harcourt
2. Laning, E. (1971). The act of drawing. McGraw-Hill Companies.
3. Ching, F. D., &Juroszek, S. P. (2010). Design drawing. John Wiley & Sons.
4. O'Rourke, N., Psych, R., & Hatcher, L. (2013). A step-by-step approach to using SAS for factor analysis and structural equation modelling. SAS Institute.
5. Speed, H. (2012). The practice and science of drawing. Courier Corporation.

Subject Code	DS1004	**Course Title**	Representation Techniques
Contact Hours	L-2, T-0, P-2	**Credit**	3
Programme	B.Des	**Semester**	1
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Different ways in design ideas can be represented for better visualization. **[07H Lecture,+3H Lab]**
Development of an analytical attitude and ability to deal with complexity of imagination and visualization of object from any angle. **[07H Lecture,+3H Lab]**
Understanding and representing the structure of forms in detail with wireframes. **[07H Lecture,+3H Lab]**
Color representation in the object drawing with section and exploded view**.** **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Wood, P., & McDonnell, P. (1994). Scientific illustration: a guide to biological, zoological, and medical rendering techniques, design, printing, and display. John Wiley & Sons.
2. Buxton, B. (2010). Sketching user experiences: getting the design right and the right design: getting the design right and the right design. Morgan Kaufmann.
3. Powell, D. (1990). Presentation techniques. New York: Little, Brown & Company.
4. Tal, D. (2010). Google Sketch up for site design: a guide to modelling site plans, terrain and architecture.John Wiley & Sons.
5. Zeman, N. B. (2014). Essential Skills for 3D Modelling, Rendering, and Animation. CRC Press.

Subject Code	HS1001	**Course Title**	Effective Communication Skills
Contact Hours	L-2, T-0, P-0	**Credit**	2
Programme	B.Tech	**Semester**	I
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (30%), Quiz II (10%), End term (50%)		

Why English? ,Effective Communication Skills-2l, Technical English-2l, Technical Reports -5 L, Tender Notices-2l, Holding Meetings-3l, Good Presentation-3l, Group Discussion-2l, Curriculum Vitae (Cv), Or Resume, Bio-Data, Job Application Letter-3l, Interview-2l, Phonetics.-2l, Grammar-1l

Text/Reference books:

1. Developing Communication Skills- Krishna Menon- Macmillan Publication House.
2. Remedial Grammar- F.T. Wood- Macmillan
3. Personality Development and Soft Skills- BarunMitra- Oxford Publication House.
4. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success- Pearson Education

Subject Code	EC1001	**Course Title**	Introduction to Profession
Contact Hours	L-1, T-0, L-0,	**Credit**	1
Programme	B.Tech	**Semester**	I
Pre-requisites	NIL		
Evaluation scheme	Quiz (100%)		

Learning Objective: Overview of Electronics and Communication Engineering

Course Detail :

Module 1: Introduction to Engineering
(history,motivation,ethics,science vs Engineering vs technology)
Module 2: Introduction to Electronics and Communication Engineering
(history,major areas of ECE)
Module 3: Interdisciplinary approach, selection of electives
Module 4: Applications of Electronics and Communication Engineering
Module 5: Case Studies and Technological Innovations
(Embedded System, VLSI and Nano Technology, 5G Communication, Artificial Intelligence, Robotics, Bio

Medical, Microwave and THz Technology, SCADA and Smart Grid etc.)

Text/Reference books:

1. Developing Communication Skills- Krishna Menon- Macmillan Publication House.
2. Remedial Grammar- F.T. Wood- Macmillan
3. Personality Development and Soft Skills- BarunMitra- Oxford Publication House.
4. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success- Pearson Education

Subject Code	ME1001	**Course Title**	Introduction to Profession
Contact Hours	L-1, T-0, L-0,	**Credit**	1
Programme	B.Tech	**Semester**	I
Pre-requisites	NIL		
Evaluation scheme	Quizzes (50%), Assignments (50%)		

Learning Objective: Birds' eye view of Mechanical Engineering

Course Detail :

1. Essential difference among Science, Engineering and Technology
2. Introduction to Mechanical Engineering
3. Mechanical Engineering as a profession/career
4. Applications of Mechanical Engineering
5. Examples and Case Studies
6. Technological Innovations

Text/Reference books:

1. Developing Communication Skills- Krishna Menon- Macmillan Publication House.
2. Remedial Grammar- F.T. Wood- Macmillan
3. Personality Development and Soft Skills- BarunMitra- Oxford Publication House.
4. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success- Pearson Education

Subject Code	SM1001	**Course Title**	Introduction to Profession
Contact Hours	L-1, T-0, L-0,	**Credit**	1
Programme	B.Tech	**Semester**	I
Pre-requisites	NIL		
Evaluation scheme	Quizzes (50%), Assignments (50%)		

Learning Objective: Birds' eye view of Mechanical Engineering

Course Detail :

1. Essential difference among Science, Engineering and Technology
2. Introduction to Smart Manufacturing
3. Smart Manufacturing as a profession/career
4. IoT, IIoT, Industry 4.0
5. Applications of Smart Manufacturing
6. Examples and Case Studies
7. Technological Innovations

Text/Reference books:

1. Developing Communication Skills- Krishna Menon- Macmillan Publication House.
2. Remedial Grammar- F.T. Wood- Macmillan
3. Personality Development and Soft Skills- BarunMitra- Oxford Publication House.
4. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success- Pearson Education

Subject Code	DS1001	**Course Title**	Introduction to Profession
Contact Hours	L-1, T-0, L-0,	**Credit**	1

Programme	B.Des	**Semester**	I
Pre-requisites	NIL		
Evaluation scheme	Quiz: 04: 25% each		

Learning Objective:

Course Detail :

1. Introduction to Design
2. Advent
3. History
4. Application Areas
5. Design Thinking
6. The user in design
7. Eminent Designers
8. Different facets of Design
9. The Design Journey
10. Technology and Design
11. Design as a profession
12. What design can and cannot
13. Opportunities in Design
14. The Design Canvas

Text/Reference books:

1. Norman, D. (2013). *The design of everyday things: Revised and expanded edition*. Basic books
2. Pipes, A. (2003). *Foundations of art and design*. Laurence King Publishing.
3. Eames, C., & Eames, R. (2004). *The India Report*. National Institute of Design
4. Balaram, S. (2011). *Thinking design*. SAGE Publications India.

B.Tech / B.Des

Semester-II

Subject Code:	NS103b	**Course Title**	Linear Algebra
Contact Hours	L-2, T-1, P-2	**Credit**	4
Programme	B.Tech	**Semester**	II
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid term (30%), Quiz II (15%), End term (40%)		

Course Detail -

Module 1: Probability: **[21H]**

Basic Set Operations, Algebra and Sigma algebra, Measurable Space, Measure, Measurable Function, Probability Measure. **[4H]**

Random Variable, Function of Random Variable, Probability Mass Function, Probability Density Function, Cumulative Probability Distribution Function, Independent Event, Expectation, Variance, Covariance, Correlation. **[5H]**

Conditional Probability Measure, Law of Total Probability, Baye‟s Formula, Baye‟s Theorem, Function of Several Variables, Joint and Marginal Distribution Function **[4H]**

Moments, Moments Generating Function, Characteristic Function, Inversion Theorem, Uniqueness Theorem, Important Statistical Inequalities **[4H]**

Mode of Convergence, Convergence in Law, Convergence in Measure, Convergence in rth Mean, Almost Sure Convergence, Weak Law of Large Numbers, Strong Law of Large Numbers, Center Limit Theorem. **[9H]**

Module 2: Linear Alegbra: **[14H]**

Text/Reference books:

Subject Code:	NS1004	**Course Title**	Physics II
Contact Hours	L-3, T-1, P-2	**Credit**	4
Programme	B.Tech	**Semester**	II
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%),Lab (20%) End term (40%)		

Course Detail :

The Electric Field, Divergence and curl of electrostatic fields, potential and its relation with electrostatic Field, The energy of a continuous charge distribution, conductors and induced charges, Laplace's Equation, theorems regarding boundary conditions, Separation of Variables, The Method of Images. **[6H]**

Dielectrics, The field of a polarized object, bound charges, Gauss's Law in the Presence of Dielectrics, Energy in Dielectric Systems **[3H]**

The Lorentz Force Law, magneto statics and The Biot-Savart Law, The Divergence and Curl of magnetic field, The Vector Potential, Magnetization, Effect of a Magnetic Field on Atomic Orbits: diamagnetism, Bound Currents, Ampere's law in Magnetized Materials, Brief idea of ferromagnetism **[6H]**

Electromotive Force, Motional emf, Electromagnetic Induction, energy in magnetic fields, Maxwell's modification of Ampere's law, Maxwell's equations, Boundary condition **[6H]**

Poynting theorem, Electromagnetic Waves, Reflection and Transmission of a wave, Electromagnetic Waves in Vacuum and dielectric, Energy and Momentum & intensity in Electromagnetic Waves, Reflection and Transmission of light at Normal Incidence, Reflection and Transmission of light at oblique Incidence and Snell's law **[9H]**

Superposition of light having same frequency, Coherent and random sources, Yong's double slit experiment: superposition by splitting of wave front, parallel film and Newton's ring: superposition by splitting of amplitude, Michel sons and Febry perot interferro metre, spatial and temporal coherence **[6H]**

Fraunh offer's and Fresnel's diffraction, diffraction from single slit, double slit and grating, resolution, dispersive power and resolution of a grating, Basics of a Laser **[6H]**

Lab Experiments:

1. Single slit diffraction of Laser light
2. Diffraction due to grating
3. Newton's ring
4. Dispersive power of a grating using spectrometer
5. e/m by millikan oil drop experiment
6. e/m by Thomson method method
7. Balmer series
8. Charging and discharging of a capacitor
9. Frank hertz Experiment

Text/Reference books:

1. Introduction to Electrodynamics: David J Griffiths
2. Introduction to optics: Frank L. Pedrotti, Leno M. Pedrotti, Leno S. Pedrotti
3. Principles of electromagnetic: Matthew N. O. Sadiku
4. Optics: Eugene Hecht

Subject Code:	DS1006	**Course Title:**	Design Fundamental 2
Contact Hours:	L-3, T-0, P-0	**Credit:**	3
Programme :	B.Des	**Semester :**	II
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Understanding of characteristics of different elements & their inter-relationship with various elements and to the composition. **[07H Lecture,+3H Lab]**

Balance – Structural balance and visual balance**.** **[07H Lecture,+3H Lab]**

Materials, hardware and software etc**.** **[07H Lecture,+3H Lab]**

Symmetry, Asymmetry, Radial Balance, Golden proportion, Rules of composition, Scale & Proportion - Unity & Variety – Harmony, Rhythm, Perspective, Emphasis, Orientation, and Repetition. **[07H Lecture,+3H Lab]**

Text/Reference Books:

1. Bervin, M. E. (1984). Design Through Discovery: The Element and Principles. Holt, Rinehart and Winston, Washington.
2. Wong, W. (1972). Principles of two-dimensional design. John Wiley & Sons.

3. Brommer, G. F. (1994). “Collage techniques: A guide for artists and illustrators” Watson-Guptill Publications.

Subject Code:	DS1007	**Course Title:**	Introduction to Ergonomics in Design
Contact Hours:	L-3, T-0, P-0		
Programme :	B.Des	**Credit:**	3
Pre-requisites:	NIL	**Semester :**	II
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Genesis. Systems concepts, evolution. **[07H Lecture,+3H Lab]**
Components, biomechanics, anthropometry**.** **[07H Lecture,+3H Lab]**
Application, relation to design, ergonomics of product, space and communication **[07H Lecture,+3H Lab]**
Sector specific application of ergonomics like craft, agriculture, transportation etc **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Bridger, R. (2008). Introduction to ergonomics. CRC Press.
2. Chakrabarti, D. (1997). Indian anthropometric dimensions for ergonomic design practice. National institute of design.
3. Sanders, M. S., & McCormick, E. J. (1987). Human factors in engineering and design McGraw-Hill Book Company.
4. Woodson, W. E., Tillman, B., & Tillman, P. (1992). Human factors design handbook: information and guidelines for the design of systems, facilities, equipment, and products for human use.

Subject Code:	DS1008	**Course Title:**	Software Skills
Contact Hours:	L-0, T-0, P-3	**Credit:**	2
Programme :	B.Des	**Semester :**	II
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail –

Software skills related to communication design, specially related to some specific software's used in visual prototyping, film making, creating special effects.

Text/Reference books:

1. Macario, J. (2008), Graphic Design Essentials: Skills, Software and Creative Solutions, Pearson Publications.
2. Henry, K. (2012), Drawing for Product Designers (Portfolio Skills), Laurence King Publishing.
3. Eissen, K. (2014), Sketching: Product Design Presentation. BIS Publishers, B.V.

Subject Code:	DS1005	**Course Title**	Engineering Graphics
Contact Hours	L-2, T-0, P-3	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	II
Pre-requisites	NIL		
Evaluation scheme	Quiz I (5%), Midterm (30%), Quiz II (5%), Lab (20%) End term (40%)		

Introduction **[2H]**

Lines, Lettering, Sketching, Principle of Dimensioning, Basic geometrical constructions, Scales, Engineering Curves.

Orthographic Projections **[3H]**

Pictorial view, Multi-view, Multi-view Drawing, Terminology, First angle projection and its features, Third angle projections and its features, Symbols, Section lines or hatching, Conversion of pictorial view into orthographic view.

Projections of Points **[2H]**

Location of a point, Conventional representations, Projections of a point located at different locations.

Projections of Lines **[3H]**

Introduction, Orientation of a line, Projections of a line located at different locations, Projections of a line in different angles.

Projections Planes **[3H]**

Introduction, Orientation of a plane, Projections of a plane located at different locations, Trace of a plane, Plane inclined to both the reference planes.

Projection of Solids **[3H]**

Introduction, Classification of solids, Recommended method of labelling, Orientation of solids, Drawing projections of a solid at different orientation of its axis, Identify visible and hidden lines.

Sections of Solids **[2H]**

Introduction, Terminology, Types of section planes, Section by a plane perpendicular to VP, HP and both.

Development of Surfaces **[2H]**

Introduction, Classification of surfaces, Methods of development, Development of prism, pyramid, cylinders, cone, trays, Applications.

Intersection of Surfaces **[4H]**

Introduction, Engineering Applications, Method of determining the curves of intersection, Types of interpenetrating solids, Intersection by prism, cylinder, pyramid and cone by another solid.

Axonometric Projection **[4H]**

Introduction, Principles of isometric projections, Terminology, Isometric scales, Four centre method to draw ellipse, Dimensioning of isometric projection, Isometric view of right solids, solid containing non-isometric lines, truncated solids, composite solids, Conversion of orthographic view into isometric views, Oblique projections, Perspective projections.

Text/Reference books:

1. N D Bhatt Engineering Drawing, 49th edition Charoter, Publishing House, 2006.
2. B Agrawal and C M Agrawal, Engineering Drawing (2nd Ed), McGraw Hill, New Deli, 2014.
3. Dhananjay A Jolhe, Engineering drawing, TMH, 2008.
4. T E French, C J Vierck and R J Foster, Graphic Science and Design, 4th edition, McGraw Hill, 1984.
5. W J Luzadder and J M Duff, Fundamentals of Engineering Drawing, 11th edition, Prentice-Hall of India, 1995.
6. K Venugpoal, Engineering Drawing and Graphics, 3rd edition, New Age International, 1998.
7. K. Venkata Reddy, Engineering Drawing, 2nd edition, BS Publications, 2008.

Subject Code:	HS1002	**Course Title**	Culture and Human Values
Contact Hours	L-2, T-2, P-0	**Credit**	3
Programme	B.Tech	**Semester**	II
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (30%), Quiz II (10%), End term (50%)		

A collection of Shlokas from Gita and Upanishads-	**[2H]**
Pearls of Confucius-	**[2H]**
Excerpts from the *Arthashastra* of Chanakya-	**[2H]**
Poems from Tagore's *Gitanjali*-	**[1H]**
Speech of Swami Vivekananda-	**[2H]**
Excerpt from the book of APJ Abdul Kalam, '*Ignited Minds*'.-	**[2H]**
Speech 'Tryst with Destiny' of JawaharLal Nehru-	**[1H]**
Excerpts from *Hamlet* of William Shakespeare-	**[2H]**
Excerpts from Bacon's '*Of Studies*'.-	**[2H]**
Excerpts from Mahatma Gandhi's *' Simple Life'*.-	**[1H]**
The Gold Frame.-	**[2H]**
Death is a Reality-	**[1H]**
Company You Keep-	**[1H]**
The Temptation of Possession-	**[1H]**
Discretion is the Best Weapon-	**[1H]**
Akbar and Tansen-	**[1H]**
Gender Studies- Woman and Home- Rabindranath Tagore.-	**[2H]**
Excerpts from Male Brain and Female brain of Dr.Brizendine.-	**[2H]**

Text/Reference books:

1. "Wisdom Through the Ages- A Reader" Edited and compiled by Prof. Adhikari, Part compilation on Gender Studies by Dr.Mamta Anand.
2. Gitanjali- Rabindranath Tagore- Macmillian
3. Complete Works – William Shakespeare- Oxford Edition
4. Complete Works – Swami Vivekananda- Advaita Trust

Year Long Courses (Common for B.Des and B.Tech)

Subject Code:		**Course Title**	Professional Development Course
Contact Hours	L-1, T-0, L-0,	**Credit**	1
Programme	B.Des/B.Tech	**Semester**	II
Pre-requisites	NIL		
Evaluation scheme			

Course Detail

1: Personal Empowerment

(A). Self-assessment to discover one's Strengths, Areas of Improvements and Personality Profile.

(B). Effective Communication Skills

- Word Power enhancement
- Attention to Detail: spacing, punctuation, spelling, and other finer aspects
- Verbal and non-verbal communication skills
- Written English with emphasis on writing grammatically correct technical/official letters, applications and reports.
- Getting rid of inhibitions and building confidence
- Assertive and Submissive communication
- Using Language for Convincing and Persuasion
- Art of asking Questions
- Practice sessions

(C). Personal Grooming, Formal Dressing and Body Language

- Basics of Power Dressing
- Corporate Dress Code
- Importance of Self Grooming and Personal Hygiene
- Gestures & Postures, Tone of Voice, Voice Modulation
- Workplace Etiquette & Culture

- How to introduce yourself

B.Tech Semester III

Subject Code:	CS2002	**Course Title**	Computer Organization and Architecture
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme			

Introduction: Functional components and operational concepts of a computer, Performance of a computer. **[04H]**

Memory Subsystem: Semiconductor memories: SRAM and DRAM cells, Internal organization of a memory chip, Organization of a memory unit, Error correction, Read-Only Memories, Interleaved Memories, Cache Memories: Concept, Mapping methods, Caches in commercial processors, Memory management unit: Concept of virtual memory, Address translation, Hardware support for memory management, Secondary storage: Hard Disks, RAID, Optical Disks, Magnetic Tape Systems. **[10H]**

Input/Output Subsystem: Access of I/O devices, I/O ports, I/O control mechanisms: Program controlled I/O, Interrupt controlled I/O, and DMA controlled I/O, I/O Interfaces: Serial port, Parallel port, PCI bus, SCSI bus, USB bus, FireWire and InfiniBand. **[10H]**

Representation of Instructions: Computer Arithmetic, Machine Instructions, Operands, Instruction Sets: Addressing Modes, Instruction Formats, Instruction set architectures: CISC and RISC architectures **[05H]**

Processing Unit: Organization of a processor: Registers, ALU and Control Unit, Data path in a CPU, Instruction cycle, Instruction Pipelining, Organization of a control unit: Control Unit Operations, Hardwired control unit, Microprogrammed control unit. **[10H]**

Introduction to Multiprogramming and Multiprocessing. **[03H]**

Text/Reference books:

1. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", Fifth Edition, McGraw-Hill, 2002.
2. M. Morris Mano, Computer System Architecture, Third Edition, Prentice Hall of India, 2007.
3. W. Stallings , "Computer Organization and Architecture – Designing for Performance", Tenth Edition, Prentice Hall of India, 2015.
4. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design – The Hardware/Software Interface", Fifth Edition, Morgan Kaufmann, 2013.
5. J. P. Hayes, "Computer Architecture and Organization", Third Edition, McGraw-Hill, 2002.

Subject Code:	EC2002	**Course Title**	Digital Electronics and Microprocessor Interfacing
Contact Hours	L-3, T-0, L-2,		
Programme	B.Tech	**Credit**	4
Pre-requisites	NIL	**Semester**	III
Evaluation scheme	Quiz I (10%), Mid term (25%), Quiz II (10%), End term (35%), Lab (20%)		

Learning Objective: To impart basic knowledge of analysis and design of various digital electronics circuits and knowledge on Microprocessors and Microcontroller to solve real world problems in an efficient manner.

Course Detail :

Module 1: Number Systems and Boolean Algebra, Simplification of functions using Karnaugh map and Quine McCluskey Method, Boolean Function Implementation, Minimization and Combinational Design, Examples of Combinational Digital Circuits, Hazards in Combinational Circuits, Hazard free realization. **[10H]**

Module 2: Introduction to Sequential circuits: Latches and Flip-Flops (RS, JK, D, T and Master Slave), Design

of a Clocked Flip-Flop, Flip-Flop conversion, Practical Clocking aspects concerning Flip-Flops. Counters: Design of Single Mode and Multimode Counters, Ripple Counters, Synchronous Counters, Shift Registers, Shift Register Counters and Random Sequence Generators. **[12H]**

Module 3: Introduction to Microprocessors: The 8085 microprocessor architecture, Programmer's model, Instruction set, instruction Format, Addressing modes, Machine cycle, Timing diagrams, and memory map, interfacing memory and I/O devices, The 8085 assembly language programming, Looping, block transfer, bit manipulation, time delay routines, stack and subroutine, I /O programming, interrupt handling. **[12H]**

Module 4: Interfacing of 8085: Handling of I/O ports and port programming using IN/OUT instruction, STACK handling and Signed Number Arithmetic, Interfacing instructions and control word structure for various pins like 8255, 8155, 8279,8259, etc. **[08H]**

Text/Reference books:

1. Digital Design by M Morris Mano and Michael D Ciletti, Pearson Prentice Hall, 4 th Edition.
2. Digital Logic Circuit Analysis and Design by - Victor P. Nelson, H. Troy Nagle, J. David Irwin & Bill D. Carrol, Prentice Hall.
3. Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh Gaonkar, Penram International Publishing; 6th edition.
4. Microprocessors and interfacing by Douglas Hall, McGraw Hill Education; 3rd edition.

Subject Code:	ME2002	**Course Title**	Manufacturing Process
Contact Hours	L-3, T-0, P-2	**Credit**	4
Programme	B.Tech/B.Des	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%), End term (40%), lab (20%)		

Introduction: Introduction to Manufacturing, Historical Perspective, Importance, etc Mechanical Properties In Design & Manufacturing. **[02H]**

Casting: Fundamentals of casting process, features of casting, Casting Processes, Classification, Significances. **[03H]**

Metal Forming: Hot & Cold Working, Bulk Deformation processes like Rolling, Forging, Extrusion and Drawing, Sheet metal forming (Shearing & Drawing operation). **[03H]**

Machining: Machining, Mechanism of machining, Chip Formation, Temperature, Tool Wear, Tool Life, Machining Processes, Brief introduction to Single point and multi-point cutting operations. Introduction to Grinding & Finishing. **[03H]**

Metal Joining: Fundamentals of Welding, Classification of welding, processes, Introduction to Gas & Are Welding, Ultrasonic Welding, Friction Welding, Resistance welding, Brazing, Soldering and Adhesive bonding. **[03H]**

Polymers: Polymer products manufacturing, Extrusion, Injection molding, Blow molding , Thermoforming, Compression molding and Transfer Molding. **[03H]**

Modern Manufacturing Processes: Introduction to rapid prototyping, classification and various RP processes. Introduction to various unconventional machining processes and their classification. Introduction to automation, Flexible manufacturing systems and CNC. **[06H]**

Manufacturing of Electronic Device: Manufacturing of semiconductor devices and silicon wafers. Devices fabrication Techniques, Surface Films Depositions, Lithography, Etching, Processes Integration and Packaging. Printed circuit boards and Techniques for micro / nano fabrication. **[05H]**

Lab Experiments:

1. Practice on various Measuring instruments
2. To performed joining of two thick MS plates by V groove Butt Joint using arc welding (MMAW)
3. To performed joining of two thin MS plates by Lap Joint using oxy acetylene gas welding
4. To learn and practice turning, parting operation on lathe machine
5. To perform grooving, threading and knurling operations on lathe machine
6. To perform step and taper turning operation on lathe machine
7. To learn operations of Vertical Milling M/C and perform a practice job like T Slot Cutting.
8. To learn operations on horizontal milling machine and prepare a Spur Gear
9. To learn various fitting operations like Drilling, Taping, Radios, Square Cut in MS metal working.
10. To learn various sheet metal operations of GI Sheet and prepare a funnel cone by using GI Sheet.
11. Process demonstration of Ultrasonic Plastic & Metal Welding
12. Process demonstration of Tool Wear Measurement

Text/Reference books:

1. SeropeKalpakjian, Steven R Schmid, "Manufacturing Engineering and Technology", Pearson Education.
2. Callister, "Materials Science and Engineering" John Wiley & Sons Inc.
3. Smith William. "Foundation of Materials Science and Engineering", McGrwa Hill, 4th Edition.
4. V. Raghwan,"Materials Science and Engineering" 5th Edition.
5. Mikel P. Groover, "Fundamentals of Modern Manufacturing", John Wiley & Sons inc.
6. John A Schey, "Introduction to Manufacturing Processes", McGraw Hill 3rd Edition.

Subject Code:	CS2003	**Course Title**	Database Management System
Contact Hours	L-3, T-0, P-2	**Credit**	4
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%), End term (40%), lab (20%)		

Introduction of DBMS: Evolution of Database Management Systems, Concept of data models, database system architecture. **[05H]**

Data Models: ER Model: ER Schema, entity-sets, ER diagram, Specialization & generalization, Aggregation;

Relational Model: Relations, Keys, Constraints; ER Schema to Relational model; Relational algebra; tuple and domain relational calculus. **[10H]**

Structured Query Language: SQL data types, Types of SQL commands, SQL operators, Tables, views and indexes, Queries and sub queries, Aggregate functions, assertion, trigger, integrity & SQL, security implementation with SQL, Embedded SQL. (Will be covered in the Lab hours. Lab will also include exercises on development of a complete database based application) **[10H]**

Database Design: Functional Dependencies, decomposition, canonical cover, Normalization (1NF- 5NF), Dependency preservation, multivalued dependencies, Join dependencies. **[07H]**

Transaction Management: Transaction concept, ACID properties, Serializability, Concurrency control techniques, Recovery concepts and techniques. **[05H]**

Storage Structure & File Organization: Indexing, ordered indices: B+ tree and B tree index files, Introduction to Client Server and Distributed Databases **[05H]**

ext/Reference books:

1. R. Elmasri, S. B. Navathe, D. V.L.N. Somayajulu, S. K. Gupta, "Fundamentals of Database Systems," 7th edition, Pearson Education, 2015.

Subject Code:	EC203a	**Course Title**	Principle of Analog Communications
Contact Hours	L-2, T-0, L-2	**Credit**	2
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Evaluation-I: 50%, Evaluation-II 50%		

Learning Objective: In this course undergraduate students will learn about the signal, system, modulation and transmission of signal using different techniques such as amplitude and angle modulation.

Course Detail :

Introduction to Communication Systems and review of signal & system: Communication network and channel, Difference between Analog and Digital type of signal and Communication, Classification of Signals and systems, Fourier series, Fourier transform and its Properties and examples, Impulse Response, and Transfer Function.

Amplitude Modulation: General amplitude Modulation, Double Sideband (DSB) Modulation, Single-Sideband and Vestigial-Sideband Modulations. Implementation and generation techniques of AM Modulators and demodulators.

Angle Modulation: Basic definition, Phase modulation, frequency modulation, relationship between frequency and phase modulation, bandwidth of power and spectrum of FM signal, Narrowband and wideband frequency modulation, Transmission bandwidth of FM signal, Generation and detection techniques of angle modulation.

Text books:

1. Haykin, S., "Communication System", Fourth Edition, Wiley and Sons, 2005.
2. Lathi, B.P., "Modern Digital and Analog Communication System", Oxford University Press, 2006.

Reference books:

1. John G. Proakis and Masoud Salehi, "Communication System Engineering", Prentice Hall,2006.
2. Taub and Schilling, "Principles of Communication System", Tata McGraw-Hill, 1991.

Subject Code:	EC203b	**Course Title**	Network Theory (Analysis and Synthesis)
Contact Hours	L-2, T-0, P-0	**Credit**	2
Programme	B.Tech	**Semester**	III
Pre-requisites	Fundamentals of Electrical Engineering		
Evaluation scheme	Quiz Exam (40%), Assignment (10%), End-Term (50%)		

Learning Objective:

- To make the students capable of analyzing any given electrical network.
- To make the students learn how to synthesize an electrical network from a given impedance/ admittance function.
- To develop hierarchical thinking to see more complex systems as a generalization of simple circuits and techniques.

Course Detail :

Introduction: Network elements, formulation of network equation, network representations, Transient analysis in RL, RC, and RLC networks with DC and AC excitation, response to step, impulse and ramp inputs, coupled circuits: self-inductance and mutual inductance, coefficient of coupling, and dot convention. **[09H]**

Two-Port Networks: Characteristics of linear time-invariant networks, network parameters (short circuit admittance parameters, open circuit impedance parameters, transmission parameters, image parameters, and hybrid parameters), interconnections of networks (tee and pie circuit representation, cascade, and parallel connections). **[08H]**

Graph theory: Network graphs, tree, branches, chords, fundamental cut-sets and loops, incidence, tie-set, cut-set matrices, and their applications in network analysis. **[05H]**

Network Synthesis: Positive real function, physical realizability conditions, Hurwitz property, positive

realness, properties of positive real functions, synthesis of R-L, R-C, and L-C driving point functions, Foster and Cauer forms, introduction to two-port network synthesis, and basics of filter design. **[06H]**

Text/Reference books:

1. M.E. Van Valkenburg, *Network Analysis*, Prentice-Hall, 2006.
2. M.E. Van Valkenburg, *Network Synthesis*, Prentice Hall, 2007.
3. F. F. Kuo, *Network Analysis and Synthesis*, John Wiley and Sons, 1966.
4. S.Seshu and M.B. Reed, *Linear Graphs and Electrical Networks*, Addison Wesley, 1961.
5. N. Balabanian and T.A. Bickart, *Linear Network Theory: Analysis, Properties, Design and Synthesis*, Matrix Publishers, Inc. 1981.
6. L.O. Chua, C.A. Desoer, E.S. Kuh, *Linear and Nonlinear Circuits*, McGraw Hill, 1987.
7. W. H. Hayt Jr., J.E. Kemmerly, *Engineering Circuit Analysis*, McGraw-Hill, 1971.
8. J. A. Edminister, and M. Maqvi, *Theory and Problems of Electric Circuits*, Schaum's Outline Series, TMH.

Subject Code:	ME2003	**Course Title**	Solid Mechanics
Contact Hours	L-2, T-2, P-2	**Credit**	4
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Midterm (25%), Quiz II (15%), Assignment (10%), End term (40%)		

Stress & strain: Tension, compression, shearing stress & strain; Poisson's ratio: stress-strain relationship, Hooke's law; elastic constants and their relations, stress-strain curves, anisotropy & orthotropy, thermal stresses, composite bars. **[08H]**

Members subjected to flexural loads: Theory of simple bending, bending moment and shear force diagrams, relationship between bending moment, shear force and load, flexural relation, bending stresses, section modulus and transverse shear stress distribution. **[08H]**

Deflection of Beams: Differential Equations of the Deflection Curve, Deflections by Integration of the Bending-Moment Equation, Deflections by Integration of the Shear-Force and Load Equations, Method of Superposition, Moment-Area Method, Discontinuity Functions, Use of Discontinuity Functions in Determining Beam Deflections. **[08H]**

Principal Stress and Strain: Principal planes, stresses & strains, maximum normal &shear stresses, Mohr's circle of stress & strain. **[05H]**

Torsion: Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity. **[05H]**

Theories of Elastic Failures: The necessity for a theory, different theories, significance and comparison. **[04H]**

Buckling: Buckling and Stability, Columns with Pinned Ends, Columns with Other Support Conditions. **[04H]**

Text/Reference books:

1. Beer and Johnston , “Mechanics of Materials”, 5th Edition, McGraw Hill
2. James M. Gere, “Mechanics of Materials”, 6th Edition, Thomson Learning Inc.
3. Shames and Pitarresi, Introduction to Solid Mechanics, PHI

Subject Code:	SM2003	**Course Title**	Solid Mechanics + Design of Mechanical Components
Contact Hours	L-3,T-1,P-2		
Programme	B.Tech	**Credit**	4
Pre-requisites	NIL	**Semester**	III
Evaluation scheme	20% Assignment/ Quiz, 20% Mid Sem, 40% End Term, 20% Lab+ Project		

Learning Objective: This course will introduce concepts of stress and strain and designing of mechanical components

Course Detail:

Introduction to Design: **[02H]**

Design requirements, factor of safety, steps in mechanical engineering design

Stress & strain : **[06H]**

Tension, compression, shearing stress & strain; Poisson's ratio stress-strain relationship. Hooke's law, elastic constants and their relations, stress-strain curves, anisotropy & orthotropy, thermal stresses, composite bars

Members subjected to flexural loads: **[06H]**

Theory of simple bending, bending moment and shear force diagrams, relationship between bending moment, shear force and load, flexural relation bending stresses section modulus and transverse shear stress distribution

Design for Simple Stress : **[06H]**

Design of Cotter and Knuckle Joint Design of Bolted Joints and levers. Design of leaf spring

Principal Stress and Strain: **[04H]**

Principal planes, stresses & strains, maximum normal & shear stresses, Mohr's circle of stress & strain

Torsion and combined loading: **[10H]**

Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity Design of Shafts, keys and Coupling helical torsion spring

Theories of Elastic Failures: **[04H]**

The necessity for a theory, different theories, significance and comparison

Design for variable loading: **[04H]**

Concept of variable loading, designing component under variable loading

Lab experiments

1 To perform tensile test on steel and cast iron and compare the results

2. To Perform compression and shear test on steel bar and determine compressive strength, shear strength and bending strength of the bar

3. To perform bending test on a beam.

4. To determine the bending stress & strain in a cantilever beam, using resistance strain gauges.

5.To determine the Brinell Hardness/ Rockwell Hardness number for the given specimen

6. To determine the energy absorbed by the given specimen by Izod impact Test and Charpy Impact Test.

7. To study the effect of cantilever loading on standard rotating bending specimen, also study the characteristics of S-N curve for ferrous materials.

8. To perform torsion test on a wire.

9. 12 Project work

Text Books:

1. Popov EP, Engineering Mechanics of Solid. Pearson Ed
2. Shames and Pitarresi, Introduction to Solid Mechanics, PHI
3. Shigley J. "Mechanical Engineering Design"TMH, 6th Edition 2003
4. Bhandari V., "Design of Machine Elements", TMH, 2nd Edition, 2007
5. PSG Data Handbook

Reference Books:

1. Beer, Johnson and Dewolf, Mechanics of Materials", TMH

2. Kazimi, Solid Mechanics, TMH
3. Nash, Theory and problems of Strength of Materials (Schaum's Outline Series), TMH
4. Sarkar B., Strength of Materials, TMH
5. Hibbler R.C. Mechanics of Materials, Pearson
6. Timoshenko and Young, Elements of Strength of Materials, MGH
7. Crandall Dahl and Lardner, An Introduction to the Mechanics of Solids, MGH
8. Juvinall RC and Marshek K.M. "Fundamentals

Subject Code:	EC204a	**Course Title**	Electronics Devices and Circuits
Contact Hours	L-2, T-0, P-0	**Credit**	2
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%), End term (40%), lab (20%)		

Review of theory of semiconductor, PN junction diode theory, contact potential and current components, energy band diagram for PN Junction, Diode I-V Characteristics, breakdown voltage and leakage current Diode applications rectifier half wave and full wave with filter design, clipping and clamping circuit analysis and design, Special purpose diodes zener diode and its application for regulator, varactor diode, PIN diode, tunnel diode, photodiode, Schottkey barrier diode and LED. **[10H]**

Junction field effect transistor (JFET), device structure and physical operation, IV characteristics, n-channel and p-channel JFET, Biasing and small signal analysis and JEFT applications as voltage amplifier. MOSFET basics, the inversion cannel formation, the derivation of the IV characterises, triode region and saturation region operation, body effect and channel length modulation, Modeling of the MOSFET, Basing, Common source, common drain, and common gate configurations. MOSFET as an amplifier and as a Switch, Single stage MOS Amplifier, MOSFET small signal model for analysis of single stage amplifier, high frequency MOSFET model and frequency response, Current mirror, differential amplifier using MOSFET. **[15H]**

Operation of BJT, Current Components, currents gains α and β, BJT Biasing and Q point & Regions of Operation, Bias Stability, Transistor in CB, CE, CC configuration, Transistor leakage current I_{CBO} and I_{CEO} and breakdowns.Introduction to amplifiers, RC Coupled amplifiers, frequency response, Transistor re Model, Transistor H parameter, BJT Small Signal Analysis, BJT and FET High frequency modelling, Transistor as a switch and power dissipation in the transistor. **[10H]**

Feedback Amplifiers, Oscillators (Different types), Differential Amplifiers, power amplifier, Operational Amplifiers and its Applications. Logic Families using BJT and MOSFET for Digital Applications. **[07H]**

Laboratory Experiments

1. Introduction to laboratory equipment
2. Clipping and Clamping Circuits Design and analysis
3. Rectifier full wave with filter design
4. Zerner regulator design and analysis
5. JFET characteristics and Baising
6. BJT as switch performance and measurments and verification by simulations tools (pSpice)
7. RC coupled amplifier design and analysis small sigal and high frequency Lab and pSpice
8. MOSFET characterstics and various baising
9. Single stage MOS Amplifier CS, CD and CG and Cascode stages
10. Current mirror using BJT and MOSFET

Text/Reference books:

1. Electronic Circuits Analysis and Design, Donald Neamen.
2. Microelectronics Circuits 5th Edition BySedra and Smith Oxford Publication
3. Electronic Devices and Circuits David A Bell. Oxford Publication
4. Integrated Electronics: Analog and Digital Circuits and Systems, Millman Jacob and Halkias, Christos C. ,McGraw Hill 2004
5. Electronics Device and Circuit TheoryBoylestad,Robert L. and NashelskyLouis,Ninth Edition, Printice Hall of India 2005

Subject Code:	EC204b	**Course Title**	Instrumentation and Measurement
Contact Hours	L-2, T-0, P-0	**Credit**	2
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%), End term (40%), lab (20%)		

Course Detail:

Basic terminologies (range, span, settling time dead zone, input impedance), Static and Dynamic characteristics, first order and second order instruments with step, ramp and sinusoidal input, output characteristics. **[05H]**

Strain gauge, derivation of gauge factor, strain gauge rosette, unbalanced wheatstone bridge, AC bridges for capacitance, inductance, phase and frequency measurement. Ultrasonic and its applications for measurement of flow, displacement and non-destructive testing. **[05H]**

LVDT, phase compensation, phase sensitive demodulation, thermistor and its linearization, RTD, its construction, three wire and four wire method Muller bridge, Thermocouple, their relative comparison, cold junction compensation using AD590, grounded thermocouple, potentiometer as displacement sensor, Capacitance as displacement and level transducer, push pull arrangement, Pressure transducer [Bourdon gauge, diaphragm gauge (metal and semiconductor) etc]. **[08H]**

Signal Conditioning Circuits, Quantization, Resolution, Sample and Hold Circuits, Analog (Successive Approximation, Ramp, and Flash) and Digital (R-2R, Binary weighted) Converters. **[04H]**

Text/Reference books:

1. Measurement Systems Application and Design, Ernest O. Doebelin, McGraw-Hill
2. Principles of Industrial Instrumentation,2e. Front Cover. Patranabis. Tata McGraw-Hill
3. Clarence W de Silva, MECHATRONICS - An Integrated Approach, CRC Press
4. Alan S Morris, Measurement and Instrumentation Principles, Butterworth-Heinemann

Subject Code:	ME2004	**Course Title**	Engineering Thermodynamics
Contact Hours	L-3, T-2, P-0	**Credit**	4
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Quiz II (10%), Midterm (20%), Quiz III (10%), Assignment (10%), End term (40%)		

Course Detail :

Introduction to Thermodynamics, Systems, Properties, State of a system. Thermodynamic Equilibrium, Processes; Zeroth law of thermodynamics, Ideal Gas, Work and Heat Transfer, Principles of Energy Conversion, Energy Interactions, First Law, Energy Transport Mechanisms, Point and Path Function,

Internal Energy. **[12H]**

First Law applied to various Processes; Constant Volume, Constant Pressure, Isothermal, Reversible-adiabatic, etc.; Applications of First Law to Flow and Non-flow Processes. **[12H]**

Second Law of Thermodynamics, Kelvin-Planck and Clausius statements; Carnot theorem; Available Energy, Entropy, Heat Engine, Heat Pump. **[12H]**

Applications: Gas Power Cycles, Otto, Diesel and Brayton; Vapour Power Cycles, Rankine Cycle, Power Plant Operation; Refrigeration Cycles. **[12H]**

Text/Reference books:

1. Fundamentals of Thermodynamics by Sonntag (Wiley)
2. Fundamentals of Engineering Thermodynamics by Moran and Shapiro (Wiley)
3. Thermodynamics: An Engineering Approach by Cengel and Boles (TMH)
4. Engineering Thermodynamics by P K Nag (TMH)

Subject Code:	NS2001	**Course Title**	Biology for Engineers
Contact Hours	L-2, T-0, P-0	**Credit**	2
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		

Evaluation scheme

Course Detail :

Cells, Cellular Organelles, Nucleic Acids (DNA, RNA structure and function), Proteins- Different levels of structures, Folding and mis-folding, Protein Purification techniques; Enzymes, Carbohydrates, Lipids & Lipid membranes, Drug Discovery. Topics would emphasize importance of biomolecule vis-à-vis numerous every day applications.

Text/Reference books:

1. Berg, J. M., Tymoczko, J.L., and Stryer, L., Biochemistry, W.H. Freeman & Company, 6th edition, 2006.
2. Alberts, B., Alexander, J., Lewis, J., Raff, M., Roberts, K., Walter, P., Molecular Biology of the Cell, 6th edition, Garland Science Publishing, 2007.
3. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level, Publisher : Wiley; 5th edition (29 February 2016)

IT Workhop I

Subject Code:	IT2E01	**Course Title**	Matlab and Simulink, Pspice
Contact Hours	L-0, T-0, P-2	**Credit**	2
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Lab Assignments (20%), Quiz (20%) End-Term (60%)		

Learning Objective: Learning the software tools MATLAB, Simulink and Pspice for solving and applying on electronic circuits.

Course Detail :

MATLAB

Introduction of MATLAB,

Basic Operation of Differentiation, Integration, Linear Equations, matrix operations to solve system of linear equations, Convolution with practical application

Plotting Functions: Plot subplot, Histogram, bar chart, curve fitting

Logical Operators and Functions, Graphical User Interface

Signals processing tool box, Impulse, step, and response of LTI systems.

Fourier transform and Laplace Transform

Simulink

Building simple Simulink simulations.

Running Simulink simulation to predict a system's behaviour.

PSpice

Introduction to PSpice and components, Simple Dependent Sources, Transient Analysis, Steady State AC Analysis with the transistor, Simulation of Transistor as an amplifier in CE,CB and CC mode, Frequency Response, Special Sources, Pulse Sources, SIN Sources, Voltage & Current Controlled Switches, Sub-circuits with Op-amp examples with PSpice,

Text/Reference books:

Subject Code	DS2005	**Course Title**	Studies in Form
Contact Hours	L-2, T-0, P-2	**Credit**	3
Programme	B.Des	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Simple geometric form, complex forms, nature and form, human figure, space and form, color and form etc. **[07H Lecture,+3H Lab]**

To appreciate and articulate the language of form, to sensitize students towards manipulation of forms in 2D and 3D also Form integration and transition. **[07H Lecture,+3H Lab]**

Experiment with different aspect of forms; understand nature and structure of form, basic techniques of Form. **[07H Lecture,+3H Lab]**

Manipulation and their applications to generate Forms and Shapes with desirable objects. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Hann, M. (2013). Structure and Form in Design: Critical Ideas for Creative Practice. A&C Black.

2. Warell, A. (2001). Design Syntactics: A functional approach to visual product form Theory, Models, and Methods. Chalmers University of Technology.

3. Boden, M. A. (2012). Creativity and art: three roads to surprise.

Subject Code	DS2006	**Course Title**	Industrial Design 1
Contact Hours	L-2, T-0, P-2	**Credit**	3
Programme	B.Des	**Semester**	III
Pre-requisites	NIL		

Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)

Simple products, product color and aesthetics. **[07H Lecture,+3H Lab]**

Simple products, Design from consumers point of view, product language**.** **[07H Lecture,+3H Lab]**

Aesthetic aspect, functionality, product semantic, meaning of sign and symbol, product analysis, product form and psychology**.** **[07H Lecture,+3H Lab]**

White goods, medical products, complex products etc. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Heufler, G. (2004). Design basics. NiggliVerlag.
2. Bramston, D. (2010). Basics Product Design 03: Visual Conversations (Vol. 3). AVA Publishing.
3. Bramston, D. (2008). Basics Product Design 01: Idea Searching (Vol. 1). AVA Publishing.
4. Cuffaro, D&Zaksenberg, I (2013) The Industrial Design Reference & Specification Book.

Subject Code	DS2007	**Course Title**	Communication Design 1
Contact Hours	L-2, T-0, P-2	**Credit**	3
Programme	B.Des	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Communication basics, semiotics, semantics, and typography and: Introduction to Communication Design. **[07H Lecture,+3H Lab]**

Effective Communication, Human Perception, Aesthetics, Emotion and Subjectivity, Visual Perception and Cognition: Human Eye, Optical Illusion, Color Perception, Depth Perception, Motion Perception. **[07H Lecture,+3H Lab]**

Visual Language: Semiotics - Semantics, Syntactic, Pragmatics, Sign - Design of Icon, Index, Symbol and Logo. Visual Hierarchy: Visual Focal, Visual Order, Eye Movement, Visual Flow and Continuity, Visual Composition **[07H Lecture,+3H Lab]**

Information Design: Information Chunking, Grids, Visual Abstraction of Quantitative information, Application of Gestalt Laws of grouping, Information Graphics. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Malamed, C. (2011). Visual language for designers: principles for creating graphics that people understand. Rockport Pub.
2. Arnheim, R. (1969). Visual thinking. Univ of California Press.
3. Bertin, J. (1981). Graphics and graphic information processing. Walter de Gruyter.
4. Barry, A. M. (1997). Visual intelligence: Perception, image, and manipulation in visual communication.SUNY Press
5. Meirelles, I. (2013). Design for information: an introduction to the histories, theories, and best practices behind effective information visualizations. Rockport publishers.
6. Krum, R. (2013). Cool infographics: Effective communication with data visualization and design. John Wiley & Sons.

OE1 Choose any one course from below electives

Subject Code:	OE2E01	**Course Title**	Sensors and Actuators
Contact Hours	L-0, T-0, P-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%), End term (30%) Lab (30%)		

1. Introduction: Classification of sensors and actuators, sensing and actuating strategies, general requirements for interfacing and actuation, sensing, transduction, actuation. **[02H]**

2. Performance Characteristics of Sensors and Actuators: Input/output characteristics, accuracy, errors, repeatability, sensitivity analysis, hysteresis, Nonlinearity, saturation, frequency response, dynamic characteristics, calibration, resolution, excitation, impedance, applications. **[03H]**

3. Temperature Sensors and Thermal Actuators: Thermoresistive sensors: Thermistors, Resistance temperature sensors, Silicon resistive sensors, Thermoelectric sensors, PN junction temperature sensors, Optical and acoustic temperature sensor. **[03H]**

4. Optical sensors: Photodiodes, phototransistors and photoresistors based sensors, Photomultipliers, light- to-light detectors, infrared sensors (thermal, PIR, AFIR, thermopiles), CCD sensors and detectors. **[03H]**

5. Electric and Magnetic Sensors and Actuators: Motors as actuators (linear, rotational, stepping motors), magnetic valves, inductive sensors (eddy current, LVDT, RVDT, Proximity), Hall Effect sensors, Magnetoresistive sensors, Magnetostrictive sensors and actuators, Magnetometers (fluxgate, search-coil, Squid), Voice coil actuators (speakers and speaker-like actuators), Bolometers (microwaves). **[04H]**

6. Mechanical Sensors and Actuators: Accelerometers (capacitive, piezoelectric, piezoresistive, thermal), Force sensors (strain gauges, tactile sensors), Pressure sensors (semiconductor, piezoresistive, capacitive, VRP), Gyroscopes (mechanical, optical, fiber-optics). **[05H]**

7. Acoustic Sensors and Actuators: Ultrasonic sensors (piezoelectric, electromagnetic), Piezoelectric actuators, Piezoelectric Resonators, Microphones, hydrophones, speakers, buzzers. **[03H]**

8. MEMs and Smart Sensors: Micro-Electro-Mechanical (MEMs) Sensors and Actuators, Smart sensors, ASIC based sensors, Wireless Sensors and Issues Associated with Wireless Sensors, Sensor Arrays). **[03H]**

9. **Interfacing Methods and Circuits:** Amplifiers: operational amplifiers, power amplifiers, A/D and D/A converters, bridge circuits, interfacing to microprocessors, data transmission, excitation methods and circuits, Power requirements, signal translation, isolation, noise, interference, compensation (Temperature, drift, etc.). **[02H]**

Lab work

1. Experiment on Strain Gauge.
2. Experiment on LVDT.
3. Digital-to-Analog converter using R-2R & Binary.
4. Experiment on Optical Transducer.
5. Study of H-Bridge & design using Transistors.
6. Study of PWM (Pulse Width Modulation) & its use to control the speed of a DC Motor.
7. Study of Stepper Motor & its control circuit.
8. Study of Servo Motor & its control circuit.
9. Assembly of Speaker (Study of Voice Coil Actuator).
10. Experiment on Basic Op-Amp Circuit & its use as comparator.
11. Demonstration of Piezoelectric Actuation.

12. Construction of Project.

Text/Reference books:

1. Ida, N., Sensors, Actuators, and their Interfaces; Scitech Publishing
2. deSilva, Sensors and Actuators: Control System Instrumentation, CRC Press

Subject Code:	OE2E02	**Course Title**	Probability and Random Processes
Contact Hours	L-0, T-0, P-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	10 % (Quiz 1), 20% Mid Sem, 10 % (Quiz 2), 40% End Sem, 20% Project		

Learning Objective: Basics of probability to design and study probabilistic models

Course Detail :

Introduction to probability: mathematical background - sets, set operations, sigma and Borel fields; classical, relative-frequency and axiomatic definitions of probability; conditional probability, independence, total probability, Bayes' rule; repeated trials; random variables: cumulative distribution function, continuous, discrete and mixed random variables, probability mass function, probability density functions**.** **[10H]**

Functions of a random variable; expectation - mean, variance and moments; characteristic and moment-generating functions; Chebyshev, Markov and Chernoff bounds; special random variables-Bernoulli, binomial, Poisson, uniform, Gaussian and Rayleigh; joint distribution and density functions; Bayes' rule for continuous and mixed random variables; joint moments, conditional expectation**.** **[10H]**

Covariance and correlation- independent, uncorrelated and orthogonal random variables; function of two random variables; sum of two independent random variables; random vector- mean vector and covariance matrix, multivariate Gaussian distribution; sequence of random variables: almost sure and mean-square convergences, convergences in probability and in distribution, laws of large numbers, central limit theorem; elements of estimation theory- linear minimum mean-square error and orthogonality principle. **[10H]**

Random process: discrete and continuous time processes; probabilistic structure of a random process; mean, autocorrelation and autocovariance functions; stationarity- strict-sense stationary and wide-sense stationary (WSS) processes: autocorrelation and cross-correlation functions; time averages and ergodicity; spectral representation of a real WSS process-power spectral density, cross-power spectral density, linear time-invariant systems with WSS process as an input- time and frequency domain analyses; spectral factorization theorem; examples of random processes: white noise, Gaussian, Poisson and Markov processes**.** **[10H]**

Text books:

1. Probability & Random Processes by Grimmett & Stirzaker Fourth Edition, 2018.
2. Adventures in Stochastic Processes by Resnick Springer, 2013.

Reference books:

1. An Introduction to Stochastic Modeling by Taylor and Karlin, third edition Academic Press, 2011.

Subject Code:	OE2N05	**Course Title**	Complex and Linear Algebra
Contact Hours	L-0, T-0, P-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Mid-Sem-40% End-Sem-60%		

Learning Objective: Intended to familiarize the reader with the basic concepts, principles and methods of Complex analysis and Linear Algebra.

Course Detail : Review of complex numbers and operations, Functions of a Complex Variable, Analytical functions, Cauchy-Reimann equations, Elementary functions, Confonnal mapping.
Contour integrals, Cauchy's Theorem, Residue Theorem, Power series, Taylor and Laurent series, zeroes, poles, essential singularities, evaluation of integrals.
Review of Matrices Algebra, Solution of Matrices Equation, Row reduced Echelon form, Determinant, Kramer's rule.
Vector spaces, subspaces, basis, Orthogonal basis, Gram-Schmidt orthogonalization, Linear Operators, Matrix representation, Rank, Solution of Linear equations using matrices (invertibility, null space etc.), Eigenvalues, eigenvectors, diagonalisability, Symmetric systems, Positive definite.

Text/Reference books:

1. Kreysig E., "Advanced Engineering Mathematics",Wiley, 9th ed, 2006.
2. Brown and Churchil, Complex Variables and Applications, McGraw Hill, 7th ed,2014
3. Hoffman Kunze, Linear Algebra, 2nd ed, Prentice Hall, Inc.
4. S. Ponnusamy, Foundation of Complex Analysis, 2nd Ed,Narosa

Subject Code:	OE2N06	**Course Title**	Material Science
Contact Hours	L-0, T-0, P-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%), End term (40%), lab (20%)		

1. Overview of Materials and their applications. Bonding in materials. Crystal systems, packing fraction, nearest neighbour, concept of Bravais Lattice and unit cell. Miller indices in crystalline materials. Defects in crystalline materials, single crystals, poly-crystals and amorphous materials. **[12H]**

2. Band theory of solids, conductors, semiconductors and insulators, intrinsic and extrinsic semiconductors, electrical conduction, effect of temperature on conductivity. Heat capacity and thermal conductivity. Stress-strain diagram, elastic and plastic deformation, yield strength, tensile strength, elongation, modulus of elasticity, ductile and brittle fracture. **[10H]**

3. Diffusion in solids, Fick's laws and technological application of diffusion. Phase Diagrams of engineering materials; Solidification; Diffusion assisted and diffusion less solid-state phase transformations, Applications and Properties of Ceramic, Polymers and also of their Composite Materials. **[10L]**

4. Magnetic materials and their properties, magnetic hysterisis. Elements of superconductivity, Meissener's effect, type-I, type-II semiconductors, BCS Theory. Introduction to nanotechnology, 0D, 1D and 2-D materials, nanoribbons. Advance applications of nanomaterials including spintronics. **[10H]**

Text/Reference books:

1. Callister, "Materials Science and Engineering" Wiley.
2. Smith,William, "Foundations of Materials Science And Engineering", Mc Graw Hill. 3. V. Raghvan, "Materials Science and Engineering".
3. Poole and Owens "Introduction to nanotechnology", Wiley.

Subject Code:	OE2D11	**Course Title**	Design Thinking
Contact Hours	L-2, T-0, P-2	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme			

Course Detail :

1. Design history, how design thinking is different from technical thinking.
2. What is Design Thinking? Styles of Design Thinking.
3. Goal Seeking and Setting Research, Understanding Context, Visual Mapping and Resource Mapping, Categories and Trends Compositions and Judgments.
4. Opportunity Mapping and Scenario Visualization, Communications and Reflection, Presentations with Business Models.

Text/Reference books:

1. Rowe, P. G. (1991). Design thinking. MIT press.
2. Lockwood, T. (2010). Design Thinking: Integrating Innovation, Customer Experience, and Brand Value. Sky horse Publishing, Inc.
3. Plattner, H., Meinel, C., & Leifer, L. (Eds.). (2010). Design Thinking: Understand–Improve–Apply. Springer Science & Business Media.
4. Schneider, J., & Stickdorn, M. (2011). This is Service Design Thinking: Basics, Tools, Cases. Wiley.

Subject Code:	OE2D14	**Course Title**	Science and Culture a comparison
Contact Hours	L-0, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	III
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (30%), Quiz II (10%), End term (50%)		

Science and Humanities.

1. Magnifying and Classifying in Science, Linear approach to thought in Science, Hierarchical and Horizontal linkages to development through Science **[11L]**
2. Synthesis and Transformation in Cultural Progress, Concentric approach to thought in Humanities, Concentric Context to development and Culture **[11L]**
3. Indian Intellectual Traditions Unity in Diversity- From Unity to Multiplicity, Upanishads and 21st Century- Vision and Pluralism, Concept of holiness in a World of Conflict, The Spirit in Human Being, Progress in Science, Progress in Humanities. **[20L]**

Text/Reference books:

1. Progress and Values in the Humanities- Volney Gay- Columbia University, New York.
2. A Cultural History of India- A.L.Basham
3. India's Intellectual Traditions- World Association for Vedic Studies

B.Tech Semester-IV

Subject Code:	CS2005	**Course Title**	Language Theory
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quiz /Assignments (25%), Midterm (30%), End term (45%)		

Introduction of Automata, Computability, and Complexity; Mathematical notations and terminology; Finding proofs and types of proofs. **[04H]**

Finite Automata and regular languages: Formal definitions, Designing finite automata, Deterministic finite automata, Non-deterministic finite automata, Equivalence of NFAs and DFAs, finite automata with epsilon-transition; regular expressions and languages, Properties of Regular languages, conversion of RE to FA and vice versa. Pumping Lemma. **[10H]**

Push down Automata and Context free languages: Context free grammars, Designing context free grammar, Ambiguity in CFG and its removal, Chomsky normal form. Push down Automata: formal definition, graphical notations, Languages accepted by PDA, Equivalence of PDA and CFG, Non-context free languages, Pumping Lemma for CFGs. **[10H]**

Turing Machines and Computability: Formal definition of Turing machines with examples, Variants of Turing machines, **[06H]**

Decidability, un-decidability and reducibility: Decidable languages; Decidable problems concerning regular languages and context free languages, The halting problem, Post correspondence problems, Undecidable problems. **[08H]**

Computational Complexity & NP-Completeness: The class P, The class NP, Reductions, The class NP-Complete, Dealing with NP-Completeness. **[04H]**

Text/Reference books:

1. J. H. Hopcroft, R, Motwani, J. D. Ullman, Introduction to Automata Theory, Languages, and Computation, Third Edition, Pearson Education Inc., New Delhi
2. M. Sipser, Introduction to the Theory of Computation, Third Edition, Cengage Learning India Pvt. Ltd.

Subject Code:	EC2005	**Course Title**	Digital Signal Processing
Contact Hours	L-3, T-0, P-2	**Credit**	4
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Midterm (20%), Quiz II (10%), End term (40%) Practical (20%)		

Course Detail-

Module 1

Time-Domain representation & Characterization of LTI systems, Impulse response representation, Convolution integral & Convolution sum, properties of LTI systems, Stability criteria for LTI systems, Elements of Continuous time & Discrete-time LTI systems. Classification of LTI system: FIR and IIR, Recursive & nonrecursive system, LTI-DT systems -Characterization using difference equation, modelling of difference equation, Frequency Analysis of LTI Systems Frequency domain Characteristics of LTI Systems, Correlation functions and spectra at output of LTI systems. **[10H]**

Module 2

Discrete Fourier Transform and Computation DFT and its properties, Relation between DTFT and DFT, Linear filtering methods using DFT: Linear filtering as DFT, Filtering of long sequences: Overlap-add and save methods Frequency analysis of signals using DFT, FFT computations using Decimation in time and Decimation in frequency algorithms, radix 2-Butterfly structure, implementation of DFT as linear filtering: Goertzel algorithm, and Chirp algorithm. **[09H]**

Module 3

Design of Digital Filters FIR design: Windowing Techniques -Need and choice of windows -Linear phase characteristics. IIR design: Analog filter design -Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation Warping, prewarping - Frequency transformation **[09H]**

Module 4

Realization of Digital Filters & IIR filter realization: Direct form-I, direct form-II, and Parallel & cascade forms. Finite word length effects in FIR and IIR digital filters: Quantization, round off errors and overflow errors, Overview of DSP processors. **[07H]**

Module 5

Application of signal processing Applications of digital signal processing: Speech Processing: speech analysis, speech coding, subband coding, ECG processing. **[07H]**

Text Books/ Reference books:

1. John G.Proakis, Dimitris G. Manobakis, Digital Signal Processing, Principles, Algorithms and Applications, Third edition, (2000) PHI
2. S. K. Mitra, Digital Signal Processing: A Computer Based Approach, Tata McGraw Hill, 2006.
3. P. P. Vaidyanathan, Multirate systems and filter banks, Prentice Hall, 1993.
4. A. V. Oppenheim and R. W. Sehafer, Discrete Time Signal Processing, Prentice Hall, (1989).
5. Emmanuel C Ifeachor, Barrie W Jrevis, Digital Signal Processing, Pearson Education.

Experiments/ Practical:

1. Write a MATLAB script to plot common continuous time and discrete time signals.
2. Write a MATLAB program to demonstrate basic operations on signals.
3. Write a MATLAB script for finding the even and odd parts of signal and real and imaginary part of signal
4. Write MATLAB script to test to implement a digital system and test for following properties. a. Linearity b. Time Invariance
5. Write MATLAB script to plot magnitude and phase response of a system and also plot its poles and zeros and test its stability.
6. Using MATLAB analyse a constant coefficient difference equation and plot following. a. Impulse Response b. Step Response c. Output of system for arbitrary input
7. Write a MATLAB function to compute N-point DFT and IDFT, validate the result using inbuilt MATLAB functions to compute DFT/IDFT.
8. Write MATLAB script to validate following DFT properties. a. Linearity Property b. Circular Shift c. Circular Shift Property d. Time Reversal Property e. Convolution Property
9. Write MATLAB script to perform circular convolution. Validate the result using system function.
10. Write a MATLAB script to design different types of FIR filters explain with an application of filter.
11. Write a MATLAB script to design different types of IIR filters.
12. Write a MATLAB script to design different windowing techniques and its frequency response.

Subject Code	ME2005	**Course Title**	Engineering Materials and Characterization
Contact Hours	L- 3 , T- 0 ,P- 0		
Program	B.Tech	**Credit**	3
Pre-Requisites	None	**Semester**	IV
Evaluation scheme	**Quiz I (10%), Midterm (30%), Quiz II (10%), End term (50%)**		

Learning Objective: Teach students about materials used in engineering applications

Course Detail :

1. Engineering Materials and Their Properties; The Price and Availability of Materials; The Elastic Moduli; The Physical Basis of Young's Modulus; Yield Strength, Tensile Strength, and Ductility; Strengthening Methods and Plasticity of Polycrystals, Material Testing. **[05H]**
2. Fast Fracture and Toughness; Fatigue Failure; Creep, Material Testing. **[04H]**
3. Metals; Time–Temperature–Transformation Diagram; Fine-Grained Castings; Single Crystals for Semiconductors; Amorphous Metals; Light Alloys; Processing Metals; Heat Treatment **[07H]**
4. Ceramics; Ceramic Composites; Mechanical Properties of Ceramics; Production of Engineering Ceramics; Material Testing and Applications. **[04H]**
5. Polymers; Mechanical Properties of Polymers; Processing Polymers; Material Testing and Applications. **[05H]**
6. Composites; Properties of Composites and Foams; Processing of composites; Basic Mechanics of Composites; Material Testing and Applications. **[03H]**

Text/Reference books:

1. DRH Jones and M Ashby, Engineering Materials 1 4th Ed., Butterworth-Heinemann
2. DRH Jones and M Ashby, Engineering Materials 2 4th Ed., Butterworth-Heinemann
3. NE Dowling, Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue, 3rd Ed., Pearson
4. Callister, Materials Science and Engineering, 8th Ed., John Wiley & Sons Inc.

Subject Code:	CS2006	**Course Title**	Operating System
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid term (30%), Quiz II (15%), End term (40%)		

Operating systems for mainframe and desktops: A Historical Overview, Batch OS, Multiprogramming OS, Time sharing OS, Multiprocessor and Distributed systems, Clustered systems, Real Time Systems. **[02H]**

Operating system structure: OS services, system calls, System programs, System structure, Virtual machines. **[04H]**

Process Management: Process concept, Process scheduling, Operations on processes, Threads. **[03H]**

CPU Scheduling: Scheduling Criteria, Scheduling algorithms, Multiprocessor scheduling, Real time scheduling, Thread scheduling. **[04H]**

Inter process communication: Cooperating processes, The Critical Section problem, Two tasks solutions, Semaphores, Classical synchronization. **[04H]**

Deadlocks: Characterization, Methods for handling deadlocks, Prevention, avoidance and detection, Recovery. **[03H]**

Memory management: Background, swapping, Contiguous memory allocation, Paging and segmentation, Virtual memory, Demand paging, Page replacement, thrashing. **[10H]**

File system management: File concept, Access method, Directory structure, File System mounting, File sharing, Allocation methods, Protection. **[04H]**

Mass storage structure and management: Disk structure, Disk scheduling and Management, Swap space management, RAID structure. **[04H]**

Protection and Security: Goals, Domain of protection, Access matrix, Capability based systems, Security problems, User authentication, Program threats and system threats **[04H]**

Text/Reference books:

1. A. Silberschatz, B. P. Galvin, G. Gagne, Operating System, 6th Edition, John Wiley & Sons Inc., 2004
2. W. Stalling, Operating System, 6th edition, Pearson Education, 2009

Subject Code	EC2006	**Course Title**	Control Systems
Contact Hours	L- 3, T- 0 ,P-2	**Credit**	4
Programme	BTech	**Semester**	IV
Pre-requisites	Basic Electronics		
Evaluation scheme	Lab: (40%) Quiz I (20 %), Midterm (40 %),		

Module 1

Introduction: Terminology and basic structure, feedback control theory, multivariable systems

Modelling of physical systems: Transfer function and state- variable models; block diagram reductions, signal flow graph and Masons gain formula.

Time Domain Analysis: Time response of first and second order systems, steady state errors. **[10H]**

Module 2

Control System Characteristics: Stability, sensitivity, steady-state accuracy

Stability Analysis: Routh-Hurwitz test, relative stability, Root locus, Bode Plot Polar plot and Nyquist plots. **[10H]**

Module 3

Controller Design: PID Controller, Lead Lag Compensator

Discreate Domain: The z-transform and Inverse z-transform, Pulse Transfer Function, z- and s-domain Relationship, Stability**.** **[10H]**

Module 4 State Variable Methods: Concepts of state variables and state model - state models for linear continuous-time and Discrete Systems, solution of state equations for continuous and discrete systems , concepts of controllability and observability, Pole placement by State Feedback. **[10H]**

Lab:

1. Matlab Fundamentals
2. Simulink Fundamentals
3. Control Toolbox
4. Process Control Simulator
5. Lead/Lag Compensator
6. Relay Control System
7. AC servo Control
8. DC servo Control
9. Frequency Response Analysis
10. Case study

Text Books:

1. K. Ogata, Modern Control Engineering, Prentice Hall India, 2006.

Reference books:

1. I. J. Nagrath and M. Gopal, Control System Engineering, New age International, 5th edition, 2008.
2. B. C. Kuo, Automatic Control Systems, Prentice-hall of India, 7th edition, 2000.
3. M Gopal, Digital Control and state variable methods, Tata MacGraw-Hill, 2nd edition, 2003

Subject Code:	ME2006	**Course Title**	Kinematics and Dynamics of Machine
Contact Hours	L-3, T-1, L-2,		
Programme	B.Tech	**Credit**	4
Pre-requisites	NIL	**Semester**	IV
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%), End term (40%), lab (20%)		

Course Detail :

1. **KINEMATICS** : Plain motion, kinematic concepts of links; basic terminology and definitions; inversion of kinematic chains, absolute and relative motion, kinematics and structure diagrams, equivalent linkages, vector diagram, displacement, velocity and acceleration polygons, analysis, instantaneous centres, special graphical methods for slider crank mechanism. **[08H]**
2. **KINEMATIC SYNTHESIS OF MECHANISMS** : Introduction, Movability of four bar linkage, Function Generation, path generation, motion generation, Errors in synthesis problems, Chebyshev spacing of precision points. **[06H]**
3. **GEARS :** Fundamental law of gearing, classification and basic terminology, involute tooth profile and its kinematic considerations, type of gears, standards in tooth forms, gear trains, simple, compound, reverted and epicyclic gear trains. **[08H]**
4. **CAMS :** Classification of Followers and Cams, Terms used in Radial Cams, Cam Mechanism and its Uses, Displacement,Velocity and Acceleration Diagrams, When the Follower Moves With Uniform Velocity, Simple Harmonic Motion, Uniform Acceleration and Retardation and Cycloid Motion, Construction of Cam Profile for a Radial Cam, Operating a Knife Edge, Roller and Flat Faced Follower. **[05H]**
5. **GOVERNORS :** Functions, Difference between Governor and Flywheel, Various Terms Used, Types of Governor-Watt, Porter,Proell & Hartnell; Inertia Governor, Sensitiveness and Stability of Governor; Isochronous Governor, Hunting, Effort and Power ofa Porter Governor, Controlling Force Diagrams For Porter and Spring Controlled Governor, Coefficient of Insensitiveness. **[04H]**
6. **TURNING MOMENT AND FLYWHEEL :** Turning Moment Diagram for a Four Stroke Cycle I.C. Engine and Multi Cylinder Engine, Fluctuation of Energy and Production of Energy and Co-Efficient of Fluctuation of Energy, Co-Efficient of Fluctuation of Speed, Energy Stored in a Flywheel, Dimensions of the Flywheel Rim, Fly Wheel in Punching Press. **[05H]**
7. **BALANCING OF MACHINERY :** Necessity of Balancing, Static and Dynamic Balancing, Balancing of Rotating Masses in one Plane, In Different Planes -Analytical and Graphical Methods, Partial Unbalanced Primary Force in an Engine, Balancing of Reciprocating Masses, Condition of Balance in Multi Cylinder in Line Engines. Balancing of V Engine. **[06H]**
8. **STAIC AND DYNAMIC FORCE ANALYSIS** : 2 and 3 force members, torque addition, free body diagram, Inertia forces, D'alembert's Principle, offset inertia forces, equivalent force analysis for various mechanisms, matrix method. **[06H]**

Experiments:

Experiment No. 1

1. To study inversions of 4-bar mechanisms, single and double slider crank mechanisms.
2. To study various types of gears and gear trains.
3. To study various types of steering mechanisms.
4. Study jump phenomenon in the cam-follower system.
5. Study of Gyroscopic effect and determination of gyroscopic couple on motorized gyroscope.
6. To perform the experiment for static balancing on static balancing machine.
7. To perform the experiment for dynamic balancing on dynamic balancing machine.
8. To understand the balancing of reciprocating masses.
9. Determine the moment of inertia of connecting rod by compound pendulum method and tri-flair suspension pendulum.

10. To verify the relation $T=2\pi\sqrt{l/g}$ for a simple pendulum.

11. To determine whirling speed of the shaft and study effect of shaft diameter and end conditions on the same.

12. To study the performance characteristics curves, stability and sensitivity of the Governors: Porter, Proell and Hartnell.

13. To study various types of dynamometers.

Text/Reference books:

1. Rattan S.S., .Theory of Machines., TMH
2. Thomas Bevan, .Theory of Machines., CBS
3. Theory of Mechanisms & Machinesby Ghosh & Mallick, EWP
4. John J. Uicker, Jr., Gordon R. Pennock and Joseph E. Sigley (2005), "Theory of Machines and Mechanisms (3rdEd)," Oxford University Press, Indian Edition.
5. K J Waldron and G L Kinzel (2004), "Kinematics, Dynamics and Design of Machinery (2nd Ed)," Wiley

Subject Code:	CS2007	**Course Title**	Design & Analysis of Algorithm
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid term (30%), Quiz II (15%), End term (40%)		

Course Detail :

Models of Computation: space and time complexity measures, lower and upper bounds; Search Trees: TRIE; B+ Trees, Binomial Trees. **[10H]**

Design techniques: the greedy method, divide-and-conquer, dynamic programming, backtracking, branch and bound; examples **[10H]**

Lower bound for sorting; Selection. **[02H]**

Graph Algorithms: connectivity, strong connectivity, bi-connectivity, topological sort, shortest paths, minimum spanning trees, The disjoint set union problem; **[10H]**

String matching; **[02H]**

NP-completeness; Introduction to approximate algorithms and Randomized algorithms. **[08H]**

Text/Reference books:

1. T.H.Cormen, C ELeiserson, R LRivestand C Stein,Introduction to Algorithms, MIT Press.
2. J. Kleinberg and E.Tardos,Algorithm Design, Addison Wesley
3. A.Aho, J. E.Hopcroftand J. D.Ullman,TheDesign and Analysis of Computer Algorithms, Addison-Wesley.
4. S.Sahni,Data Structures, Algorithms and Applicationsin C++, McGraw-Hill.
5. M. T. Goodrich and R.Tamassia,Algorithm Design: Foundations, Analysis and Internet Examples, John Wiley & Sons, 2001.

Subject Code:	EC207a	**Course Title**	AI and its Application
Contact Hours	L-2, T-0, L-0,	**Credit**	2
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail :

Module I

What is AI? AI Concepts, Terminology, and Application Areas, AI: Issues, Concerns and Ethical Considerations, The Future with AI, uninformed search, Heuristic search **[07H]**

Module II

Uncertainty in AI, Uncertainty, Probability, Syntax and Semantics, Inference, Independence and Bayes' Rule, Bayesian Network, Neural Networks, Support Vector Machine **[07H]**

Module III

Classification & Regression, Supervised, Unsupervised and Reinforcement Learning, Theory, concepts and applications **[07H]**

Module IV

Applications of AI: Speech processing, Image Processing, Data Classification **[07H]**

Text/Reference books:

1. Nilsson, N. J., Principles of Artificial Intelligence. Palo Alto, CA: Tioga (1981).
2. S. Rajasekaran and G.A.Vijaylakshmi Pai, Neural Networks Fuzzy Logic, and Genetic Algorithms, Prentice Hall of India, 2003
3. Nilsson, N. J. Artificial Intelligence - A Modern Synthesis. Palo Alto: Morgan Kaufmann. (1998).

Subject Code:	EC207b	**Course Title**	Architecture of Cellular Systems
Contact Hours	L-2, T-0, L-0,	**Credit**	2
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail :

Module 1

Fundamental of Cellular Systems

Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Trunking and grade of service, Coverage and capacity improvement in cellular systems. **[07H]**

Module II

Cellular Network Standards

Second Generation (2G) and Third Generation (2G) cellular networks, Architecture and Technologies of 2G and 3G, TDMA, CDMA. **[07H]**

Module III

4G and Introduction to 5G

4G: Architecture, Technology, LTE. Introduction and system concepts to 5G **[07H]**

Module IV

5G Architecture, 5G radio-access technologies, Interference management, mobility management, and dynamic reconfiguration. **[07H]**

Text Books:

1. T. S. Rappaport, Wireless Communications: Principles and Practice, Pearson Education, 2004.
2. A. Osseiran, J.F. Monserrat and P. Marsch, 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016.

Reference books:

1. Saad Z. Asif, 5G Mobile Communications: Concepts and Technologies, CRC Press, 2019

Subject Code:	ME2007	**Course Title**	Manufacturing Technology
Contact Hours	L-3, T-0, L-2,	**Credit**	4
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quizzes (15%); Mid-sem (35%) and End-sem (45%)		

Course Detail :

Machining and Mechanics of Metal Cutting: **[14H]**

Introduction to orthogonal & oblique cutting; Chip information mechanism; heat generation and cutting tool temperature, tool geometry –ASA, ORS, NRS and relationships, selection of tool angles. Cutting tool material; tool wear; tool life and machinability; surface finish; cutting fluids. Merchant's circle diagram, coefficient of friction, stress, strain and strain rate, shear angle. Lee and Shaffer's Relationship: Friction in Metal cutting-sticking & sliding

Material Removal Processes: **[08H]**

Basic operations of turning, shaping, slotting and planning, drilling and boring, milling. Introduction multi-point cutting tools; twist drill, helical milling cutter. Practical machining operations with machining parameters, force magnitudes, power consumption, material removal rate, time per pass.

Cutting Force Measurement: **[02H]**

Basic methods of measurement, axially loaded members, cantilever beam, rings and octagon, dynamometer requirements machine tool dynamometers.

Economics of Machining: **[04H]**

Cutting parameters for minimum production cost criteria; maximum production and profit rate criterion. Restrictions on cutting conditions (power, speed, force and vibration, surface finish).

Metal Forming: **[10H]**

Plasticity: Introduction to stress, strain, stress-strain relationships, Mechanics of Forming Processes: Rolling, Forging, Drawing, Deep Drawing Extrusion, Punching and Blanking.

Casting: **[04H]**

Design of riser, runner and gating system, mechanism and analysis of solidification

Text/Reference books:

1. M.C. Shaw, Metal Cutting Principles, 2ndEdition Oxford University Press, England 2005.
2. A. Ghosh and A.K. Malik, Manufacturing Science. Affilated East West press 1985.
3.Mikel P. Groover, "Fundamentals of Modern Manufacturing", John Wiley & Sons inc

Subject Code:	SM2007	**Course Title**	Cyber Physical Production Systems
Contact Hours	L-2, T-0, P-2,	**Credit**	3
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		

Evaluation scheme	Quiz/ assignment/ attendance -20 , Mid Sem - 15, End Sem - 30, Lab -15, Project - 20

Learning Objective: The course aims to provide the students an exposure to the connection between the production systems and cyber world. Various elements of production system and cyber world and their integration will be covered in the course.

Course Detail :

1. An overview of the production system – **[02H]**

2. Introduction to Cyber Physical System – **[01H]**

3. Introduction to Cyber Physical Production System – **[03H]**

4. Different levels of Cyber Physical Production System

a. "Level 1: Physical world (field level) - material, machines, tools, material handling and associated cyber systems like sensors, actuators, computer integrated manufacturing system- **[10H]**

b. Level 2: Control Level - edge computing, an introduction to data flow protocols, virtual" reality - **[03H]**

c. Level 3: Supervisory control- scheduling, FMS, quality control- **[02H]**

d. Level 4: Planning level- Computer Aided Production Planning and Control, Inventory control - **[02H]**

e. Level 5: Management level -Sales and forecasting, Distribution, finance, design, factory" and plant layout **[02H**

5. Introduction to Smart Manufacturing - **[02H]**

6. Introduction to Blockchain Technology – **[01H]**

Lab:

Experiment 1: Introduction to AVR microcontrollers and electronic circuit

Experiment 2: Introduction to sensors and actuators and building simple system for actuating an LED based on sensor signal using ATMEGA microcontroller.

Experiment 3: Controlling a motor using ATMEGA microcontroller.

Experiment 4: Programming on CNC lathe machine - simple operation Experiment 5: Programming on CNC lathe machine - complex operation

Experiment 6: Building a production system using machines and material handling device

Experiment 7: Connecting the sensors, actuators to the Internet through Node CMU microcontroller for the transfer of the simple information.

Experiment 8 to 12: Developing a cyber physical producti0n system by combining different components

Text/Reference books:

1. **Groover, Automation, Production System, Computer Integrated Manufacturing, Pearson Publishing**
2. **Various research papers.**

Subject Code:	CS2008	**Course Title**	Computer Networks
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid term (30%), Quiz II (15%), End term (40%).		

Introduction: History and Development of Computer Networks, Review of Data communication concepts and techniques, Networks Topologies, Network model components, layered network models (OSI reference model, TCP/IP networking architecture **[10H]**

Data Link and MAC sublayer:

- Preliminaries of Error Control, Flow Control and Sliding Window Protocols.
- Aloha Protocols, CSMA Protocols, Collision Free Protocols, Local Area Networks -- Ethernet, Wireless LAN, Broadband Wireless. **[10H]**

Network Layer: Routing Algorithms, Subnets, Congestion Control Algorithms, Internetworking – Bridges and Routers **[10H]**

Transport Layer: Connection Establishment, and release, TCP, UDP, Flow Control and Congestion Control, Quality of Services. **[10H]**

Application Layer Potocols and Introduction to Network Security. **[02H]**

Text/Reference books:

1. Andrew S. Tanenbaum, David J. Wetherall , Computer Networks, 5th Edition, Pearson Publications, 2010.
2. W. Stallings, Data and Computer Communication, 10th Edition, Pearson Publication, 2013.
3. B. A. Forouzan, Data Communications and Networking, 5th Edition, McGraw Hill Publication, 2012.
4. B. S. Davie and L. L. Peterson, Computer Networks: A Systems Approach, 5th Edition, Morgan Kaufmann Publication, 2011.

Subject Code	EC2008	**Course Title**	Analog Integrated Circuit Design
Contact Hours	L- 3 , T- 0 ,P- 2	**Credit**	4
Program	B.Tech	**Semester**	IV
Pre-Requisites	None		

Evaluation scheme	Quiz I (10%), Midterm (30%), Quiz II (10%), End term (40%) Practical (10%)

Module 1

Introduction to Analog Design & Basics CMOS Device Physics Why analog, Why Integrated, Why CMOS, general concepts levels of abstraction, robust analog deign, General considerations- MOSFET as a switch, MOSFET structure, MOS symbols. MOS I/V characteristics: threshold voltage, derivation of I/V characteristics, second order effects. MOS device models- MOS device layouts, MOS device capacitances, MOS small signal models, MOS spice models, nMOS v/s pMOS devices, long channel v/s short channel devices. **[07H]**

Module 2

Basic concepts of amplifiers, Common Source Stage : common source with resistive loads, CS stage with diode-connected load, CS stage with current-source load, CS stage with triode load, CS stage with source degeneration, source follower, common gate stage, cascode stage, folded cascade stage, choice of device models. **[07H]**

Module 3

Differential Amplifiers Current Sources and Mirrors : Single ended and differential operation, basic differential pair- qualitative analysis, quantitative analysis, common mode response, differential pair with MOS loads, Gilbert cells. Current sources, basic current mirrors, cascade current mirrors, wilson current mirror, large signal and small-signal analysis. **[07H]**

Module 4

Frequency Response of Amplifiers and Noise : Miller effect, association of poles with nodes, frequency response of all single stage amplifiers, comparators, charge-pump circuits and multipliers, data converters, analog interconnects, analog testing and layout issues, low voltage and low power circuits. Introduction to RF electronics, basic concepts in RF design. Noise Spectrum, Amplitude Distribution, Correlated and Uncorrelated Sources, Thermal Noise, Flicker Noise, Noise in all Single Stage Amplifiers, Noise in Differential Pairs, Noise Bandwidth. **[07H]**

Practical

Lab 1 Introduction to EDA tools (Cadence) and Overview on Analog Circuit Design Custom IC Design Flow, Analog IC Design Flow, Procedure for analog IC design with CMOS inverter as an example(Schematic entry to GDS-II file generation) **[07H]**

Lab 2 Design and Simulation of basic analog circuit with given specification Common Source Stage-common source with resistive loads, CS stage with diode-connected load, CS stage with current-source load, CS stage with triode load, CS stage with source degeneration, cascade stage Differential amplifier design with given specifications, Basic Current mirror design and simulation **[07H]**

Text Books:

1. Design of Analog CMOS Integrated Circuits. Razavi, McGraw-Hill, 2001.

Reference books:

1. CMOS Circuit Design, Layout and Simulation, R.Jacob Baker,H.W.Li, and D.E. Boyce, Prentice-Hall of India,1998.

2. Analog VLSI Signal and Information Process, Mohammed Ismail and Terri Faiz, Mc Graw Hill book company 1994.

3. Analysis and design of Analog Integrated circuits, Paul R. Gray and R.G.Meyer, "John Wiley and sons, USA"", (3rd Edition), 1993.

4. RF Microelectronics, Prentice-Hall PTR,1998",

5. Journals: (i) IEEE Journal of Solid state Circuits (ii) IEEE Trans. on Communications, B. Razavi, Prentice-Hall ,1998.

Subject Code:	ME2008	**Course Title**	Fluid Mechanics and Machines
Contact Hours	L-3, T-1, L-2,	**Credit**	4
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Lab Work (20%) Quiz I-II (10%), Mid-Term (25%), Assignment (10%), End-Term(35%)		

Learning Objective:

- Understand the basics of fluid statics, kinematics and dynamics, used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc.
- Understand the importance of flow and pressure measurements and its applications in Industries
- Recognize the basic design concepts of a pipe flow and understand the various losses in a flow system.
- Realize the significance of non-dimensional parameters.
- Carry out dimensional analysis and establish relationship between the dependent and independent variables
- Understand boundary layer formation and concepts related to flow separation
- Accquire knowledge about the testing of fluid machineries for its performance characteristics

Course Detail :

Module I

Fluid Statics: Definition of Fluid & Characteristics – Concept of Continuum - Properties of fluids- Classification of Fluids – Pascal's and Hydrostatic Law- Hydrostatic Forces on Different Surfaces – Determination of Total Pressure and Centre of Pressure – Buoyancy – Centre of Buoyancy – Metacentre – Conditions of Equilibrium for Submerged and Floating Bodies. **[08H]**

Module 2

Fluid Kinetics, Dynamics & Flow Through Pipes: Description of Fluid Motion – Lagrangian and Eulerian Methods – Types of Fluid Flow – Stream Function and Velocity Potential – Rotation – Vorticity – Flow Lines, Reynolds Transport Theorem – Continuity Equation – Euler's Equation – Bernoulli's Equation and its Practical Applications

Hydraulic and energy gradient – Laminar flow through circular conduits and circular annuli-Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation –friction factor- Moody diagram- commercial pipes- minor losses. **[22H]**

Module 3

Dimensional Analysis: Dimensional analysis and similitude, dimensionless parameters, kinematic and dynamic similarity**.** **[05H]**

Module 4

Pumps: Impact of jets – Euler's equation – Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles – Centrifugal pumps– working principle – work done by the impeller – performance curves – Reciprocating pump- working principle – Rotary pumps –classification. **[10H]**

Module 5

Turbines: Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles – work done by water on the runner – draft tube. Specific speed – unit quantities – performance curves for turbines – governing of turbines **[10H]**

List of Practical

1. To Determine Bernoulli's Theorem.
2. To determine friction factor for the given pipes and also plot friction factor vs Reynold's number for all the pipes and compare it with the Moody's chart.
3. To calculate the Coefficient of Discharge Cd, Coefficient of Velocity Cv, and Coefficient of Contraction Cc for various heads over orifice fitted in the side of a tank. And to draw a relationship between these coefficients and the size of the orifice
4. To compute Piezo-metric head and draw Hydraulic Gradient Line for the given flow passage
5. To determine Experiments performance and operating characteristics of Francis turbines
6. To determine Experiments performance and operating characteristics of centrifugal pumps
7. To determine the Coefficient of Discharge of the given Venturimeter
8. To determine the Coefficient of Discharge of the given Orifice meter.
9. To determine Experiments performance and operating characteristics of pumps – reciprocating
10. To determine Experiments performance and operating characteristics of Kalpan turbine-1KW

11. To Determine Head loss Coefficient for the given bend in pipe available
12. Determination of the metacentric height and position of the metacentric height with angle of heel of ship model.

Text Books:

1.Yunus A. Çengel, John M. Cimbala (2013) Fluid Mechanics: Fundamentals And Applications, McGraw-Hill, 3rd Edition.

2 Dr.R.K.Bansal, (2012), A Textbook of Fluid Mechanics and Hydraulic Machines, 5th Edition, Laxmi Publication. Not allowed

Reference Books:

1. Robert W. Fox, Alan T. McDonald, Philip J. Pirtchard John W. Mitchell (2015), Introduction to Fluid Mechanics, 9th Edition, Wiley Publications.

2. P.N.Modi and S.M.Seth (2011), Hydraulics and Fluid Mechanics including Hydraulic Machines, 17th Edition.

3. Donald F. Elger, Barbara C. Williams, Clayton T. Crowe, John A. Roberson (2013) Engineering Fluid Mechanics, John Wiley & Sons, 10th Edition.

Subject Code:	NS2001	**Course Title**	Biology for Engineers
Contact Hours	L-2, T-0, P-0	**Credit**	2
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		

Evaluation scheme

Course Detail :

Cells, Cellular Organelles, Nucleic Acids (DNA, RNA structure and function), Proteins- Different levels of structures, Folding and mis-folding, Protein Purification techniques; Enzymes, Carbohydrates, Lipids & Lipid membranes, Drug Discovery. Topics would emphasize importance of biomolecule vis-à-vis numerous every day applications.

Text/Reference books:

1. Berg, J. M., Tymoczko, J.L., and Stryer, L., Biochemistry, W.H. Freeman & Company, 6th edition, 2006.
2. Alberts, B., Alexander, J., Lewis, J., Raff, M., Roberts, K., Walter, P., Molecular Biology of the Cell, 6th edition, Garland Science Publishing, 2007.
3. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level, Publisher : Wiley; 5th edition (29 February 2016)

Subject Code:	DS2009	**Course Title:**	Design Research Including user Study
Contact Hours:	L-2, T-0, P-2		
Programme :	B.Des	**Credit:**	3
Pre-requisites:	NIL	**Semester :**	IV
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail

Qualitative and qualitative research methodology, **[07H Lecture,+3H Lab]**

Questionnaire design, validation, repeatability testing, psychophysical scales**,** **[07H Lecture,+3H Lab]**

Direct observation and activity analysis,photography as a tool in design research et**[07H Lecture,+3H Lab]**

Persona, scenario, story boarding. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Laurel, B. (2003). Design research: Methods and perspectives. MIT press.
2. Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., &Wensveen, S. (2011). Design research through practice: From the lab, field, and showroom. Elsevier.
3. Creswell, J. W., & Clark, V. L. P. (2007). Designing and conducting mixed methods research.
4. Creswell, J. W. (2013). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

Subject Code:	DS2010	**Course Title:**	Materials and Processes
Contact Hours:	L-2, T-0, P-2	**Credit:**	3
Programme :	B.Des	**Semester :**	IV
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail-

Importance of Material in Design, Conventional Materials in Design. **[07H Lecture,+3H Lab]**

Material Science and Material Affordance in Product Design**.** **[07H Lecture,+3H Lab]**

Manufacturing of Materials; Material Formation; Shaping and Joining**.** **[07H Lecture,+3H Lab]**

Emerging Materials; Sustainable Materials and Processes; Material Experience in Design **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Ashby, M. F., & Johnson, K. (2013). Materials and design: the art and science of material selection in product design. Butterworth-Heinemann.
2. Lefteri, C. (2007). Making it: Manufacturing techniques for product design. Laurence King.
3. Ulrich, K. T. (2003). Product design and development. Tata McGraw-Hill Education.

Subject Code:	DS2011	**Course Title:**	Industrial Design 2

Contact Hours:	L-2, T-0, P-2	**Credit:**	3
Programme :	B.Des	**Semester :**	IV
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail-

Complex products, design as a strategic tool, design and innovation, design process, user study, need identification. **[07H Lecture,+3H Lab]**

Sigma analysis of user and product activity, usability, material analysis, visual analysis, factor analysis. **[07H Lecture,+3H Lab]**

Physiology analysis, technical analysis, environmental analysis, economic analysis, ideation, analogies, selection of an idea, detail design, **[07H Lecture,+3H Lab]**

Design for culture, design for manufacture, design for assembly, product rendering, mock-up and prototype, final manufacture. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Cross, N. (2008). Engineering design methods: strategies for product design. John Wiley & Sons.
2. Whitten, J. L., Barlow, V. M., & Bentley, L. (1997). Systems analysis and design methods. McGraw-Hill Professional.
3. Cuffaro, D., &Zaksenberg, I. (2013). The Industrial Design Reference & Specification Book: Everything Industrial Designers Need to Know Every Day. Rockport Publishers.
4. Krippendorff, K. (2005). The semantic turn: A new foundation for design. crc Press.

Subject Code:	DS2012	**Course Title:**	Communication Design 2
Contact Hours:	L-0, T-0, P-6	**Credit:**	3
Programme :	B.Des	**Semester :**	IV
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail-

Introduction to Print Media: Forms of Printing, History and Evolution Interrelation of Print and Digital Technologies, Applications. Introduction to Typography **[07H Lecture,+3H Lab]**

Principles, Techniques and Applications. **[07H Lecture,+3H Lab]**

Introduction to Photography: History and Evolution, Camera Principles, Techniques and Applications. Introduction to Moving pictures: History and Evolution of Cinema, Video and Animation; Principles Techniques and Applications. Visual Identity Design: **[07H Lecture,+3H Lab]**

Introduction to Identity Design, Branding and Rebranding; Applications in - Stationary Design, Template Design, Souvenir Design, Signage Design and Web Design. Introduction to Human Computer Interface: Graphic User Interface, Characteristics, Principles and Applications. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Kipphan, H. (2001). Handbook of print media: technologies and production methods. Springer Science & Business Media.
2. Kernan, A. B. (1987). Printing Technology, Letters, & Samuel Johnson. Princeton University Press.
3. McLean, R. (1988). The Thames and Hudson manual of typography.
4. Craig, J. (1990). Basic Typography: a design manual. Watson-Guptill Publications.

Subject Code:	DS2013	**Course Title:**	Design Project 3
Contact Hours:	L-3, T-0, P-2	**Credit:**	4
Programme :	B.Des	**Semester :**	IV
Pre-requisites:	NIL		
Evaluation scheme	Minor project (20%), Major project (30%), Weekly assignment (50%)		

OE2 Choose any one course from below electives

Subject Code	OE2E05	**Course Title**	Antenna Theory and Design
Contact Hours	L-3,T-0, P-0	**Credit**	3
Programme	B.Tech./B.Des	**Semester**	IV
Pre-requisites	Electromagnetic Theory		
Evaluation scheme	Quiz I (10%), Midterm (30 %), Quiz II (10 %), End term (40 %) Project (10%)		

Module 1

Fundamental Concepts: Radiation mechanism, Radiation pattern, near/far-field regions, directivity and gain, bandwidth, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, reciprocity theorem, vector potentials for electric and magnetic current sources. **[08H]**

Module 2

Radiation from Wires and Loops: Infinitesimal dipole, half-wave dipole, quarter-wave monopole antenna, small loop antenna. **[08H]**

Module 3

Aperture, Reflector and Microstrip Antennas: Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, reflector and cassegrain antennas, basic of microstrip antennas and feeding techniques, broad band antennas. **[08H]**

Module 4

Antenna Arrays: Analysis of uniformly spaced Two-element and N-element linear arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays. **[08H]**

Text Books:

1. Antenna Theory: Analysis and Design, Constantine A. Balanis, Wiley, Indian Edition, 2005.
2. Antenna and Wave propagation, J D Kraus, TMH.
3. Antenna and Wave propagation, A. R. Harish and M. Sachidananda, Oxford University Press, 2007.

Reference books:

1. Electromagnetic Waves and Radiating Systems, E.C. Jordan and K.G. Balmain, Prentice Hall of India, 2005.
2. Elements of Electromagnetics, Mathew N. O. Sadiku, Third Edition, Oxford Press.

Subject Code:	OE2D05	**Course Title:**	Packaging Design and Branding
Contact Hours:	L-2, T-0, P-2	**Credit:**	3
Programme :	B.Tech/B.Des	**Semester :**	IV
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail-

Global Packaging Branding and Promotion**.** **[07H Lecture,+3H Lab]**

Digital Image Manipulation Applications. **[07H Lecture,+3H Lab]**

Packaging Research and conceptualization, Packaging Design Approaches and Techniques. **[07H Lecture,+3H Lab]**

Packaging Design Realization, Packaging Form and Elements. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Van Roojen, P., &Hronek, J. (2010). Basic Packaging. Pepin Press.
2. Denison, E., &Ren, G. Y. (2001). packaging prototypes 3: Thinking Green (Vol. 3). RotoVision.
3. Pecht, M. (1991). Handbook of electronic package design (Vol. 76). CRC Press.
4. Bringhurst, R. (1992). The elements of typographic style (Vol. 127). Point Roberts: Hartley & Marks.

Subject Code:	OE2D06	**Course Title:**	Interface Design
Contact Hours:	L-2, T-0, P-2	**Credit:**	3
Programme :	B.Des	**Semester :**	IV
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail

Interface design basics, **[07H Lecture,+3H Lab]**

Interface and interaction, components **[07H Lecture,+3H Lab]**

Usability principles. **[07H Lecture,+3H Lab]**

Application of interface design in product and space. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Tidwell, J. (2010). Designing interfaces. "O'Reilly Media, Inc.".
2. Stone, D., Jarrett, C., Woodroffe, M., & Minocha, S. (2005). User interface design and evaluation. Morgan Kaufmann.
3. Baumann, K., & Thomas, B. (2002). User interface design of electronic appliances. CRC Press.

Subject Code:	OE2M06	**Course Title**	Fundamental of Robotics
Contact Hours	L-3, T-0, L-0,	**Credit**	3
Programme	B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (20%), Quiz II (10%), End term (30%), Lab (30%)		

Course Detail :

Module 1: Introduction **[02H]**

1. Introduction and Classification of robots
2. Introduction to Mechanical, Electrical and Electronics Elements of robots such as joints, links

Module 2: Robot Kinematics **[11H]**

1. Robot as Mechanism
2. Joints and degrees of freedom
3. Position and orientation of a rigid body
4. Homogeneous transformations, Euler Angle
5. Direct kinematics of serial robots, Introduction to D-H parameters and its physical significance
6. Inverse kinematics of serial robots
7. Kinematics of mobile robot, Non-holonomic and holonomic robots

Module 3: Sensors and Actuators **[05H]**

1. Sensors for robots: Introduction and their characteristics:

a. Position, Velocity and Acceleration sensors

b. Force, pressure and Torque sensors

c. Light, infrared, proximity and range finder sensors

2. Actuators for robots: Introduction to servo and stepper motors, pneumatic and hydraulic actuators

Module 4: Robot Motion and Control **[08H]**

1. Brief introduction to trajectory planning for serial robots
2. Reactive navigation for mobile robot
3. Global navigation
4. Trajectory-following control –basics of feedback and motion control

Module 5: Intelligent robots **[02H]**

Intelligent robots: Programmable and autonomous

Lab:

1. Demonstration of components of a robot
2. Practice on joints, links and degrees of freedom
3. Simulation of position and orientation of a robot
4. Simulation for forward kinematics of puma or similar robot
5. Simulation for kinematics of mobile robot
6. Inverse kinematics analysis of puma or similar robot
7. Practice on Sensors and actuators (2 labs)
8. Simulation and hardware implementation of Trajectory following robot (4 labs)

Text/Reference books:

1. Introduction to Robotics by Saeed B. Niku
2. Robot Motion and Planning by Choset
3. Introduction to Robotics: Mechanics and Control by Craig
4. Robot Modeling and Control by M. Spong, S. Hutchinson, and M. Vidyasagar

Subject Code:	OE2S09	**Course Title**	Management Concept and Technology
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme	**Quiz I (10%), Midterm (20%), Quiz II (10%), End term (60%)**		

Course Detail :

Introduction to Operations Management:

Functional Subsystems of Organization, Definition, Systems Concept of Production, Types of Production Systems – Flow Shop, Job Shop, Batch Manufacturing, The Project, Productivity, Strategic Management – Corporate Strategic, Generic competitive Strategies, Functional Strategies, Gross Domestic Product and its impact, World Class Manufacturing. **[06H]**

Product & Process Design and Analysis:

Product Design and Analysis is (Definition), new product development - its concepts, Steps of Product Design, Process Planning and Design -Selection of Process, Process Selection Decision, Process Planning Design, Responsibilities of Process Planning Engineer, Steps in Process Planning. Process Design - Process Research, Pilot Development, Capacity Consideration, Commercial Plan Transfer, Enhanced Capacity Using Optimization. Value Analysis/Value Engineering – History of Value Analysis/Value Engineering, When to Apply Value Analyses is, Function, Aims, Value Engineering Procedure, Advantages and Application Areas. Standardization: Standardization Procedure, Advantages of Standardization, Application of Standardization. Ergonomic Considerations in Product Design. **[09H]**

Statistical quality control: Quality Improvement in the Modern Business Environment, the DMAIC Process Methods and Philosophy of Statistical Process, Control Charts for Variables, Control Charts for Attributes Process and Measurement System Capability Analysis **[07H]**

Plant Location & Plant Layout:

Factors Influencing Plant Location, Break -even Analysis. Single Facility Location Problem, Multi facility Location Problems –Model for Multi -facility Location Problem, Method of Transformation, Model to Determine X - Coordinates of New Facilities, Model to Determine Y - Coordinate, Plant Layout - Plant layout introduction, Classification of Layout, Advantages and limitations of Product Layout, Advantages and limitations of Group Technology Layout, Layout Design Procedures. **[06H]**

Scheduling:

Introduction, Johnson's Problem, Extension of Johnson's rule. Job Shop Scheduling: Introduction, Types of Schedules, Schedule Generation, heuristic Procedures, Priority Dispatching Rules. Two Jobs and Machines Scheduling. **[04H]**

Materials Management:

Integrated Materials Management, Components of Integrated Materials Management – Materials Planning, Inventory Control, Purchase Management, Stores Management. Inventory Control - Inventory Decisions, Costs Trade Off. Models of Inventory, Operation of Inventory Systems, Quantity Discount, Implementation of Purchase Inventory Model, Purchasing Management, Stores Management – Incoming Materials Control, Store Accounting, Obsolete Surplus and Scrap Management, ABC Analysis, XYZ Analysis, VED Analysis is, FSN Analysis, SDE Analysis. **[08H]**

Text/Reference books:

1. Panneerselvam " Production and Operations Management" PHI,2012
2. H.Kaushal, Production / Operations Management, Case Study Solutions, MacMillan, 2012.
3. Ajay K Garg, Production and Operations Management, TMH, 2012
4. B. Mahadevan, Operations Management: Theory and Practice, Second Edition, Pearson, 2010.
5. Danny Samson "Operations Management: Integrated Approach" Cambridge, 2012.
6. Kenneth K. Boyer, Rohit Verma, Operations Management: Cengage Learning, 2011.
7. Dipak Kumar Bhattacharyya, Production and Operations Management, Universities Press,2012.
8. Prof. L.C. Jhamb: Production Operations Management, 18th ed ition, Everest Publishing House,2013.
9. J.K, Sharma: Operations Research, Macmillian, 2013

Year Long Courses (Common for B.Des and B.Tech)

Subject Code:	PC2002	**Course Title**	Professional Development Course
Contact Hours	L-1, T-0, L-0,	**Credit**	1
Programme	B.Des/B.Tech	**Semester**	IV
Pre-requisites	NIL		
Evaluation scheme			

Course Detail :

Strengthen Aptitude

(A). Reasoning Aptitude

- Syllogisms / Deductions
- Analytical Reasoning
- Logical Reasoning
- Data interpretation
- Clocks & Calendars
- Different patterns of puzzles – Quant based
- Data arrangement analysis and critical reasoning
- Data sufficiency
- Coding Decoding and all others.

(B). Quantitative Aptitude

- Vedic Mathematics concepts
- Concepts and Problem solving for time, speed, and distance; percentage; Profit, loss, and discount; age problems, number properties; ratio and proportion; mixtures and solutions; time and work etc.
- Concepts and Problem solving for permutation and combination; probability; geometry; number series; word problem etc.

(C). Verbal Aptitude

- General grammar rules
- Comprehension and logic questions
- Concept building - reading comprehension, vocabulary building, confusing words, suitable words, verbal analogy, spotting errors in sentences etc.
- Advance reading comprehension

- Passage analysis
- Vocabulary testing
- Jumbled sentences
- Sentence improvisation

(D). Preparation for Psychometric Tests and Story Building Concepts

B.Tech Semester-V

Subject Code:	DS3001	**Course Title:**	Engineering Design - Including Design and Fabrication Project
Contact Hours:	L-1, T-0, P-6		
Programme :	B.Tech	**Credit:**	4
Pre-requisites:	NIL	**Semester :**	V
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Introduction to Engineering Design: Importance of Design, Design Philosophy, History of Design, Design Paradigm, the Design Process, Good Design, Engineering Analysis, Design phases, Product and Process Cycle. **[06H]**

Need Identification and Problem Definition: Identifying customer needs, Benchmarking, Quality Function Deployment, Engineering Design Specification **[06H]**

Concept Design: Creativity and Problem Solving, Functional requirements, Product Component Decomposition, Product Function Decomposition, Conceptual Decomposition, Generating Design Concepts, Product Form and Geometry, Product Aesthetics, Evaluating alternative Concepts, Theory of Inventive Problem Solving, Axiomatic Design, Concept Evaluation Methods, Decision Making. **[06H]**

Embodiment Design: Introduction, Product Architecture, Configuration Design, Parametric Design, Best Practices, Industrial Design, Human Factors Design, Design For X (DFX) - Function, Assembly, Manufacture, Environment,Robustness, Reliability, Recyclability, etc. **[06H]**

Materials Selection: Performance Characteristics of Materials, the Material Selection Process, Economics of Materials, Material Selection Methods. **[08H]**

Selection of Manufacturing Processes: Manufacturing Processes, Costs of Manufacturing, Process Selection. **[04H]**

Text/Reference books:

1. Ulrich, Karl.T. and Eppinger, Steven.D.(2012). Product Design and Development, McGraw-Hill
2. Buede, Dennis.M. (2009). The Engineering Design of Systems: Models and Methods, John Wiley & Sons inc

Course Code	CS3011	**Course Title**	Artificial Intelligence
Contact Hours	L-3,T-0,P-0	**Credit**	3
Program	B.Tech	**Semester**	V
Pre-requisites	None		

Evaluation Scheme	Quiz I (10%), Mid-Term (20%), Quiz II (10%), End term (40%), Project (20%)

Learning Objective : The students will understand the principles and development of artificial intelligence. They will also learn its many applications in different areas.

Course Details:

Module 1: Overview: foundations, scope, problems, and approaches of AI, Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents, Artificial Intelligence programming techniques. Problem-solving through Search: forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications. **[10H]**

Module 2: Knowledge Representation and Reasoning: ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications. Planning: planning as search, partial order planning, construction and use of planning graph. **[10H]**

Module 3: Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, bayesian networks, probabilistic inference, sample applications, Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications. **[10H]**

Module 4: Machine Learning and Knowledge Acquisition: learning from memorization, examples, explanation, and exploration, learning nearest neighbour, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, applications, Sample Applications of AI. **[10H]**

Text/Reference books:

1. N. J. Nilsson, Artificial Intelligence-A Modern Synthesis. Palo Alto: Morgan Kaufmann, 1998.
2. N. J. Nilsson, Principles of Artificial Intelligence. Palo Alto, CA: Tioga, 1981.
3. E. Rich, K. Knight, Artificial Intelligence, New York: McGraw Hill, 1991.
4. S.S.V Chandra, S. A. Hareendran, Artificial Intelligence and Machine Learning, PHI, 2014.

Subject Code:	EC3011	**Course Title**	Digital Communication
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	V
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Course Detail :

Review of Random Variables and Random Processes. **[03H]**

Optimum Receivers for the AWGN channel, Signal Design for bandlimited channels. **[10H]**

Digital Pass Band Transmission and Reception: Introduction to Pass band Transmission model: Generation, Detection, Signal space diagram, Error performance - Coherent and Non-coherent detection systems, bit error probability and Power spectra of BPSK, QPSK, FSK and MSK schemes, Differential phase shift keying, Comparison of Digital modulation systems using a single carrier - Carrier and symbol synchronization.**[12H]**

Information theory and error control coding: Communication channel, Channel matrix, Channel capacity, Discrete memory less channels, Linear block codes - Cyclic codes - Convolutional codes - Maximum likelihood decoding of convolution codes-Viterbi Algorithm, Trellis coded Modulation. **[07H]**

Overview of spread spectrum: Pseudo-noise sequences: a notion of spread spectrum: Direct sequence spread spectrum, Frequency hop spread spectrum, Maximum length and Gold codes. **[10H]**

Text/Reference books:

1. John G. Proakis, Masoud Salehi, “Fundamentals of Communication Systems” Pearson, 2005.
2. H. P. Hsu, “Analog and Digital Communications,” Schaum’s Series, Tata McGrawHill, 2e, 2006
3. Simon Haykins, “Communication Systems” John Wiley, 4th Edition, 2001
4. H. Taub, D. Schilling, and G. Saha, “Principles of Communication Systems, ” McGraw-Hill” 2013.
5. B. P. Lathi and Z. Ding, “Modern Digital and Analog Communication Systems,” Oxford Univ. Press,

January 2009, 4/e.
6. S. Haykin and M. Moher, “An Introduction to Analog and Digital Communications,” Wiley, January 2006, 2/e.

Subject Code:	ME3011	**Course Title:**	Heat Transfer
Contact Hours:	L-3, T-0, P-2	**Credit:**	4
Programme :	B.Tech	**Semester :**	V
Pre-requisites:	NIL		
Evaluation scheme			

Course Detail :

1. Introduction to heat transfer **[06H]**
2. Conduction: Fourier's Law, One dimensional heat transfer, with and without heat generation, Transient conduction, Through Composite walls. **[10H]**
3. Extended Surfaces: Heat transfer from finned surfaces, Fin Efficiency, Effectiveness. **[08H]**
4. Convection: Free and forced convection, Flow and thermal boundary layer equations, laminar flow through circular pipe, constant heat flux and constant wall temperature conditions, Overall heat transfer coefficient. Heat exchangers. **[10H]**
5. Thermal Radiation: Radiation properties, Plank's Law, Kirchoff's law, Heat exchange between two surfaces **[08H]**

Text/Reference books:

1. Fundamentals of Heat and Mass Transfer, F. P. Incropera and D.P. Dewitt (Wiley)..
2. Heat and Mass Transfer, JP Holman

Subject Code:	DS3009	**Course Title:**	Service Design
Contact Hours:	L-2, T-0, P-2	**Credit:**	3
Programme :	B.Des	**Semester :**	V
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail:

Provides insights into the relationships between people, technology (in the broadest sense of the word - paper is a technology) and design. **[07H Lecture,+3H Lab]**

Using cultural and design theories as frameworks it explores through hands-on design projects and case studies the ways in which service design practices creatively engage with new trends in society. **[07H Lecture,+3H Lab]**

The ways in which technologies change society, and the ways in which people (users) shape design practices. **[07H Lecture,+3H Lab]**

Reconsider designers and users as the ultimate authors of all new designs, technologies or services. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. ERL, T. (2008). SOA: principles of service design (Vol. 1). Upper Saddle River: Prentice Hall.
2. This is service design thinking: Basics, tools, cases. BIS, 2012.
3. Macintyre, M., Parry, G., & Angelis, J. (Eds.). (2011). Service design and delivery. Springer Science & Business Media.

Subject Code	DS3010	**Course Title**	Sustainable Design
Contact Hours	L-2, T-0, P-2	**Credit**	4
Programme	B.Des	**Semester**	5
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Sustainable design principles. **[07H Lecture,+3H Lab]**

Physical, mental, spiritual, cultural, social, ethical and economic issues in designing for sustainability. **[07H Lecture,+3H Lab]**

Ecological footprints, ecosystem impact. Waste, reuse and recycling, benign emissions, green design, integrated DFE/Eco design, **[07H Lecture,+3H Lab]**

Design for sustainability, eco innovation, system-wide product/service strategies, sustainable consumption, health, modeling and mapping. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Williams, D. E. (2007). Sustainable design: Ecology, architecture, and planning. John Wiley & Sons.
2. Bhamra, T.& Lofthouse, V. (2007). Design for sustainability: a practical approach. Gower Publishing, Ltd.
3. Vallero, D. A., &Brasier, C. (2008). Sustainable design: the science of sustainability and green engineering. John Wiley & Sons

Subject Code:	DS3011	**Course Title:**	Design Management
Contact Hours:	L-2, T-0, P-2	**Credit:**	3
Programme :	B.Des	**Semester :**	V
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Skills, knowledge and learning style evaluation, personal goal setting and professional development planning. **[07H Lecture,+3H Lab]**

Insight into the context that businesses and organizations operate in, how they view and use design, and their relationship with designers. **[07H Lecture,+3H Lab]**

Examine the roles of design and innovation in achieving organizational objectives. **[07H Lecture,+3H Lab]**

To bring together the languages of design and business, it considers organizational objectives, how design and innovation deliver value and return on investment is evaluated. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Best, K. (2006). Design management: managing design strategy, process and implementation. AVA publishing.
2. Cooper, R., Junginger, S., & Lockwood, T. (Eds.). (2013). The handbook of design management. A&C Black.
3. Martin, R. L. (2009). The design of business: Why design thinking is the next competitive advantage. Harvard Business Press.

OE1 Choose any one course from below electives

Subject Code:	OE3C24	**Course Title**	Parallel Computing
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	V
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid term (30%), Quiz II (15%), End term (40%)		

Course Detail :

Paradigm of Parallel Computing: Flynn's taxonomy, Pipelining, SIMD, MIMD, Classification of parallel computers **[05H]**

Programming Parallel Computers: Parallel Programming, Parallel Languages, Cognitive Training **[04H]**

Connectivity: Synchronizing Communications, role of Memory, Network design, System Interconnections **[04H]**

Data Flow Computer: dataflow graphs, elements of dataflow computers **[04H]**

Software Issues in Parallel Computing: ideal Situation, using existing serial programs **[04H]**

Text/Reference books:

1. Elements of Parallel Computing, V Rajaraman, Prentice Hall, 2006
2. Parallel Computing: Principles and Practice, T. J. Fountain, Cambridge University press, 2006

Subject Code:	OE3E25	**Course Title**	VLSI Design Modeling
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	V
Pre-requisites	NIL		
Evaluation scheme			
Course Detail :			
Text/Reference books:			

Subject Code:	OE3E25	**Course Title**	VLSI Design Modeling
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	V
Pre-requisites	NIL		
Evaluation scheme			
Course Detail :			
Text/Reference books:			

Subject Code:	OE3M26	**Course Title**	Computer Aided Design
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	VI
Pre-requisites	NIL		
Evaluation scheme	Quizzes (20%); Mid-sem (20%) Programming Project (20%) and End sem (40%)		

Course Detail :

Introduction:

Objective, scope, overview, CAD software, mathematical background, applications **[04H]**

Transformations:

Rotation, translation, scaling, reflection, shear and combined transformations in 2D and 3D, computer-aided assembly **[06H]**

Projections:

Orthographic, axonometric, oblique and perspective projections **[04H]**

Curves:

Parametric representation of analytic curves, representation of synthetic curves- Hermite/ Ferguson, Bezier, B-spline, rational curves, NURBS/NUBS, curve manipulations, Analytical properties **[10H]**

Surfaces:

Surface representation, parametric representation of analytic surfaces- plane, ruled, surface of revolution etc., representation of synthetic surfaces- Hermite, Bezier, B-spline, coons, sculptured etc., surface manipulations, curves on surfaces, surface with irregular boundaries, analytic properties, application in reverse engineering, design of turbine blades etc. **[08H]**

Solids:

Introduction, representation of solids, fundamentals of solid modeling, solid representation schemas (B-rep, CSG, Sweep, ASM etc), solid manipulations, solid modeling-based applications in manufacturing and assembly (CNC machining, Rapid prototyping). **[08H]**

Advanced Topics:

Geometric modeling using point clouds, CAD/CAM data exchange **[02H]**

Text/Reference books:

1. Zeid, Ibraheim, CAD/CAM: Theory and Practice, Revised First Edition, Tata McGraw Hill,2007.
2. Rogers, D.F and Adams, J.A., Mathematical Elements for Computer Graphics, Tata McGraw Hill, 2002.
3. Mortenson, Michael E., Geometric Modeling, Third Edition, Industrial Press Inc., 2006.
4. Saxena and Sahay, Computer Aided Engineering Design, Anamaya Publications
5. Faux, I. D. and Pratt, M. J., Computation Geometry for Design and Manufacture, John Wiley (Ellis Horwood Ltd.), 1983.
6. Choi, B. K., Surface Modeling for CAD/CAM, Elsevier.
7. Farin, Gerald, Curves and Surfaces for Computer Aided Geometric Design – A Practical Guide, Academic Press Inc.1991.
8. Lee, Kunwoo, Principles of CAD/CAM/CAE Systems, Addison Wesley, 1999.
9. Yamaguchi, Curves and Surfaces in Computer Aided Geometric Design, Springer, 1988.
10. Ryan, D. L., Computer-Aided Graphics and Design, Marcel Dekker Inc., 1994.

Subject Code:	OE3M27	**Course Title**	Vibration of Mechanical Systems
Contact Hours	L-3, T-0, P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites	NIL	**Semester**	V
Evaluation scheme	Quizes (20%); Mid-sem (35%) and End-sem (45%)		

Course Detail :

Introduction to vibration and un-damped free vibrations:

Types of vibrations. Single degree of freedom systems and Simple problems. Formulation- Newton's second law, Energy method and Principle of virtual work. Introduction, undamped free vibration – natural frequency of free vibration, stiffness of spring elements, effect of mass of spring. **[10H]**

Damped free vibrations:

Single degree freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement. **[06H]**

Forced Vibration:

Single degree freedom systems, steady state solution with viscous damping due to harmonic force, solution by complex algebra. Concept of response, Reciprocating and rotating unbalance, vibration isolation – transmissibility ratio. Energy dissipated by damping, sharpness of resonance, base excitation. **[08H]**

Systems with two degrees of freedom:

Introduction, principal modes and normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, free vibration in terms of initial conditions. Geared systems. Forced Oscillations – Harmonic excitation. Applications: (a) Vehicle suspension (b) Dynamic vibration absorber (c) Dynamics of Reciprocating Engines. **[09H]**

Numerical methods for Multi degree Freedom Systems:

Orthogonality of principal modes, Holzer's method, Rayleigh's method. **[04H]**

Vibration monitoring and analysis:

Introduction, Accelerometer and vibrometers. Machinery signatures, Selection of Transducers and signal conditioning. Analysis Techniques, Machine failure modes, Measurement location, Vibration severity criteria, vibration frequency analysis. Case studies. **[05H]**

Text/Reference books:

1. Thomson, W.T., Theory of vibration with applications, Third Edition, 1997.
2. Rao, S. S., Mechanical Vibrations, Fourth Edition, Addison Wesley, 2004.
3. Caollacott, R. A.; Chapman, Mechanical Fault Diagnosis and Condition Monitoring, Chapman and hall, 1977.
4. Rao, J. S., Advanced Theory of Vibration, Wiley Eastern Ltd. New Delhi, 1992.
5. Jones, R. J. and Wykes, C., Holographic and Speckle Interferometry, Cambridge University Press, Cambridge, 1983

Subject Code:	DS5011	**Course Title:**	Applied Ergonomics
Contact Hours:	L-2, T-0, P-2	**Credit:**	3
Programme :	B.Des	**Semester :**	V
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail :

Ergonomics in transportation design**,**	**[07H Lecture,+3H Lab]**
Medical equipment design**,**	**[07H Lecture,+3H Lab]**
Ergonomics in toy and game design**.**	**[07H Lecture,+3H Lab]**
Ergonomic principles in developing pleasurable products etc.	**[07H Lecture,+3H Lab]**

Text/Reference books:

1. Burke, M. J. (1991). Applied ergonomics handbook. CRC Press.
2. Karwowski, W., &Marras, W. S. (Eds.). (1998). The occupational ergonomics handbook. CRC Press.
3. Duffy, V. G. (Ed.). (2008). Handbook of digital human modelling: Research for applied ergonomics and human factors engineering. CRC press.

Subject Code	DS5012	**Course Title**	Visual Ergonomics
Contact Hours	L-2, T-0, P-2	**Credit**	4
Programme	B.Des	**Semester**	5
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail :

Visual ergonomic principles**,**	**[07H Lecture,+3H Lab]**
Ergonomics in typography**.**	**[07H Lecture,+3H Lab]**
Ergonomics in cartography.	**[07H Lecture,+3H Lab]**
Ergonomics in information design.	**[07H Lecture,+3H Lab]**

Text/Reference books:

1. Anshel, J. (Ed.). (2005). Visual ergonomics handbook. CRC Press.
2. Anshel, J. (2002). Visual ergonomics in the workplace. CRC Press.
3. Woodson, W. E., Tillman, B., & Tillman, P. (1992). Human factors design handbook: information and guidelines for the design of systems, facilities, equipment, and products for human use.

Subject Code:	OE3D25	**Course Title**	Lighting Design
Contact Hours	L-2, T-0, P-2	**Credit**	3
Programme	B.Des	**Semester**	V
Pre-requisites	NIL		
Evaluation scheme	Assignment I (15%), Midterm (30%), Assignment II (15%). End term (40%)		

Learning Objective: The course will help to develop basic knowledge about Illumination ngineering and its application in space. It will also help to develop the idea about methods and tools required for the lighting design in both interior and exterior spaces.

Detailed Course Content:

Module 1 : Fundamentals of Illumination Engineering, Photometric standards Measurement of Photometric quantities. Colorimetry **[10H]**

Module 2 : Visual system-structure. continuous adjustment of photopic, scotopic and mesopic vision, visual perception, Glare. **[10H]**

Module 3 : Basic concepts of lighting design- design objectives, design parameters, qualitative & quantitative evaluation of lighting "systems. **[10H]**

Module 4 : Lighting Guidelines, Lighting Design Tools. Case Studies. **[10H]**

Text/Reference books:

1. Meshkov, V. V. (1981). Fundamentals of illumination engineering, Mir.
2. Handbook, l. L. (1995). Illuminating Engineering. Society, USA.
3. Steffy, G. 2002 . Architectural lighting design. John Wiley & Sons.

ubject Code:	DS3015	**Course Title:**	Design Forecasting and Trend Research
Contact Hours:	L-3, T-0, P-0		
Programme :	B.Des	**Credit:**	3
Pre-requisites:	NIL	**Semester :**	VI
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Competitor product analysis**,** **[07H Lecture,+3H Lab]**

Future trends, **[07H Lecture,+3H Lab]**

Patent Search / Review of IP**,** **[07H Lecture,+3H Lab]**

International developments study and, new materials and processes review. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Raymond, M. (2010). The trend forecaster's handbook. Laurence King.
2. Kahn, K. B. (2010). New-Product Forecasting. John Wiley & Sons, Ltd.
3. Mendelsohn, L. B. (2000). Trend forecasting with technical analysis.

OE04 (Choose any one course from below electives)

Course Code	OE3C28	**Course Title**	Cyber Security
Contact Hours	L-2, T-0, P-3	**Credit**	3
Program	B.Tech/B.Des	**Semester**	VI
Pre-requisites	None		
Evaluation Scheme	Quiz I (10%), Mid-Term (20%), Lab (20%), End term (40%), Project (10%)		

Learning Objective : This course is aimed at giving students the introductory concepts of Cyber Security. The course will introduce the concepts of Cybersecurity and will enable the students to create secure networking infrastructure.

Course Details:

Module 1: Introduction: Basics of cybersecurity, cyber attacks, attack vectors, vulnerability assessment,

Threat analysis and modeling, cyber laws and ethics. **[06H]**

Module 2: Identifying and defending against cyber attacks: Dictionary attacks, Software exploits- SQL Injection, XSS; Social engineering exploits- phishing attacks; Network attacks- MITM, Broadcast storms, session hijacking, denial of service, zero day vulnerabilities. **[10H]**

Module 3: Intrusion Detection and Prevention: Firewalls, anti virus softwares, Intrusion detection tools, defending against malicious software, hardening operating system, honeypots, data security. **[08H]**

Module 4: Malware analysis and Defense: Types of malware, malware analysis techniques, malware functionalities: malware behaviour, covert malware launching, malware-focused network signatures; static malware analysis: antivirus scanning, reverse engineering; dynamic malware analysis: sandboxing, **[10H]**

Cybersecurity Lab: **[32H]**

1. Setting up an virtual lab for cybersecurity experiments.
2. Understanding the basic assessment tools:- ifconig, whois, nslookup, ping, traceroute, telnet
3. Network monitoring tools: wireshark, snort, metasploit, nmap, tcpdump"
4. Burp suit & DVWA for software exploits and defense: SQL injection, XSS, etc."
5. Performing and defending against network exploits: MITM, session hijacking, ARP spoofing, etc."
6. Installing snort IDS for log assessment.
7. Using IP tables in linux to create firewalls.
8. Analyzing malware behaviour and launching covert malwares, building trojans
9. Static malware analysis techniques: anti virus scanning, hashing, reverse enigineering
10. Dynamic malware analysis techniques: sandboxes, registry comparison with regshot, debugging with OLLYDBG
11. Project.

Text/Reference books:

1. Brooks, Charles J., Grow, Christopher, Craig, Philip A., Short, Donald, ''Cybersecurity Essential" by Sybex

2 . John Snowden, “Cybersecurity: An Ultimate Guide to Cybersecurity, Cyberattacks, and Everything you should knw about being safe on the Internet”, willey.

"3. Georgia Weidman, "Penetration Testing: A Hands-On Introduction to Hijacking'', no starch" press

"4. Michael Sikorski and Andrew Hoing, ''Practical Malware Analysis: A Hands-On Guide to Disecting Malicious Software'',no starch press

Course Code	CS8007	**Course Title**	Social Network Analysis
Contact Hours	L-3, T-0, P-0	**Credit**	3
Program	B.Tech/B.Des	**Semester**	VI
Pre-requisites	None		
Evaluation Scheme	Assignments (10%), Project (20%),Midterm (30%), End term (40%)		

Learning Objective :

1. To enable the students to master the knowledge about network growth models and their Characteristics.
2. Formalize different types of entities and relationships as nodes and edges and represent this" information as relational data
3. Use advanced network analysis software to generate visualizations and perform empirical investigations of network data.
4. Interpret and synthesize the meaning of the results with respect to a question, goal, or task."
5. Collect network data in different ways and from different sources while adhering to legal standards and ethics standard.

Course Details:

Module1:

Introduction: How services such as Facebook, LinkedIn, Twitter, etc. are using SNA to understand their users and improve their functionality.

Network Concept: Introduction, Graphs, Paths and components, Adjacency Matrices, Ways and Modes, Matrix Product, node degree, types of nodes and types of ties, actor attributes **[08H]**

Module2:

Random network models: Erdos-Renyi , Barabasi-Albert , Watts-Strogatz, small-world model, shortest path, six degree of separation

Social Network Visualization Tools: Gephi, NetLogo, Pajek, EgoNet **[08H]**

Module3:

Characterizing whole network: Cohesion, reciprocity, Transitivity and clustering

Coefficient, Triad census

Network centrality: Undirected Non-valued networks, Degree, Eigenvector, betweeness Directed Non-valued, Networks: Degree, Eigenvector, closeness.

Valued Networks, Negative tie

Community Detection: clustering, community structure, modularity, overlapping communities **[10H]**

Module4:

Link Prediction The Katz Score, Hitting & Commute Time, Rooted PageRank, SimRank, Predictors Summary, Meta-measures

Information Diffusion: Cascading Behavior, Herd Behavior, Information, Cascade Model, Threshold Model, Cascade Maximization, Epidemic Modeling. **[08H]**

Module 5:

Security and Privacy in Social Network: Introduction, K-Anonymity, L-Diversity, Q-Anon,

T- Closeness **[08H]**

Text/Reference books:

1. Liu, Bing, Web data mining. Springer-Verlag Berlin Heidelberg, 2007.
2. Chakrabarti, Soumen, Mining the Web: Discovering knowledge from hypertext data, Morgan Kaufmann, 2003.
3. Scime, Anthony, ed. Web mining: applications and techniques, IGI Global, 2005.
4. Hitzler, Pascal, Markus Krotzsch, and Sebastian Rudolph, Foundations of semantic web technologies, CRC Press, 2011.
5. King, Andrew B. Website optimization. "O'Reilly Media, Inc.", 2008.
6. Segaran, Toby. Programming collective intelligence: building smart web 2.0 applications, "O'Reilly Media, Inc.", 2007.
7. Charu.C. Aggarwal, Social Network Data Analytics, Springer Science+Business Media, LLC, 2011

Subject Code:	OE3E29	**Course Title**	Industrial Microwave and Communication
Contact Hours	L- 3 , T- 0 ,P- 0		
Programme	B.Tech/B.Des	**Credit**	3
Pre-Requisites	Electromagnetics	**Semester**	VI
Evaluation scheme	Quiz I (25 %), Midterm (25%), Quiz II (25 %), End term (25 %) Project (%)		

Course Detail

Module 1

Waveguide Components: Overview of Attenuators, Phase Shifters, Matched Loads, Detector Mounts, Slotted Sections, E and H Plane Tees, etc. Signal Generators: Fixed Frequency, Sweep Frequency and Synthesized Frequency Oscillators, PLL for high frequency generation **[10H]**

Module 2

Industrial Microwave: Noise Sources and Noise meters used in microwave measurements, frequency meters and VSWR meters, Measurement of frequency, attenuation, VSWR and impedance, cavity measurements: Q factor, bandwidth; Dielectric and magnetic properties of materials: Cavity and waveguide methods, Measurement of Power: Calorimetric and Microwave bridges; principles of Time and frequency domain reflectometry, Spectrum Analyser and Network Analyser, Measurement of Scattering parameters of passive and active devices **[10H]**

Module 3

Processes in Industrial Microwave: Microwave in process control instrumentation, Microwave waste disposal, Microwave in agriculture and medicine, hyperthermia, etc. Microwave Heating, Microwave absorbers, EMC and EMI **[10H]**

Module 4

Microwave Communication: Microwave Radio and its components, Free space propagation model, ground reflection, Earth and its effect on propagation, Clutter theory, Fresnel Zones: First and Second order Fresnel Zones, Signature width of radio, tolerance limits, Practical Link Budget calculations, Atmospheric Attenuation **[10H]**

Text Books:

1. Microwave Devices and Circuits, Samuel Y Liao, Pearson
2. Microwave Engineering, David M Pozar, Wiley
3. Microwave Measurements, Ananjan Basu, CRC Press

Reference books:

1. T.S. Rappaport, “Wireless Communications,” Pearson Education, 2003.

Subject Code:	OE3D12	**Course Title**	Communication Skills Management
Contact Hours	L-3, T-0, P-0		
Programme	B.Tech/B.Des	**Credit**	3
Pre-requisites	NIL	**Semester**	VI
Evaluation scheme	Presentation (15%), Midterm (30%), Group Discussion (15%), End term (40%)		

Learning Objective:

- To prepare all the students for placements in campus recruitments.
- To facilitate students with cognitive, behavioral, social and psychological underpinnings with communication
- To enable students to display their working knowledge in English communication skills in both academia and realia.

Detailed Course Content:

Module 1 : Self-introductions - Giving impromptu talks - Extempore speech - Comprehensive reading and writing - Intensive reading and extensive reading - Note taking – Note making - Listening to specific information - Listening to a panel discussion – Critical appreciation and reviews -Overcoming communication apprehension and inhibition **[08H]**

Module 2 : Casual interactions — Chatting — Personal and social communication - Public speaking skills - Constructive and destructive communication - Sharing sheer knowledge, beliefs and conventions - Survival communication - Silent communication Convivial communication **[10H]**

Module 3 : Essentialities of English in oral and written business communication - Strong business acumen - Understanding employer perceptions - Understanding job-specific industrial demands - Refined body language and culture - Updating the functional notions of Multinational Corporations (MNC) -Understanding the profile of the company - Performing both hard and soft skills – Business etiquette and professionalism **[08H]**

Module 4 : Positive and constructive intuitions - Self-assumptions and perceptions - Keen observations - Grasping and profound understanding - Surface and deeper memory skills – Critical thinking and logical analysis - Creativity and innovative skills - Steadfastness and assertiveness in communication — Understanding and equipping inherited talents and skills to craftsmanship - Emotional and social intelligence **[08H]**

Module 5: Technical Presentations - Open and closed group discussions on technical and contemporary topics - Mock interviews - Small talk - Writing short notes - Eliciting and reporting work related enquiries - Self-evaluation and peer review of group discussions **[08H]**

Text/Reference books:

1. Comfort. Jeremy, et al. (2011). Speaking Effectively: Developing Speaking Skills for Business English. Cambridge: Cambridge University Press.
2. Kenneth Anderson, Joan Maclean, (2013). Tony Lynch, Study Speaking, 2nd Edition, UK: cambridge, University Press.
3. Rizvi, Ashraf. (2017). Effective Technical Communication. McGraw-Hill India.
4. Rutherford, Andrea J. (2001). Basic Communication Skills for Technology. New Delhi: Pearson Education.
5. Michael Cornwall. Go Suck a Lemon: Strategies for Improving Your Emotional Intelligence. Kindle Edition.
6. Travis Bradberry and Jean Greaves (2005). The Emotional Intelligence Quick Book. Touchstone Publications.

Subject Code:	OE3D20	**Course Title:**	Industrial Design (Elective 1)
Contact Hours:	L-2, T-0, P-2	**Credit:**	4
Programme :	B.Tech/B.Des	**Semester :**	6
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail-

Industrial design application in furniture design. **[07H Lecture,+3H Lab]**
Industrial design application in interior and space design. **[07H Lecture,+3H Lab]**
Industrial design application in transportation design**.** **[07H Lecture,+3H Lab]**
Industrial design application in display and control design. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Arden, P. (2003). It's not how good you are, it's how good you want to be. Phaidon.
2. Hirschberg, J. (1999). The creative priority: Putting innovation to work in your business.
3. Cross, N. (2008). Engineering design methods: strategies for product design. John Wiley & Sons.

Subject Code	OE3M04	**Course Title**	Computer Aided Manufacturing
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme:	B.Tech/B.Des	**Semester**	VII
Pre-requisites:	NIL		
Evaluation scheme	Quiz: Mid-sem: Project: End-sem		

Objective: To analyze different aspects of CAM, CNC programs, basics robotics, material handling system, production management system and thus, create interdisciplinary thoughts

Unit 1:

Computer aided manufacturing: CAM concepts, objective sense scope, nature and type of manufacturing system, evolution, benefits of CAM, role of management in CAM, concepts of computer integrated manufacturing ,impact of CIM on personal, role of manufacturing engineers, CIM basic functions **[08H]**

Unit 2:

NC/CNC machine tools: NC and CNC technology: types, classification, specification and components, construction details, controllers, sensors and actuators, CNC hardware: circulating ballscrew, fiction slides,step/servomotors . Axis designation, NC/CNC Tooling, fundamental programming, types of format, part programming, programming for drilling,lathe and milling, canned cycles, parametric subroutines **[08H]**

Unit 3:

Programmable logic controllers: Relay device components, programmable controller architecture, programming a programmable controllers, tools for PLC logic design **[06H]**

Unit 4:

Flexible manufacturing system and automated guided vehicle system: Types of flexibility, FMS components, FMS application and benefits, FMS planning and control, quantitative analysis, simple problems. Automated guided vehicle system- Application, vehicle guidance technology, vehicle management and safety **[08H]**

Unit 5:

Industrial robotics : Robot anatomy and related attributes:classification of robots, robot control systems, end effectors, sensors, accuracy and repeatability, Industrial robot application, robot part programming, simple problems **[06H]**

Text or References:

Subject Code:	OE3M27	**Course Title**	Vibration of Mechanical Systems
Contact Hours	L-3, T-0, L-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-requisites	NIL		

Evaluation scheme	Quizes (20%); Mid-sem (35%) and End-sem (45%)

Course Detail :

Introduction to vibration and un-damped free vibrations: Types of vibrations. Single degree of freedom systems and Simple problems. Formulation- Newton's second law, Energy method and Principle of virtual work. Introduction, undamped free vibration – natural frequency of free vibration, stiffness of spring elements, effect of mass of spring. **[10H]**

Damped free vibrations: Single degree freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement. **[06H]**

Forced Vibration: Single degree freedom systems, steady state solution with viscous damping due to harmonic force, solution by complex algebra. Concept of response, Reciprocating and rotating unbalance, vibration isolation – transmissibility ratio. Energy dissipated by damping, sharpness of resonance, base excitation. **[08H]**

Systems with two degrees of freedom: Introduction, principal modes and normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, free vibration in terms of initial conditions. Geared systems. Forced Oscillations – Harmonic excitation. Applications: (a) Vehicle suspension (b) Dynamic vibration absorber (c) Dynamics of Reciprocating Engines. **[09H]**

Numerical methods for Multi degree Freedom Systems: Orthogonality of principal modes, Holzer's method, Rayleigh's method. **[04H]**

Vibration monitoring and analysis: Introduction, Accelerometer and vibrometers. Machinery signatures, Selection of Transducers and signal conditioning. Analysis Techniques, Machine failure modes, Measurement location, Vibration severity criteria, vibration frequency analysis. Case studies. **[05H]**

Text/Reference books:

1. Thomson, W.T., Theory of vibration with applications, Third Edition, 1997.
2. Rao, S. S., Mechanical Vibrations, Fourth Edition, Addison Wesley, 2004.
3. Caollacott, R. A.; Chapman, Mechanical Fault Diagnosis and Condition Monitoring, Chapman and hall, 1977.
4. Rao, J. S., Advanced Theory of Vibration, Wiley Eastern Ltd. New Delhi, 1992.
5. Jones, R. J. and Wykes, C., Holographic and Speckle Interferometry, Cambridge University Press, Cambridge, 1983

Course Code	OE3M31	**Course Title**	Machine Learning
Contact Hours	L-3,T-0,P-0	**Credit**	3
Program	B.Tech/B.Des	**Semester**	VI
Pre-requisites	None		
Evaluation Scheme	Quiz I (10%), Mid-Term (20%), Quiz II (10%), End term (40%), Project (20%)		

Learning Objective : In this course students will learn to train the machine using different machine algorithms to solve the real-world prediction problems.

Course Details:

Module 1: Learning Problem, Designing a Learning System, Types of Learning. Supervise Learning: Linear

and Logistic regression, Decision Tree Learning. **[10H]**

Module 2: Instance-Based Learning, kNN and CBR, Bayesian Learning, Naive Bayes Classifier, Artificial Neural Network (ANN), SVM. **[10H]**

Module 3: Unsupervised Learning: Mixture Models and EM, Clustering, K-Means, DBSCAN, Hierarchical clustering, Association Rule Mining, Dimensionality Reduction. **[10H]**

Module 4: Performance Evaluation, Confusion Metrics, Evaluating Hypotheses, Confidence Interval, Hypothesis Testing Ensemble Learning Bagging and Boosting Formulating. Computational Learning Theory, Issues and practical advice in Machine Learning. **[10H]**

Text/ Reference books:

1. Tom Mitchell. Machine Learning, McGraw Hill, 1997.
2. Chris Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
3. Stephen Marsland, Machine Learning an Algorithmic Perspective, Chapman and Hall/CRC, 2014.
4. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, Foundations of Machine Learning (Adaptive Computation and Machine Learning Series), MIT, 2012.

Subject Code:	ME8017	**Course Title**	Electric Vehicle and Mobility
Contact Hours	L-3, T-0, L-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-requisites	NIL		
Evaluation scheme	Quiz (02): 10%, Mid Sem (30%), Project / Term Paper: 15%, Assignment: (5% and End Sem (40%)		

Learning Objective: Aims to learn impact of EVs on the road. Does the environmental gain from vehicle electrification justify heavy investment in charging infrastructure? Whats the economics of EVs on the road? How long will it last? Whats the prospects of EVs with IOT?

This course will help acquire elements from engineering science, sociology, environmental science, political science, economics, management science, in order to evaluate, analyze and implement the diffusion of electric vehicles where their use is relevant.

The course will be useful for post-graduate students and final year undergraduate students**.**

Course Detail :

Module1: Understand Mobility and its Evolution

Mobility Challenges, ICE vs EV

Mobility, Urban Forms and Ways of Life

Energy Storage: Introduction to Energy Storage Requirements in Electric Vehicles, Battery based energy storage and its analysis

Electric Mobility: Specifications and Evolutions **[04H]**

Module2: Electric Mobility and Environmental Impact Reduction

Climate Change

Local Impacts of Transportation

Life-Cycle Assessment (LCA) **[06H]**

Module3: Electric Vehicle Battery and Energy Management

Introduction to EV batteries

Batteries of future

Battery management systems

Introduction to energy management strategies used in electric vehicles

Automotive networking and communication

EV charging standards, V2G, G2V, V2B, V2H. **[15H]**

Module4: – Economic Analysis

Economic Analysis Tools and Concepts

Electric Mobility and Environment: Economic Balance

Macroeconomic Scale

Microeconomic Scale **[06H]**

Module5: Electric Mobility and Infrastructures: Technical and Economic Dimensions

Issues and Situational Analysis
Electric Mobility Business possibilities
Mobility Services
Connected Mobility
integration of EVs in smart grid
Simulations and case studies in above mentioned areas **[10H]**

Text/Reference books:

1. **Course or other web links (https://www.coursera.org/learn/electric-vehicles-mobility)**

OE05 (Choose any one course from below electives)

Course Code	CS8009	**Course Title**	Image Processing
Contact Hours	L-3,T-0,P-0	**Credit**	3
Program	B.Tech/B.Des	**Semester**	VI
Pre-requisites	None		
Evaluation Scheme	Quiz I (10%), Mid-Term (20%), Quiz II (10%), End term (40%), Project (20%)		

Learning Objective : Understand image formation and the role human visual system plays in perception of gray and color image data. Get broad exposure to and understanding of various applications of image processing in industry, medicine, and defence.

Course Details:

Module 1: Digital Image Fundamentals: Image sensing, acquisition, sampling and quantization, basic relationships between pixels. Image Enhancement in Spatial Domain: Gray level transformation, histogram processing, smoothing and sharpening Spatial Filters. **[08H]**

Module 2: Image Transforms: Fourier transform and their properties, Fast Fourier transform, Other transforms, image enhancement in frequency domain.
[08H]

Module 3: Color Image Processing, Image Restoration, Image Compression. **[08H]**

Module 4: Wavelets and Multiresolution Analysis: Introduction to wavelets, scaling functions and subspaces, Subband coding, Subband decomposition of images, Continuous and Discrete wavelet transforms. Various morphological operators and their use in different applications. **[08H]**

Module 5: Image Segmentation: edge detection, Hough transform, region based segmentation, Representation and Description: Object representation, boundary based descriptors, region based descriptors (texture and shape features). **[08H]**

Text/Reference books:

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Third Edition, Pearson, 2012.
2. M Sonka, V Hlavac, R Boyle, Image Processing, Analysis, and Machine Vision, Third Edition, Thomson Engineering, 2007.
3. W. K. Pratt, Digital Image processing, Third Edition, John Wiley & Sons Inc., 2001.
4. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson Education, 2006.

Subject Code	OE3E09	**Course Title**	IC Fabrication
Contact Hours	L- 3 , T-0 ,P-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-Requisites			
Evaluation scheme	Quiz I (15 %), Midterm (30 %), Quiz II (15 %), End term (40%) Project (%)		

Module 1

Introduction to IC Technology: Semiconductors and Insulators: Definition, crystal structures, physical properties, Moore's law, Crystal Defects, Basic Fabrication Steps, Wafer Fabrication-CZ and FZ Techniques, MBE, LPE and MOCVD Techniques for Crystal Growth **[08H]**

Module 2

Thermal Oxidation of Silicon and Photolithography: Oxidation kinetics (general solution, Parabolic and linear growth and empirical modifications to the growth rate of SiO_2 and its kinetics), SiO_2/Si interface, charge traps and impurities redistribution at the interface, Photolithography steps, Photoresists, Physical properties of Resists (Sensitivity, Resolution, etc.), Exposure Energy Plots, Clean Room, RCA Cleaning Techniques, Gettering, Wafer Exposure Systems: Proximity, Projection and Contact Printing Systems **[12H]**

Module 3

Etching, Diffusion and Ion Implantation: Attributes of Etchants, Selectivity and Anisotropy, Wet Chemical Etching, Dry etching, Sputter Etching, Plasma Etching, Reactive Ion Etching, Etch Systems, Diffusion: Dopant Introduction and Redistribution, Diffusion Equations (Fick's laws), Constant Source, Drive-in-diffusion and Burried Gaussian Source Diffusion, Mechanisms for Diffusion, Electric Field Enhancement, Dose, Beam Current, Ion Implanter Basics, Stopping Mechanisms: Nuclear Stopping and Electronic Stopping, Channeling, Doping Profiles, Damages caused by Ion Implantation, Annealing **[15H]**

Module 4 Metallization and Process Integration

Ohmic and Schottky contacts, Metallization: PVD, CVD, Aluminium Metallization, Copper Metallization, Silicides, Basic Fabrication Process for Passive Components, pn Junctions and CMOS **[09H]**

Text Books:

1. S.M.Sze(2nd Edition)"VLSI Technology", McGraw Hill Companies Inc.
2. C.Y. Chang and S.M.Sze (Ed), "ULSI Technology", McGraw Hill Companies Inc.

Reference books:

1. James D.Plummer, Michael D.Deal, "Silicon VLSI Technology" Pearson Education

Subject Code:	OE3E32	**Course Title**	Biomedical Instrumentation
Contact Hours	L-3, T-0, L-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Course Detail :

Physiology and Transducer: Cell and its structure – Action and resting – Potential propagation of action potential – Sodium pump – Nervous system – CNS – PNS – Nerve cell – Synapse – Cardio pulmonary system – Physiology of heart and lungs – Circulation and respiration – Transducers – Different types – Piezo-electric, ultrasonic, resistive, capacitive, inductive transducers – Selection criteria. **[09H]**

Electro – Physiological Measurements: Basic components of a biomedical system – Electrodes – Micro, needle and surface electrodes – Amplifiers – Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier. ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms. **[09H]**

Non-Electrical Parameter Measurements: Measurement of blood pressure – Cardiac output – Cardiac rate – Heart sound – Respiratory rate – Gas volume – Flow rate of Co2, o2 in exhaust air - PH of blood, ESR, GSR measurements – Plethysmography. **[09H]**

Medical Imaging And PMS: X-ray machine - Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems and patient monitoring – Electrical safety. **[07H]**

Assisting And Therapeutic Equipments: Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dializers. **[07H]**

Text/Reference books:

1. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II Edition, Pearson Education, 2002 / PHI.
2. R.S.Khandpur, 'Handbook of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 2003
3. M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.
4. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley & Sons, 1975.
5. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.
6. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India) Ltd, Orient Longman ltd, 2000.

Subject Code:	OE3D06	**Course Title**	Indian Philosophy and Literature in English
Contact Hours	L-3, T-0, L-0		
Programme	B.Tech/B.Des	**Credit**	3
Pre-requisites	NIL	**Semester**	VI
Evaluation scheme	Quiz I (10%), Mid term (30%), Quiz II (10%), End term (50%)		

Course Detail :

Indian Writing in English

1. Rabindranath Tagore **[03H]**
 - Gitanjali (song no. 1-7, 13, 18,57)
2. Dr. S. Radhakrishnan- **[07H]**
- The Hindu View of Life. (1 chapter) - An Idealist View of Life. (selected readings- 1 chapter)
3. Mahatma Gandhi- **[03H]**
- The story of my Experiments with truth. (selected readings- 2 chapters)
4. Swami Vivekananda- **[05H]**
- Microcosm - Macrocosm
5. Kabir – **[04H]**
- Some songs

American Literature

1. Ralph Waldo Emerson- **[08H]**
- The America Scholar - Self Reliance
2. Henry David Thoreau- **[08H]**
- Christianity and Hinduism compared - Resistance to Civil Government
3. Some Poems- **[02H]**
- Ralph Waldo Emerson i. Brahma ii. Hamatreya
4. Henry David Thoreau **[02H]**
- Walden (book –some readings)

Text/Reference books:

1. Basham, A.L. The Wonder that was India, New Delhi: Rupa and Co., 1997
2. Buell, Lawrence, The American Transcendentalists Essential Writings, New York: Random House, 2006.
3. Gopal, Sarvepalli, Radhakrishnan: A Biography, New Delhi: Oxford University Press, 2003.
4. Iyengar, Srinivas K.R., Indian Writing in English, New Delhi: Sterling Publishers, 2002.
5. Mcdermott, Robert A., Basic Writings of S. Radhakrishnan, Mumbai:Jaico Publishing House, 2002.
6. Mumukshananda, Swami, The Complete works of Swami Vivekananada, Calcutta: Swami Mumukshananda, 1994.
7. Narayan, Shriman, The Selected works of Mahatma Gandhi, Ahmedabad: Navjivan Trust, 1997.
8. Radhakrishnan, S., An Idealist View of Life, New Delhi: Indus Publishers, 1994.
9. Radhakrishnan, S., The Hindu View of Life, Mumbai: Blackie and Son Publishers, 1983.
10. Tagore, Rabindranath, Gitanjali, New Delhi: Macmillan India Limited, 1997.

Subject Code:	OE3D21	**Course Title:**	Communication Design
Contact Hours:	L-2, T-0, P-2	**Credit:**	3
Programme :	B.Tech/B.Des	**Semester :**	VI
Pre-requisites:	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail-

Communication design application in furniture design. **[07H Lecture,+3H Lab]**

Communication design application in interior and space design. **[07H Lecture,+3H Lab]**

Communication design application in transportation design. **[07H Lecture,+3H Lab]**

Communication design application in display and control design. **[07H Lecture,+3H Lab]**

Text/Reference books:

1. Williams, R., & Newton, J. (2009). Visual communication: integrating media, art, and science. Routledge.
2. Worth, S., & Gross, L. P. (1981). Studying visual communication (pp. 134-147). L. P. Gross (Ed.)

Philadelphia: University of Pennsylvania Press
3. Baldwin, J., & Roberts, L. (2006). Visual communication: from theory to practice. Ava Publishing.

Subject Code:	OE3M10	**Course Title**	Finite Element Methods for Mechanical Engineering
Contact Hours	L-3, T-0, L-0		
Programme	B.Tech/B.Des	**Credit**	3
Pre-requisites	NIL	**Semester**	VI
Evaluation scheme	Quiz (10%), Project (20%) Mid-Sem(30%) and End-sem(40%)		

Learning Objective: Basic course of finite element methods and understanding the FE software (ANSYS & Abaqus)

Course Detail :

Module1:
Objective of the Course, Basic Steps in FEM Formulation, Finite element formulation starting for governing equation: Weighted residual Method, Galerkin Method, Weak (Variation), Ritz Method. **[10H]**

Module2:
1-D Elements, Spring and Truss elements, Basis Functions and Shape Functions. Convergence Criteria, assembly, imposition of boundary conditions. **[10H]**

Module3: Plane Strain and Stress, Problems with CI continuity: Beam Bending, Connectivity and Assembly of CI Continuity Elements. 2-D elements, Truss elements, Beam elements, (Triangles and Quadrilaterals) and Shape Functions. Numerical integration, Sub-parametric, Iso-parametric and Super-parametric Elements. **[10H]**

Module4: Dynamics of Finite element, Free Vibration Problems, Formulation and solution of Eigen Value Problem, explicit and implicit methods. **[10H]**

Text/Reference books:

1. O C Zienkiewicz and R L Taylor, The Finite Element Method, 3d ed.McGraw-Hill, 1989
2. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1982.
3. Seshu P. Text Book of Finite Element Analysis, PHI, 1st Edition, 2003.
4. Cook, Malkus and Plesha, Concepts and Applications of Finite Element Analysis, John Wiley and Sons
5. Daryl L Logan : A First Course In The Finite Element Method CL Engineering; 5th edition
6. Chandrupatla : Introduction to Finite Elements in Engineering",3rd Edition, Prentice-Hall of India, Eastern Economy Editions.

Subject Code:	ME8016	**Course Title**	Biomaterials Science and Engineering
Contact Hours	L-3, T-0, L-0		
Programme	B.Tech/B.Des	**Credit**	3
Pre-requisites	NIL	**Semester**	VI
Evaluation scheme	**Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)**		

Course Detail :

Introduction: Requirements of biomaterials, Classification of biomaterials, Mechanical properties of biomaterials, Effects of processing on properties of biomaterials **[05H]**

Biological Materials: Structure of proteins, collagen, elastic proteins, polysaccharides, chitin and chitosan, structure properties relationships **[06H]**

Metallic Implant Materials: Some common examples and properties of metals used as implants: stainless steel, titanium and titanium alloy, cobalt chrome alloys. Problem of corrosion, corrosion behavior and the importance of passive films for tissue adhesion, wear, fatigue, stress shielding, stress-corrosion cracking. Host tissue reaction with metals. **[06H]**

Polymeric Implant Materials: Some common examples and properties of polymers used as implants: PE,

PMMA, Silicon Rubber, Polyester, Acetals, Biodegradable Polymers. (Classification according to thermosets, thermoplastics and elastomers). Viscoelastic behavior: Tg, creep-recovery, stress relaxation, strain-rate sensitivity. Host tissue reaction: importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. **[06H]**

Ceramics Implant Materials: Definition of bioceramics. Common types of bioceramics (inert and bioactive types) and their properties (importance of wear resistance and low fracture toughness). Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction). **[06H]**

Composite Implant Materials: Mechanics of improvement of properties by incorporating different elements. Composites theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g hydroxyapatite). Textile composites. Host tissue reactions. **[06H]**

Testing of Biomaterials: In-vitro testing. Mechanical test: wear, fatigue, tensile, corrosion studies and fracture toughness. Effect of physiological fluid on the properties of biomaterials. In-vivo testing (animals). Ex-vivo testing. Contact allergy to biomaterials. Standards. **[05H]**

Text books:

1. Biomaterials Science-Ratner, Hoffman, Schoen, Lemons (Elsevier; ISBN 0-12-582461)
2. Biomaterials -Temenoff and Mikos (Pearson Prentice Hall; ISBN 0-13-009710-1)
3. Materials Science and Engineering: An Introduction -Callister (John Wiley and Sons; ISBN 0-471-13576-3)
4. Science and Engineering of Materials -Askland and Phule (Thomson; ISBN 0-534-55396-6

Reference books:

1. SH Teoh (Ed), Engineering Materials for Biomedical Applications, World Scientific, 2004.
2. JB Park and RS Lakes (Eds), Biomaterials - An Introduction, Springer-Verlag, 3rd Edition, 2007.
3. BD Ratner, AS Hoffman, FJ Schoen, JE Lemons (Eds), Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 2nd Edition, 2004

OE06 (Choose any one course from below electives)

Course Code	CS8011	**Course Title**	Machine Learning
Contact Hours	L-3,T-0,P-0	**Credit**	3
Program	B.Tech/B.Des	**Semester**	VI
Pre-requisites	None		
Evaluation Scheme	Quiz I (10%), Mid-Term (20%), Quiz II (10%), End term (40%), Project (20%)		

Learning Objective : In this course students will learn to train the machine using different machine algorithms to solve the real-world prediction problems.

Course Details:

Module 1: Learning Problem, Designing a Learning System, Types of Learning. Supervise Learning: Linear and Logistic regression, Decision Tree Learning. **[10H]**

Module 2: Instance-Based Learning, kNN and CBR, Bayesian Learning, Naive Bayes Classifier, Artificial Neural Network (ANN), SVM. **[10H]**

Module 3: Unsupervised Learning: Mixture Models and EM, Clustering, K-Means, DBSCAN, Hierarchical clustering, Association Rule Mining, Dimensionality Reduction. **[10H]**

Module 4: Performance Evaluation, Confusion Metrics, Evaluating Hypotheses, Confidence Interval, Hypothesis Testing Ensemble Learning Bagging and Boosting Formulating. Computational Learning Theory, Issues and practical advice in Machine Learning. **[10H]**

Text/ Reference books:

5. Tom Mitchell. Machine Learning, McGraw Hill, 1997.
6. Chris Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
7. Stephen Marsland, Machine Learning an Algorithmic Perspective, Chapman and Hall/CRC, 2014.
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, Foundations of Machine Learning (Adaptive Computation and Machine Learning Series), MIT, 2012.

Subject Code:	OE3C34	**Course Title**	Cyber Physical Systems
Contact Hours	L-3, T-0, L-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-requisites	NIL		
Evaluation scheme	Quiz I (20%), Mid-Term (20%),End term (40%), Project (20%)		

Objective:

This course is designed to offer learners an introduction to cyber physical system and its applications in business world. This course provides an insight into concepts of structure, function, and challenges in cyber physical system. Related technologies and challenges are also introduced to present the overall techno-economic and social scenario before the learners.

Course Detail :

Unit 1:Introduction to CPS and CPPS **[06H]**

Introduction, Concept maps of cyber physical system and cyber physical production system, literature survey and trends, Need for cyber physical systems, Applications and economics of cyber physical system

Unit 2: Structure and function cyber physical production system (CPPS) **[10H]**

Concept of embedded computer systems, internet of things, industrial internet of things, internet of services, ubiquitous computing, sensors and actuators, RFID, IPv4 and IPv6, International standards and safety considerations

Unit 3: Introduction to Industry 4.0 (IR 4.0) **[08H]**

Various industrial revolutions, digitalization and networked economy, enablers and challengers to IR 4.0, smart manufacturing, smart logistics, smart cities, comparison of present factory with IR 4.0 factory, trends and predictive analysis for business transformation

Unit 4: Related technologies to IR 4.0 **[06H]**

Robotic automation; collaborative robotics; support system for IR 4.0; mobile computing; cyber security; role of data, information, knowledge and collaboration in IR 4.0 factories, cloud computing

Unit 5: Business issues in CPS and Case studies **[10H]**

Opportunities and challenges, future of work and skill amongst workers, strategies for competition, strategies for collaboration, business models for CPS Study of various CPS modules in different real-life industrial situations, Design and synthesis of CPS, Troubleshooting in CPS, Application in smart grid, autonomous automobile, medical monitoring, industrial control and robotic systems

Text/Reference books:

1. Editor(s): Houbing Song, Danda B. Rawat, Sabina Jeschke, Christian Brecher,Cyber-Physical Systems: Foundations, Principles and Applications, Academic Press (2017)
2. Raj Rajkumar and Dionisio De Niz ;Cyber-Physical Systems 1st Edition, Pearson India (2017)
3. Y. Maleh ;Cybersecurity And Privacy In Cyber PhysicalSystems, Taylor & Francis Ltd; (2019)
4. Li ;Reinforcement Learning for Cyber-Physical Systems; Routledge; (2019)

Subject Code	OE3E15	**Course Title:**	Information Theory and Coding
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-Requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Course Detail:

Module 1

Review of probability theory, Entropy: marginal entropy, joint entropy, conditional entropy and the chain rule for entropy. Mutual information between ensembles of random variables. **[06H]**

Module 2

Source Coding theorems: prefix, variable and fixed length codes. Channel models and channel capacity. Channel Coding theorem. **[09H]**

Module 3

Linear Block Codes: Generator and parity check matrices, Minimum Distance, Syndrome decoding, Bounds on minimum distance. **[09H]**

Module 4

Cyclic Code: Finite Fields, binary BCH codes, RS Codes. Convolutional Codes: Encoders, Trellis, Viterbi decoding. **[18H]**

Text Books:

1. Thomas M. Grover and Joy A. Thomas, “Elements of Information Theory,” Wiley.
2. John G. Proakis and Masoud Salehi, “Digital Communications,” 5th edition, McGraw Hill.

Reference books:

1. Csisz´ar & K¨orner, “Information Theory: Coding Theorems for Discrete Memoryless Systems”, Cambridge university press, 2011.

Subject Code:	OE3E35	**Course Title**	Speech Processing
Contact Hours	L-3, T-0, L-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-requisites	NIL		
Evaluation scheme	Midterm (35%), End term (45%), Project (20%)		

Learning Objective: This course will provide learners with an understanding of speech processing

Course Detail :

Module I:

Applications, pattern recognition, feature extraction, modeling, testing; Speech recognition: Objective, issues, block diagram description, classification, development of speech recognition system using vector quantization (VQ), dynamic time warping (DTW), Hidden Markov Model (HMM) and Neural networks (NN); **[10H]**

Module II:

Speech synthesis: Objective, issues, block diagram description, classification, development of speech synthesis system using articulatory, parametric, concatenative and HMM based approaches. **[10H]**

Module III:

Speaker recognition: Objective, issues, block diagram description, classification, development of speaker recognition system using VQ , DTW, GMM NN and HMM;" **[10H]**

Module IV:

Speech enhancement: Objective, issues, block diagram description, classification, enhancement of noisy speech, reverberant speech enhancement and multi -speaker speech processing."

Text/Reference books:

1 . L. R. Rabiner, B. H. Jhuang and B. Yegnanarayana."Fundamental s of speech recognition", Pearson Education, 2009.

"2. J . R. Deller, Jr., J. H. L. Hansen and J. G. Proakis Discrete-Time Processing of Speech Signals, Wiley- IEEE Press, NY, USA, 1999."

"Reference books:

1. D. O'Shaughnessy, Speech Communications: Human and Machine, Second Edition, University Press, 2005.

"2. J . Benesty , M. M . Sondhi and Y. Huang , ''Hand book of speech processing)', Springer, 2008."

Subject Code:	OE3D37	**Course Title**	Application for Renewable Energy Resources in Design
Contact Hours	L-2, T-0, L-2		
Programme	B.Tech/B.Des	**Credit**	3
Pre-requisites	NIL	**Semester**	VI
Evaluation scheme	Assignment I (15%), Midterm (30%), Assignment II (15%), End term (40%)		

Learning Objective: The course will help to develop basic knowledge about Renewable Energy Resources and its application in Design. It Will also help to develop the idea about methods and tools required for the sustainable design.

Course Detail :

Module 1 : Introduction to Energy sources, Prospects of renewable energy sources, Environmental impact of renewable energy towards sustainability. Solar Energy: Solar radiation, Different types of Solar Collectors, Principle of energy conversion in solar cells, Different types of PV Cell, Design of PV array, Application of Solar Energy. **[7H Lecture+3H Lab]**

Module 2 : Wind Energy: Principle of Wind energy conversion; Basic components, various types of windmills and their constructional features; design considerations, site selection considerations and applications. Bio Energy : Resources and conversion process, Biogas generation plants classification and applications. **[7H Lecture+3H Lab]**

Module 3 : Geo thermal Energy: nature of geothermal energy, geothermal sources, application and future prospects. Ocean Energy: Ocean Thermal Electric Conversion (OTEC) systems, Energy from tides, basic principle of tidal power and application, power from wave, wave energy conversion devices, application and future prospect. **[7H Lecture+3H Lab]**

Module 4 : Hydrogen Energy: Hydrogen production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen energy. Fuel Cells: Design principle and operation of fuel cell, Types of fuel cells, application of fuel cells. Magneto hydrodynamics (MHD) energy conversion: Principle of MHD power generation, Design problems and developments, application and future prospect. **[7H Lecture+3H Lab]**

Text/Reference books:

1. Rai, G.D. (1988). Non conventional Energy Sources. Khanna Publishers.
2. Bansal, N. K., Kleemann, Manfred, Meliss, Michael (1990). Renewable energy sources and conversion technology. Tata Mc Graw Hill.
3. Desai Ashok V. 1990 Non conventional Energy. New Age International Publishers Ltd.

Subject Code:	OE3D39	**Course Title**	The scope in **Traditional Media** Arts
Contact Hours	L-2, T-0, P-2	**Credit**	3
Programme	B.Tech/ B.Des	**Semester**	VI
Pre-requisites	NIL		
Evaluation scheme	Assignment I (15%), Midterm (30%), Assignment II (15%), End term (40%)		

To prepare students to perceive, experience, visualize, create and exhibit their works and to use these skills in the main core esteem.

This course will be helpful in developing:

- drawing, painting and installation skills.
- conceiving and conceptualizing ideas into actual work of art/design.
- through their artwork sensitivity towards social and regional issues.
- presentation skills, the ability to work in groups and handle responsibilities.

Detailed Course Content:

Module 1 : Understanding art Indian and western art **[10H]**

Module 2 : Techniques applied in still life: sketching, water and oil colours **[10H]**

Module 3 : Evaluation and skills in Landscape drawing and painting: outdoor practice rapid sketching and painting. **[10H]**

Module 4 : Printmaking using different surfaces **[10H]**

Text/Reference books:

1. Drawing Still Life, Publisher: Unicorn Books (l January 2009) by PROSENJIT SAHA (Author ARUNDHATI SAHA (Author)
2. A History of Fine Arts in India and West, Publisher: Orient BlackSwan (1989) by E. Tomory (Author)
3. A World History of Art, Publisher: Laurence King Publishing; 7th Revised edition edition (10 August 2009) by High Honour (Author), John Fleming (Author)

Subject Code:	OE3M18	**Course Title**	Maintenance and Reliability
Contact Hours	L-3, T-0, L-0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Learning Objective: This course will introduce the basic maintenance and reliability concepts and tools. It will give an understanding about how to apply these concepts and tools at different phases of systems' life cycle and can have a significant impact on company profitability.

Course Detail :

Module1: Maintenance Concepts and Strategies: Introduction, maintenance functions and objectives, maintenance planning and scheduling, maintenance organization. General Introduction to Maintenance Types: Breakdown, emergency, corrective, predictive, and preventive; maintenance prevention; design-out maintenance, productive maintenance, shutdown maintenance and scheduled maintenance. **[08H]**

Module2: Condition Based Maintenance: Principles of CBM, pillars of condition monitoring, CBM implementation and benefits; condition monitoring techniques- visual monitoring, vibration monitoring, wear debris monitoring, corrosion monitoring, performance monitoring **[08H]**

Module3: Basic Concepts of Reliability: Probability distributions used in maintenance engineering- Binomial, Poisson, Exponential, Normal, Log-normal, Gamma and Weibull distribution; failure rate, hazard rate, failure modes, MTTR, MTBF, MTTF **[10H]**

Module4: System Reliability Models: System reliability–n-component series systems, m-component parallel systems and combined system; standby systems; K-out-of-m systems; redundancy techniques in system design; event space, decomposition (Key Stone), cut and tie sets, Markov analysis, reliability and quality, unreliability, maintainability, availability **[10H]**

Module 5: Repair methods for basic machine elements: beds, sideways, spindle gear, lead screws, Failure analysis, Logical and sequential fault location methods, Repair methods for material handling equipment: handling equipment, job order systems, use of computers in maintenance. **[06H]**

Text/Reference books:

1. Ebeling C.E., An Introduction to Reliability & Maintainability Engg., TMH
2. Higgins L.R., “Maintenance Engineering Hand book”, McGraw Hill, 5th Edition, 1988.
3. Srinath L.S., Reliability Engineering; East West Press.

Subject Code:	OE3M19	**Course Title**	IC Engine
Contact Hours	L- 3, T- 0, P- 0	**Credit**	3
Programme	B.Tech/B.Des	**Semester**	VI
Pre-requisites	NIL		
Evaluation scheme	Quiz (15%), Mid-sem (35%) and End-sem (50%)		

A. INTRODUCTION: **[05H]**

1. Basic definitions:
2. Brief history of the engine:
3. Definitions of various terms used in engines
4. Classification of engines - different types of engines:

B. THERMODYNAMICS OF CYCLES: **[04H]**

1. Air Standard Cycles
2. Variable Specific Heat Calculations
3. The Air Standard Engine
4. Fuel Air cycles
5. Real Cycles:
6. Computer Simulation

C. FUELS: **[03H]**

1. Properties of fuels and their measurement
2. Requirements of fuels for the petrol engine
3. Requirements of fuels for the diesel engine
4. Conventional fuels for the petrol and diesel engines
5. Alternative fuels for the petrol and diesel engines necessity for alternative fuels, requirements for alternative fuels.

D. INTAKE SYSTEM: **[02H]**

1. Intake and exhaust processes in a four-stroke cycle engine:
2. Volumetric efficiency

E. FUEL METERING IN A SPARK IGNITION ENGINE: **[02H]**

1. Mixture requirements in an si engine
2. Principle of carburetion
3. Fuel injection in a spark ignition (petrol) engine, mpfi

F. COMBUSTION IN THE SPARK. IGNITION ENGINE: **[02H]**

1. Basic combustion process
2. Analysis of cylinder pressure data
3. Ignition
4. Abnormal combustion
5. In cylinder motion

G. COMBUSTION IN THE COMPRESSION IGNITION ENGINE: **[04H]**

1. Basic combustion process
2. Analysis of cylinder pressure data
3. Fuel injection
4. Incylinder motion
5. CRDI

H. Misc: Hybrid powertrain architecture, Features like engine auto start/stop, ECU: **[02H]**

I. ENGINE EMISSIONS - FORMATION AND CONTROL: **[04H]**

1. Nature and sources of engine emissions.
2. Mechanism of pollutant formation in engines.
3. Emission control strategies.
4. Instruments for measuring exhaust emissions.
5. Emission system: muffuler and catelytic converter.
6. Introduction to Bharat stage emission standards, co emission and carbon credit

J. ENGINE TESTING AND PERFORMANCE CHARACTERISTICS: [05H]

1. Measurement techniques.
2. Performance factors and ratings.
3. Types of performance tests.
4. Performance characteristics of si engines
5. Performance characteristics of ci engines.
6. Heat balance.

K. COOLING SYSTEMS: [03H]

Need Variation of gas temperature. Piston temperature distribution. Theory of engine heat transfer and correlation. Parameters affecting engine heat transfer. Air-cooled systems. Types of water- cooling systems. Radiators, Fans, Correlation for the power required for engine cooling.

L. LUBRICATION SYSTEMS: [03H]

Causes of engine friction. Function of lubrication. Mechanism of lubrication. Journal bearing lubrication. Types of lubrication systems. Lubrication of engine components.

M. SUPERCHARGING AND TURBOCHARGING: [03H]

N. Supercharger, Supercharging methods for SI engines, Turbocharging In CI engines, Supercharged Engine performance evaluation.

Text/Reference books:

1. Ganesan, V. Internal Combustion Engines, Second Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.
2. Mathur, R.P. And Sharma, M.L. A Course In Internal Combustion engines, 8thedition, Dhanpatrai and Sons, New Delhi.
3. Fundamentals Of I.C. Engines - P.W. Gill, J.H. Smith And EJ. Ziurys.

B.Tech/B.Des Semester-VII

OE07 (Choose any one course from below electives)

Subject Code:	EC8001	**Course Title**	Advance Engineering Electromagnetics
Contact Hours	L-3, T-0, P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites	Fundamental of electromagntics and Engineering mathematics.	**Semester**	VII

Evaluation scheme

Time harmonic electromagnetic fields, Wave propagation in dielectric and lossy media, Reflection and transmission of waves, Duality principle, Image theory, Equivalence principle, Reciprocity theorem, Green's function, Radiation from source. **[12L]**

Plane waves, Wave functions, Propagation in waveguides, Rectangular Cavity, Partially filled waveguides, Hybrid modes, Modal expansion of fields, Dielectric slab waveguides, Radiation from apertures in ground planes. **[10L]**

Cylindrical waves, Bessel and Henkel functions, Cylindrical waveguides and cavity, Radial waveguides, Sources of Cylindrical waves, Wave transformation, Scattering by cylinders, Radiation from apertures. **[10L]**

Spherical waves, Spherical Bessel and Henkel functions, Legendre polynomial, Spherical cavity, Space as a waveguide, Spherical Radial waveguides, Sources of spherical waves, Spherical wave transformation, Scattering by spheres**.** **[10L]**

Text/Reference books:

1. Time Harmonic Electromagnetic Fields by Roger F Harrington, IEEE Press
2. Advanced Engineering Electromagnetics by Constantine A. Balanis, Wiley, February 2012.

Subject Code:	ME5022	**Course Title**	Industrial Instrumentation & Metrology
Contact Hours	L-3, T-0, P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites	NIL	**Semester**	VII
Evaluation scheme	Quiz (15%), Mid-sem (35%) and End-sem (50%)		

Industrial Instrumentation: Theory and Experimentation in Engineering problem solving approaches, types of engineering experiments, computer simulation and physical experimentation: Generalized measuring system, types of inputs analog and digital signals, standards, calibration and uncertainly. **[08H]**

Measurement system; performance characteristic, static performance characteristics-static calibration linearity static sensitivity, repeatability, hysteresis threshold-resolution, readability and span: Analysis of experimental data; Causes and types of experimental error, un-certainly analysis statistical analysis of data , probability distributions and curve fitting: Dynamic performance characteristics: Input types Instrument types zero order instrument, first order instrument second order instrument. **[09H]**

Experiment plans, Model building, Measurement Methods and Application Measurement of force and torque; Measurement of strain and stress; Measurements ofpressure; Flow measurement and flow visualization, measurement of temperature, optical methods of measurements; **[09H]**

Data Acquisition and Processing : Types and configurations of DAS, Signal conditioning, A/D, D/A conversion: Design, Planning, Execution and Analysis of experimental projects. **[06H]**

Metrology: Measurement of length, measurement of angle, measurement of geometric forms, straightness, flatness, roundness etc. Mechanical and optical methods. Measurement of screw threads and gears. Measurement of surface roughness and texture, introduction to CMM in-process gages, Inspection and quality monitoring. **[10H]**

Text/Reference books:

1. Mechanical Measurements by S.P. Venketeshan, IIT Madras Anne Book Pvt. Ltd. 4821 Parwana Bhawan, 1st floor 24 Ansari Road, Darya ganj, New Delhi-110 002.
2. Engineering Metrology by R. K. Jain, Khanna Publishers, and New Delhi 1997.
3. E.O. Deobelin, Measurement systems, Applications and Design 4th Edition Tata McGraw Hill 1990.
4. T.G. Beckwith, R.D. Marangoni and J.H. Tenhard Mechanical Measurements 5th ed. Addison Wesley 1993.
5. Holman, Experimental Methods for Engineers McGraw Hill 1994.

Subject Code:	OE4M40	**Course Title**	Computer Integrated Manufacturing
Contact Hours	L- 3 T- 0 P- 0		
Programme	B.Tech	**Credit**	3
Pre-requisites	NIL	**Semester**	VII
Evaluation scheme	Quiz (15%), Mid-sem (35%) and End-sem (50%)		

Course Detail:

Introduction: Production Systems; Automation in Production Systems; Manual Labor in Production Systems; Automation Principles and Strategies **[03H]**

Manufacturing Operations: Manufacturing Industries and Products; Manufacturing Operations; Production Facilities; Product/Production Relationships; Lean Production **[03H]**

Manufacturing Models and Metrics: Mathematical Models of Production Performance; Manufacturing Costs **[03H]**

Material Transport Systems: Introduction to Material Handling Equipment; Material Transport Equipment; Analysis of Material Transport Systems **[03H]**

Storage Systems: Storage System Performance and Location Strategies; Conventional Storage Methods and Equipment; Automated Storage Systems; Engineering Analysis of Storage Systems. **[03H]**

Introduction to Manufacturing Systems: Components of a Manufacturing System; Classification of Manufacturing Systems; Overview of the Classification Scheme **[03H]**

Single-Station Manufacturing Cells: Single Station Manned Workstations; Single Station Automated Cells;

Applications of Single Station Cells; Analysis of Single Station Cells **[03H]**

Manual Assembly Lines: Fundamentals of Manual Assembly Lines; Analysis of Single Model Assembly Lines; Line Balancing Algorithms; Mixed Model Assembly Lines; **[03H]**

Workstation Considerations; Other Considerations in Assembly Line Design; Alternative Assembly Systems **[03H]**

Automated Production Lines: Fundamentals of Automated Production Lines; Applications of Automated Production Lines; Analysis of Transfer Lines. **[02H]**

Automated Assembly Systems: Fundamentals of Automated Assembly Systems; Quantitative Analysis of Assembly Systems. **[02H]**

Cellular Manufacturing: Part Families; Parts Classification and Coding; Production Flow Analysis; Cellular Manufacturing; Applications of Group Technology; Quantitative Analysis in Cellular Manufacturing. **[03H]**

Flexible Manufacturing Systems: What is a Flexible Manufacturing Systems; FMS Components; FMS Applications and Benefits; FMS Planning and Implementation Issues; Quantitative Analysis of Flexible Manufacturing Systems. **[03H]**

Quality Programs for Manufacturing: Quality in Design and Manufacturing; Traditional and Modern Quality Control; Process Variability and Process Capability; Statistical Process Control; Six Sigma; The Six Sigma DMAIC Procedure; Taguchi Methods in Quality Engineering; ISO 9000. **[03H]**

Inspection Principles and Practices: Inspection Fundamentals; Sampling vs. 100% Inspection; Automated Inspection; When and Where to Inspect; Quantitative Analysis of Inspection **[02H]**

Text/Reference books:

1. Computer Integrated Manufacturing by by James A. Rehg (Author), Henry W. Kraebber(Author)

OE08 (Choose any one course from below electives)

Subject Code:	OE4M23	**Course Title**	Business Analytics Using R
Contact Hours	L-2, T-0, P-2	**Credit**	3
Programme	B.Tech	**Semester**	VII
Pre-requisites	NIL		
Evaluation scheme			

Learning Objective: The course is designed to provide in-depth knowledge of handling data and Business Analytics' tools that can be used for fact-based decision-making using real case studies.

Primary objectives of the course are:

1. Understand the emergence of business analytics as a competitive strategy.
2. Learn to analyze data using statistical learning and machine learning algorithms to enable data driven decision making.
3. Learn data visualization and storytelling through data.
4. Learn descriptive, predictive and prescriptive analytics techniques and tools.
5. Learn to analyze data using supervised and unsupervised machine learning algorithms.
6. Analyse problems from different sectors like manufacturing, service, banking and finance, sports, pharmaceutical, and aerospace etc.
7. Hands on experience with software/packages such as Microsoft Excel, R, Python.

Course Detail:

Module 1: Predictive Analytics using Supervised Learning Algorithms - Simple linear regression: coefficient of determination, significance tests, residual analysis, confidence and prediction intervals; Multiple linear regression: coefficient of multiple coefficient of determination, interpretation of regression coefficients, categorical variables, heteroscedasticity, multicollinearity, outliers, auto-regression and transformation of variables. Logistic and Multinomial Regression. **[07H]**

Module 2: Classification and Regression Trees (CART): Forecasting: Moving average, exponential smoothing, Trend, cyclical and seasonality components, ARIMA (autoregressive integrated moving average); Application of predictive analytics in retail, direct marketing, health care, financial services, insurance, supply chain etc. **[07H]**

Module 3: Ensemble Methods: Introduction to ensemble methods, random forest and boosting algorithms; Reinforcement Learning Algorithms: Markov chain and Markov Decision Process. **[07H]**

Module 4: Prescriptive Analytics: Introduction to Operations Research (OR), linear programming (LP), formulating decision problems using linear programming. Applications of linear programming in product mix, blending, cutting stock, transportation, transshipment, assignment, scheduling, planning and revenue management problems; Integer Programming (IP) problems, mixed-integer and zero-one programming. Applications of IP in capital budgeting and set covering. **[07H]**

Following case studies will be discussed:

1. Predicting Bank-Loan Defaults with **Logistic Regression Model**
2. Sales Forecasting for Gen Retailers with **Seasonal ARIMA (SARIMA) Model**
3. Predicting Customer Churn with **Decision Tree Model**
4. Predicting Probability of Malignant and Benign Breast Cancer with **Random Forest Model**
5. Predicting Flight Delays with **Multiple Linear Regression Model**
6. Customer Segmentation with **RFM Model** and **K-means Clustering**

Text/Reference books:

1. Business Analytics: The Science of Data-Driven Decision Making by U Dinesh Kumar, Wiley Publication, ISBN: 9788126568772

Course Code	OE4C24	**Course Title**	Artificial Intelligence
Contact Hours	L-2,T-0,P-2	**Credit**	3
Program	B.Tech	**Semester**	VII
Pre-requisites	None		
Evaluation Scheme	Quiz I (10%), Mid-Term (20%), Quiz II (10%), End term (40%), Project (20%)		

Learning Objective : The students will understand the principles and development of artificial intelligence. They will also learn its many applications in different areas.

Course Details:

Module 1: Overview: foundations, scope, problems, and approaches of AI, Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents, Artificial Intelligence programming techniques. Problem-solving through Search: forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications. **[10H]**

Module 2: Knowledge Representation and Reasoning: ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications. Planning: planning as search, partial order planning, construction and use of planning graph. **[10H]**

Module 3: Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, bayesian networks, probabilistic inference, sample applications, Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications. **[10H]**

Module 4: Machine Learning and Knowledge Acquisition: learning from memorization, examples, explanation, and exploration, learning nearest neighbour, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, applications, Sample Applications of AI. **[10H]**

Text/Reference books:

1. N. J. Nilsson, Artificial Intelligence-A Modern Synthesis. Palo Alto: Morgan Kaufmann, 1998.
2. N. J. Nilsson, Principles of Artificial Intelligence. Palo Alto, CA: Tioga, 1981.
3. E. Rich, K. Knight, Artificial Intelligence, New York: McGraw Hill, 1991.
4. S.S.V Chandra, S. A. Hareendran, Artificial Intelligence and Machine Learning, PHI, 2014.

Subject Code:	OE4E25	**Course Title**	Advance Antenna Theory Design
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	VII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Theory of electromagnetic radiation: Coordinate system and transformation of field quantities in different coordinate system; Basic concept and definition: Directive gain, side lobe, back lobe, polarization, co-polarization and cross polarization level, beam width, input impedance, bandwidth, efficiency. **[08H]**

Various kind of antenna with applications: Formulation of radiation integrals and its application to analysis of wire, loop and helix type antenna; Theory of aperture antenna, including the Fourier transform method and application to slot, waveguide and horn antenna; Design consideration of parabolic reflector antenna. **[08H]**

Microstrip and Planar antennas: Rectangular and circular patch; Feed to microstrip antenna: probe feed, microstrip line feed, aperture feed, electromagnetically fed microstrip patch; Circularly polarized microstrip antenna. Dielectric Resonator Antennas: Degrees of Freedom, Rectangular, Cylindrical and hemispherical DRAs, empirical formulas for calculation of resonant frequencies **[10H]**

Theory of linear and phased array: Two element and multi element array, isotropic and nonisotropic array, Binomial and Chebyshev distribution; Planar array, phased array and adaptive antenna; Feed network of microstrip antenna array; Antenna for mobile communication: handset antenna and base station antenna. **[10H]**

Modern topics on modern antenna: Planar Inverted F Antenna (PIFA), Circularly polarized Antennas and size miniaturization techniques. **[05H]**

Text/Reference books:

1. Antenna Theory, Analysis and Design, by C.A. Balanis, Wiley
2. Antenna and Wave propagation, J D Kraus, TMH.
3. Antenna and Wave propagation, A. R. Harish and M. Sachidananda, Oxford University Press,2007
4. Research papers from IEEE Antenna and Propagation Society.

Subject Code:	OE4E26	**Course Title**	Physics of Semiconductor Devices
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	VII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Introduction to Quantum Mechanics Principle of Quantum Mechanics, Schrodinger's wave equation, Application of Schrodinger's wave equation, extension of wave theory to atoms. Introduction to the Quantum Theory of Solids. **[05H]**

Electrical conductions in solids, Drift current, Density of states function, Statistical mechanics. The Semiconductor in Equilibrium, Charge carriers in semiconductor, Dopant atoms and energy levels, Extrinsic semiconductor, Statistics of donors and acceptors, charge neutrality, position of Fermi level. **[05H]**

Carrier Transport Phenomena, Carrier drift, carrier diffusion, Hall effect, graded impurity distribution. Non equilibrium excess carriers, Carrier generation and recombination, Characteristics of excess carriers, Ambipolar transport, Quasi-Fermi energy level. **[10H]**

The p-n Junction: Basic structures of the PN junction, Zero bias condition, forward bias, reverse bias condition. The p-n Junction Diode current components I/V Characteristics, small signal model of p-n junction, generation- recombination current, junction breakdown, charge storage and diode transient **[10H]**

The metal-semiconductor and semiconductor hetero-junctions, Schottky Barrier diode, Ohmic and rectifying contacts, Hetreo junction materials, energy band diagram, two dimension electron gas, equilibrium electrostatics and I/V characteristics. Junction field effect transistor, basic concept, device

characteristics MESFET, Non ideal effects, high electron mobility transistor quantum well structures. **[06H]**
Fundamentals of the Metal-Oxide-Semiconductor Field-Effect Transistor: Two terminal MOS structure,basic MOSFET operation, non ideal effects, MOSFET scaling, threshold voltage modification, radiation and hot electron effects. **[06H]**

Text/Reference books:

1. S.M. Sze Physics of Semiconductor Devices Wiley-Interscience
2. 'Semiconductor physics and devices' 5th edition Neaman Donald A. Mc Graw Hill
3. Physics of Semiconductor Devices Michael Shur, (Prentice Hall, 1990)
4. Physics of Semiconductor Devices, Massimo Rudan Springer Publication

Subject Code	OE4M27	**Course Title**	**Computer Aided Manufacturing System**
Contact Hours	L-3, T-0, P-0		
Programme:	**B.Tech**	**Credit**	**3**
Pre-requisites:	**NIL**	**Semester**	**VII**

Evaluation scheme **Quiz: Mid-sem: Project: End-sem**

Objective: To analyze different aspects of CAM, CNC programs, basics robotics, material handling system, production management system and thus, create interdisciplinary thoughts

Unit 1:

Computer aided manufacturing **[08H]**

CAM concepts, objective sense scope, nature and type of manufacturing system, evolution, benefits of CAM, role of management in CAM, concepts of computer integrated manufacturing ,impact of CIM on personal, role of manufacturing engineers, CIM basic functions

Unit 2:

NC/CNC machine tools **[08H]**

NC and CNC technology: types, classification, specification and components, construction details, controllers, sensors and actuators, CNC hardware: circulating ballscrew, fiction slides,step/servomotors . Axis designation, NC/CNC Tooling, fundamental programming, types of format, part programming, programming for drilling,lathe and milling, canned cycles, parametric subroutines

Unit 3:

Programmable logic controllers **[06H]**

Relay device components, programmable controller architecture, programming a programmable controllers, tools for PLC logic design

Unit 4:

Flexible manufacturing system and automated guided vehicle system **[08H]**

Types of flexibility, FMS components, FMS application and benefits, FMS planning and control, quantitative analysis, simple problems. Automated guided vehicle system- Application, vehicle guidance technology, vehicle management and safety

Unit 5:

Industrial robotics **[06H]**

Robot anatomy and related attributes:classification of robots, robot control systems, end effectors, sensors, accuracy and repeatability, Industrial robot application, robot part programming, simple problems

Text or References:

Subject Code:	OE4M28	**Course Title**	Finite Element Methods
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	VII
Pre-requisites	NIL		
Evaluation scheme	Quiz (10%), Project (20%) Mid-Sem(30%) and End-sem(40%)		

Learning Objective: Basic course of finite element methods and understanding the FE software (ANSYS & Abaqus)

Module 1:
Objective of the Course, Basic Steps in FEM Formulation, Finite element formulation starting for governing equation: Weighted residual Method, Galerkin Method, Weak (Variation), Ritz Method. **[10H]**

Module 2:
1-D Elements, Spring and Truss elements, Basis Functions and Shape Functions. Convergence Criteria, assembly, imposition of boundary conditions. **[10H]**

Module 3: Plane Strain and Stress, Problems with CI continuity: Beam Bending, Connectivity and Assembly of CI Continuity Elements. 2-D elements, Truss elements, Beam elements, (Triangles and Quadrilaterals) and Shape Functions. Numerical integration, Sub-parametric, Iso-parametric and Super-parametric Elements. **[10H]**

Module 4: Dynamics of Finite element, Free Vibration Problems, Formulation and solution of Eigen Value Problem, explicit and implicit methods. **[10H]**

Text/Reference books:

1. O C Zienkiewicz and R L Taylor, The Finite Element Method, 3d ed.McGraw-Hill, 1989
2. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1982.
3. Seshu P. Text Book of Finite Element Analysis, PHI, 1st Edition, 2003.
4. Cook, Malkus and Plesha, Concepts and Applications of Finite Element Analysis, John Wiley and Sons
5. Daryl L Logan : A First Course In The Finite Element Method CL Engineering; 5th edition
6. Chandrupatla : Introduction to Finite Elements in Engineering",3rd Edition, Prentice-Hall of India, Eastern Economy Editions.

OE09 (Choose any one course from below electives)

Subject Code:	OE4C31	**Course Title**	Network Security & Cryptography
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	VII
Pre-requisites	NIL		
Evaluation scheme	Project/Quiz I (30%), Mid term (30%), End term (40%)		

Course Introduction and terminology, Conventional Cryptography: Definitions, Classical encryption techniques, Finite fields, Perfect Secrecy DES, AES and other symmetric cryptography. **[12H]**

Asymmetric Cryptography: Number Theory, public key cryptography: RSA, ElGamal, and Elliptic Curve Cryptography, Key management. **[10H]**

Authentication: Message authentications and hash functions, hash algorithms, Digital Signatures and Authentication Protocols. **[10H]**

Network and System Security: a. Vulnerability, Monitoring/Sniffing, Spoofing
b. Firewalls, Intrusion Detection, c. PGP, Kerberos, d. IPSec, SSL **[10H]**

Text/Reference books:

1. W Stallings, "Cryptography and Network Security: Principles and Practice, 5/e", Prentice Hall.
2. C Kaufman, R Perlman, M Speciner, Network Security, 2/e" , Pearson Education, 2006.
3. B A Forouzan, "Cryptograpgy and Network Security", Tata McGraw Hill, 2007.
4. Aviel D Rubin, "White Hat Security Arsenal: Tackling the Threats", Addison-Wesley, 2001.
5. P. Garrett. "Making and Breaking Codes- An Introduction to Cryptology", Prentice-Hall, 2001.
6. Nigel Smart, "Cryptography: An Introduction", McGraw-Hill, 2002.
7. Schneier. "Applied Cryptography". Second Edition. John Wiley & Sons, Inc., 1996.
8. A. Menezes, P. van Oorschot, S. Vanstone. "Handbook of Applied Cryptography", CRC press, 1997.

Subject Code:	OE4E34	**Course Title**	Internet of Things
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	VII
Pre-requisites	NIL		
Evaluation scheme	Evaluation I (25%), Evaluation II (25%), Evaluation III (25%), Evaluation IV (25%)		

1. IoT definitions: overview, applications, potential & challenges, and architecture **[05H]**
2. Internet in general and Internet of Things, Internet of Everything, Web of Things, and Making Things Smart. **[04H]**
3. IoT communication protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia. **[06H]**
4. Business Issues, Aspects and Models of the Internet of Things. Making and Getting Things onto the Internet. **[02H]**
5. Local Area Networks, MAC level, link protocols such as: point-to-point protocols. IoT enabled networks: Ethernet, WiFi 802.11, Bluetooth, ZWave, RFID, ZigBee. Wireless Sensor Networks: Concept, Challenges and Implementation criteria, MWSN. **[04H]**
6. Introduction to Raspberry Pi and its integration with Sensors and Actuators. Software Defined Networks in IoT (static and mobile), Cyber Physical system. **[06H]**
7. Cloud Computing: Basics, business issues, Sensor cloud. Case studies: Smart Home, Smart Cities,

Smart Healthcare	**[03H]**

Text/Reference books:

1. Kurose, James F.; Ross, Keith W. **Computer networking: a top-down approach,** 5th ed., international ed.: Boston, Mass.: Pearson, cop. 2010
2. R Buyya, AV Dastjerdi. **Internet of Things: Principles and paradigms**, Elsevier Inc., 2016

Subject Code	OE4M35	**Course Title**	**Advanced Manufacturing Processes and Technologies**
Contact Hours	L-3,T-0 ,P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites:	None	**Semester**	
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Course Detail:

Unconventional Machining Processes: Electron Beam Machining (EBM), Plasma Arc Machining (PAM) Laser Beam Machining (LBM), Abrasive Jet Machining (AJM), Water Jet Cutting (WJM), Ultrasonic Machining (USM), Electro-Chemical Machining (ECM), Electric Discharge Machining (EDM), Wire EDM. **[20H]**

Assembly: Jigs and fixtures, principles of location and clamping, synthesis of simple jigs and fixtures. Principles of assembly, engineering theory of dimensional chains, fully interchangeable and selective assembly. **[06H]**

Metrology: Limits, fits and tolerance; automated inspection and CMM. Selection of Manufacturing processes for a given product. **[04H]**

High Speed Machining: Introduction and concepts of HSM. Issues related to HSM. Comparison with conventional manufacturing processes. **[02H]**

Finishing Processes: Introduction to finishing process, grinding, Lapping, Honing, Super Finishing. **[04H]**

Precision Manufacturing Processes: Introduction to micro fabrication processes and M4 processes: concepts of accuracy, errors, influences of dimensional wear on accuracy. **[02H]**

Suggested Textbooks:

1. V.K. Jain Advanced Machining processes, Allied Publishers New Delhi 2002.
2. Black S.C. Chiles, V.Lissaman, A.J. Martin, S.J. Principles of Engineering Manufactures Arnold Edn. 1996.

References:

1. G.F. Benedict, Nontraditional Manufacturing processes, Marcel Dekker, Inc. New York 1987.
2. A. Ghosh and A.K. Malik Manufacturing Science Affiliated East West press Ltd. New Delhi 1985.

Subject Code:	OE4M36	**Course Title**	Quality, Reliability and Maintenance Engineering
Contact Hours	L- 3 T- 0 P- 0		
Programme	B.Tech	**Credit**	3
Pre-requisites	NIL	**Semester**	VIII
Evaluation scheme	Quiz (15%), Mid-sem (35%) and End-sem (50%)		

Quality: Quality conception, quality of design, quality of conformance, cost of quality and value of quality, quality objectives, role of Statistical Quality Control (SQC) for fulfilment of quality objectives; organisation for quality factors influencing quality. In control process and out of control process, causes of deviations, chance causes and assignable causes. **[08H]**

Control Charts: General theory, charts for variables and standard deviation, fraction defectives and number of defects per unit. Process capability studies, Non-conventional control charts. **[09H]**

Acceptance Sampling: Elementary concepts, sampling by attributes, single and double sampling plans, use of Dodge Roming and Military standard sampling tables, construction and use of O.C. curves, introduction to sampling by variates, continuous sampling plans. **[08H]**

Reliability: Introduction, failure rate curve, life testing, relationship between constant failure rate, mean life and other failure rates. O.C. curve for stipulated life; Producer and consumer risk in life testing, sampling plans, MIL-STD procedures for failure sequential life testing plans. Reliability study analysis, synthesis of system reliability, design for reliability, measurement of reliability. **[09H]**

Maintenance Engineering: Machine health monitoring, preventive and predictive maintenance; condition based maintenance; maintenance planning and scheduling; Application of latest techniques like fibre optics, signature analysis, thermography in maintenance engineering; failure analysis of vital components like bearings; seals; gears etc; Maintenance strategies and computer aided maintenance. **[08H]**

Text/Reference books:

1. Reliability and Maintenance Engineering by RC Mishra
2. J. M. Juran& Frank M. Gryna : Quality Planning and Analysis Tata McGraw-Hill

OE10 (Choose any one course from below electives)

Subject Code:	OE4E38	**Course Title**	Pattern Recognition and Machine Learning
Contact Hours	L-3, T-0, P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites	NIL	**Semester**	VII
Evaluation scheme	5 % (Quiz 1), 20% Mid Sem, 5 % (Quiz 2), 40% End Sem, 30% Project		

Supervised and Unsupervised Learning; Bayes Theorum; Probability Distributions- Gaussian, Bernoulli; Central Limit Theorem; Naive Bayes; Logistic Regression. **[10H]**

K-nearest Neighbors; Support Vector Machines; Decision Trees; Random Forests; Linear Discriminant Analysis; Perceptrons; Gradient Descent; Neural Networks. [**10H]**

Convolutional Neural Networks; Algorithm Selection; Understanding Datasets; Regressions; Outliers; Clustering; Principal Component Analysis; Feature Scaling**.** **[10H]**

Constrained and Unconstrained Optimizations; Autoencoder; Reinforcement Learning; Applications**.** **[10H]**

Text books:

1. Bayesian Reasoning and Machine Learning, by David Barber, Cambridge University Press. 2000.

Reference books:

1. Understanding Machine Learning: From Theory to Algorithms, By Shai Shalev-Shwartz and Shai Ben-David, Cambridge University Press, 2014.
2. Pattern classification, Second Edition by Richard O. Duda Peter E.Hart David G.Stork, John Wiley & Sons, INC, 2015.

Subject Code:	OE4E39	**Course Title**	Electromagnetic Interference and Compatibility
Contact Hours	L-3, T-0, P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites	Fundamentals of Electromagnetic and Field Theory	**Semester**	B.Tech -I
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Basic Concepts: Introduction and Definition of EMI and EMC with examples, various parameters, sources of EMI, EMI coupling modes - CM and DM, ESD phenomena, and effects, transient phenomena, biological effects of EM radiations, SAR. **[10H]**

Coupling Mechanism: High-frequency behavior of electrical and electronic components (conductors, capacitor, inductor, resistor, mechanical switches, transformer), electromagnetic field sources and coupling paths, common-mode coupling, differential mode coupling, impedance coupling, inductive and capacitive coupling, radiative coupling, ground loop coupling, and cable-related emissions and coupling. **[10H]**

EMI Mitigation Techniques: Working principle of shielding, shielding effectiveness, solutions to EMC problems, choice of shielding materials, gasketting, and sealing, PCB level shielding, principle of grounding or earthing, lightning protection-buildings and towers, lightning safety, filters, microwave absorbers, frequency selective surfaces, and metamaterials. **[10H]**

Measurement Methods and Instrumentation: Fundamental considerations, EMI shielding effectiveness tests, shielded anechoic chamber, waveguide measurement, free space-based non-destructive testing, open field test, TEM cell for immunity test, antennas, EMC analyzer, spectrum, and network analyzers. **[08H]**

Standard and Regulations: Need for standards, generic/general standards for residential and industrial environment, product standards, National and International EMI standardizing organizations. **[04H]**

Text/Reference books:

1. Clayton R.Paul – Introduction to Electromagnetic compatibility, 2nd Edition, 2006, Wiley & Sons.
2. B. Keiser, Principles of Electromagnetic Compatibility, 3rd Edition, 1987, Artech House.
3. V. P. Kodali, “Engineering EMC Principles, Measurements and Technologies” 1996, IEEE Press, New York.

Subject Code	OE4M40	**Course Title**	Computer Integrated Manufacturing Systems
Contact Hours	L-3,T-0 ,P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites:	None	**Semester**	
Evaluation scheme	Quiz (20%), Mid-Term (30%), End-Term (50%)		

Course Detail:

Introduction: Production Systems; Automation in Production Systems; Manual Labor in Production Systems; Automation Principles and Strategies **[03H]**

Manufacturing Operations: Manufacturing Industries and Products; Manufacturing Operations; Production Facilities; Product/Production Relationships; Lean Production **[03H]**

Manufacturing Models and Metrics: Mathematical Models of Production Performance; Manufacturing Costs **[03H]**

Material Transport Systems: Introduction to Material Handling Equipment; Material Transport Equipment; Analysis of Material Transport Systems **[03H]**

Storage Systems: Storage System Performance and Location Strategies; Conventional Storage Methods and Equipment; Automated Storage Systems; Engineering Analysis of Storage Systems. **[03H]**

Introduction to Manufacturing Systems: Components of a Manufacturing System; Classification of Manufacturing Systems; Overview of the Classification Scheme **[03H]**

Single-Station Manufacturing Cells: Single Station Manned Workstations; Single Station Automated Cells; Applications of Single Station Cells; Analysis of Single Station Cells **[03H]**

Manual Assembly Lines: Fundamentals of Manual Assembly Lines; Analysis of Single Model Assembly Lines; Line Balancing Algorithms; Mixed Model Assembly Lines; **[03H]**

Workstation Considerations: Other Considerations in Assembly Line Design; Alternative Assembly Systems **[03H]**

Automated Production Lines: Fundamentals of Automated Production Lines; Applications of Automated Production Lines; Analysis of Transfer Lines. **[02H]**

Automated Assembly Systems: Fundamentals of Automated Assembly Systems; Quantitative Analysis of Assembly Systems. **[02H]**

Cellular Manufacturing: Part Families; Parts Classification and Coding; Production Flow Analysis; Cellular Manufacturing; Applications of Group Technology; Quantitative Analysis in Cellular Manufacturing. **[03H]**

Flexible Manufacturing Systems: What is a Flexible Manufacturing Systems; FMS Components; FMS Applications and Benefits; FMS Planning and Implementation Issues; Quantitative Analysis of Flexible Manufacturing Systems. **[03H]**

Quality Programs for Manufacturing: Quality in Design and Manufacturing; Traditional and Modern Quality Control; Process Variability and Process Capability; Statistical Process Control; Six Sigma; The Six Sigma DMAIC Procedure; Taguchi Methods in Quality Engineering; ISO 9000. **[03H]**

Inspection Principles and Practices: Inspection Fundamentals; Sampling vs. 100% Inspection; Automated Inspection; When and Where to Inspect; Quantitative Analysis of Inspection **[02H]**

Text Books:

1. James A. Rehg, Henry W. Kraebber, Computer Integrated Manufacturing, Pearson Prentice Hall, 2004

References:

1. A. Alavudeen, N. Venkateshwaran, Computer Integrated Manufacturing, PHI Learning Pvt. Ltd., 2008.
2. Alan Weatherall, Computer Integrated Manufacturing: From Fundamentals to Implementation, Butterworth-Heinemann, 2013.

Subject Code:	OE4M41	**Course Title**	**Micro and Nano Manufacturing**
Contact Hours	L-3, T-0, P-0	**Credit**	3
Programme	B.Tech	**Semester**	VII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Learning Objective: To give awareness of different techniques used in micro and nano manufacturing.

Module 1: Introduction to the course, classification of micromachining and nanofinishing processes, conventional micro and nano machining, Non-conventional micro and nano manufacturing and finishing approaches, micro and nanofabrication techniques, micro joining **[07H]**

Module 2: Diamond turn machining (DTM), components of DTM, requirements of DTM, material removal mechanism, molecular dynamics, tool geometry,0020CVD diamond technology, CVD diamond processes, treatment of substrate, modification of HFCVD process, nucleation and growth, deposition of 3-D substrates, wear of diamond. **[08H]**

Module 3: Laser micro and nano machining, fundamentals and their applications, focused ion beam machining, electro chemical spark micromachining, mechanism, equipment, electron beam micromachining, mechanism-process parameters, applications. Abrasive jet micromachining, erosion mechanism, powder feeding, microstructure fabrication. Ultrasonic micromachining, basic elements, mechanism of material removal, micro-hole drilling, contour machining, micro-de-burring, machining of ceramic materials. electrochemical micromachining, micro-electric discharge micromachining, principle, micro EDM system development, process parameters, analytical modeling. **[15H]**

Module 4: Micro/nano fabrication, materials for microsystems manufacture, substrates and wafers, active substrate materials, silicon and silicon components, photolithography based micro/nano fabrication processes, photo resist development, additive and subtractive techniques, CVD, PVD, etching, chemical, plasma, resists removal, large aspect ratio micro manufacturing, LIGA, deep reactive ion etching. **[12H]**

Text/Reference books:

1. Mark J. Jackson, Micro and Nanomanufacturing, Purdue University, Springer Book, 2007.
2. Waqar Ahmed and Mark J. Jackson, Emerging Nanotechnologies for Manufacturing, Second Edition, Elsevier Book, 2015.
3. Madou M. J. - 'Fundamentals of Microfabrication' - CRC Press - 2009 - 2nd Edition

OE11 (Choose any one course from below electives)

Subject Code:	OE4E44	**Course Title**	Photovoltaics: Fundamentals and Application
Contact Hours	L-3, T-0, P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites	NIL	**Semester**	VII
Evaluation scheme			

Unit 1: Introduction to course, role of renewable energy in sustainable development; renewable energy sources, Solar radiation Review of Semiconductor Physics, Charge carrier generation and recombination, p-n junction model and depletion capacitance, Current voltage characteristics in dark and light.

Unit 2: Device Physics of Solar Cells, Principle of solar energy conversion, Conversion efficiency, Single, tandem multi-junction solar cells, Numerical solar cell modeling, Numerical solar cell modeling,

Unit 3: Crystalline silicon and III-V solar cells, Thin film solar cells: Amorphous silicon, Quantum Dot solar cells, Introduction to Dye Sensitized Solar Cells, Fabrication of Dye Sensitized Solar Cells, Design of novel dyes, Design of solid electrolytes materials, Counter electrode engineering.

Unit 4: Introduction to Organic Solar Cells, Physics of Bulk Heterojunction(BHJ) Solar Cells, Morphology and charge separation in BHJ, Design of low bandgap polymers, Perovskite Solar Cells, Fabrication of perovskite solar cells, Photo physics in perovskite solar cells, Stability in perovskite solar cells, Lead free perovskite solar cells.

Unit 5: Photovoltaic system engineering, Thermo- Photovoltaic generation of electricity, Concentration and storage of electrical energy, Photovoltaics modules, system and application, Green energy building. Nanomaterials for photovoltaics, PV panels with nanostructures, Band gap engineering and optical engineering, Photo thermal cells, Energy Economy and management

Text/Reference books:

B.Des Semester-VII

Subject Code:	DS4013	**Course Title:**	Design Seminar 1
Contact Hours:	L-0, T-0, P-0	**Credit:**	2
Programme :	B.Des	**Semester :**	7
Pre-requisites:	NIL		
Evaluation scheme	Presentation (15%), Problem Identification (30%), Time management (15%), Design solution (40%)		

Subject Code:	DS4014	**Course Title:**	Design Thesis 1
Contact Hours:	L-0, T-0, P-0	**Credit:**	16
Programme :	B.Des	**Semester :**	7
Pre-requisites:	NIL		
Students in this semester would take up a technically complex project. Example designing a coffee vending machine, packaging for life saving drugs etc. The students can do design thesis in-house but it would be advisable for them to go to industry/ design firms to do the thesis.			

B.Tech/B.Des Semester-VIII

OE13 (Choose any one course from below electives)

Course Code	CS8013	**Course Title**	Mobile and Wireless Networks
Contact Hours	L-3,T-0,P-0	**Credit**	3
Program	B.Tech	**Semester**	VIII
Pre-requisites	None		
Evaluation Scheme	Quiz I (10%), Mid-Term (20%), Quiz II (10%), End term (40%), Project (20%)		

Learning Objective : After completing this course, the student will learn the enabling technology in the wireless networking along with components and subsystems used in wireless networking.

Course Details:

Module 1: (Basic of wireless communication & channel) An Overview of Wireless Systems: Wireless History, A taxonomy of wireless networks, Cellular Generations (from1G to 4G), Current & Future Wireless Technologies, Trends. Radio Propagation and Interference: Radio wave propagation, Multi-path characteristic of radio wave, Short/long term fading, Indoor and Outdoor propagation models. **[10H]**

Module 2: (Multiple Radio Access & Multiple Division Techniques for Traffic Channels)
Modulation techniques: Digital Modulation in Modern Wireless Systems (QPSK, DQPSK, p/4 DQPSK, n-QAM, OFDM). Multiple Access Techniques: Contention-Based (Random-based) Protocols (ALOHA, CSMA), Reservation based Protocols (FDMA, TDMA, CDMA), Fundamental of SC-FDMA and OFDMA, FHSS, DSSS. **[10H]**

Module 3: (Mobile Wireless Networks) Cellular concept: Basic principles of cellular systems, e.g., Cell layout, Planning, Interference. Traffic Channel Allocation & Mobility: Fixed Channel Allocation (FCA), Dynamic Channel Allocation (DCA), Hybrid Channel Allocation (HCA), Mobile IP. **[10H]**

Module 4: (Wireless LAN & PAN) Wireless LAN: Operation of IEEE 802.11 Wireless LAN, incl. CSMA/CA, RTS/CTS, power management, 802.11a/b/g/n, 802.11e. Wireless PAN: Overview of operation of low-power wireless systems based on IEEE 802.15.1 (Bluetooth) and IEEE 802.15.4 (Zigbee). Introduction to WiMAX and LTE. **[10H]**

Text/ Reference books:

1. Dharma P. Agrawal, Qing-An Zeng, Introduction to Wireless and Mobile Systems, Third Edition, Cengage learning, 2015.
2. Kaveh Pahlavan, Principles of Wireless Networks: A Unified Approach, Second Revised Edition, John Wiley & Sons, Inc., 2011.
3. Garg, Wireless Communications and Networks, Morgan Kaufmann, 2010.
4. T. S. Rappaport, Wireless Communications-Principles and Practice, Second Edition, Pearson Education, 2002.
5. William Stallings, Wireless Communications and Networks, Second Edition, Pearson, 2005.

OE14 (Choose any one course from below electives)

Subject Code	EC8021	**Course Title**	Fundamentals of 5G and Beyond 5G Mobile Wireless Networks
Contact Hours	L-3, T-0, P-0		
Programme	B.Tech	**Credit**	3
Pre-requisites	Digital communications, Mobile Communications / Wireless Communications	**Semester**	VIII
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Learning Objective: Understanding the basics of 5G and Beyond 5G Wireless communication.
Providing a basic understanding of the key technologies and enablers of 5G and beyond communication systems.
Study of 5G wireless channel models, 5G techniques e.g. massive MIMO, mmWave etc. and applications of 5G/B5G mobile wireless networks. Practical

Course Detail : Journey of 5G/B5G networks (1G to B5G/5G-NR), Wireless Channel Model and Fading, Architecture of 5G/B5G, Backbone of 5G/B5G Network (CRAN, Optical Fiber based Backbone network, Ultra Dense Network(UDN), OFDMA, NOMA, MIMO, Massive MIMO , Beamforming, Visible Light Communication (VLC)
D2D Communication, Green 5G/B5G networks, millimeter wave technology, and QoS/QoE analysis of wireless channel, application of AR/VR based on 5G/B5G.
Week 1: Journey of 5G/B5G networks (1G to B5G/ 5G-NR), Wireless Channel Model and Fading
Week 2: Architecture of 5G/B5G
Week 3: Backbone of 5G/B5G Network (CRAN and Optical Fiber based Backbone network)
Week 4: Ultra Dense Network(UDN), OFDMA
Week 5: NOMA, MIMO
Week 6: Massive MIMO , Beamforming, Visible Light Communication (VLC)
Week 7: D2D Communication, Green 5G/B5G networks
Week 8: Millimeter wave technology, QoS/QoE analysis of wireless channel and Application of AR/VR based on 5G/B5G ,

Text Books:

1. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks", Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications
5. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, - 5G Mobile Communications, Springer, 2017.

Reference books:

1. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.
2. Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge University Press.

Reference Paper:

A survey of 5G network: Architecture and emerging technologies

Subject Code:	ES407a	**Course Title**	Fundamentals of RF & Microwave Electronics
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Mathematical foundation in understanding of signals, circuits and devices: basic properties of Fourier Transforms, transmission line theory, T and π equivalent circuit, behaviour of transmission line at radio & microwave frequency. **[10 H]**

DC and Low Frequency Circuit Concepts: BJT Biasing, mode of operation small signal AC analysis. FET circuits at DC, AC analysis, first and second order AC models of FETs, high frequency models of BJT and FETs, single pole approximation, differential amplifiers, and frequency response. **[10 H]**

Circuit Representation of Two Port RF/ Microwave Networks: Impedance, Admittance, Hybrid, Transmission Matrix, Generalized S parameters, Reciprocal Networks, Loss less Networks, Signal Flow graphs and its Applications. **[10 H]**

Impedance Matching and network selection:power gain concept, mismatch factor, return loss, input/output VSWR, maximum gain, constant gain design, figure of merit, matching network design using lumped and distributed elements, stability consideration in active networks. **[10 H]**

Text/Reference books:

1. T.C. Edwards,Foundations for Microstrip Circuit Design 1st Edition, Wiley Interscience.
2. Ulrich L. Rohde, Matthias Rudolph,RF / Microwave Circuit Design for Wireless Applications, 2nd Edition, 2012.

Subject Code:	ES407b	**Course Title**	Internet of Things
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

IoT definitions: overview, applications, potential & challenges, and architecture. **[6 H]**

Internet in general and Internet of Things, Internet of Everything, Web of Things, and Making Things Smart. **[5 H]**

IoT communication protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia. **[6 H]**

Business Issues, Aspects and Models of the Internet of Things. Making and Getting Things onto the Internet. **[5 H]**

Local Area Networks, MAC level, link protocols such as: point-to-point protocols, Ethernet, WiFi 802.11, cellular internet access, and Machine-to-machine. **[6 H]**

Mobile Networking: roaming and handoffs, mobile IP, and ad hoc and infrastructure less networks. **[6 H]**

IoT examples: Case studies, e.g. sensor body-area-network and control of a smart home. **[6 H]**

Text/Reference books:

Kurose, James F.; Ross, Keith W. **Computer networking: a top-down approach,** 5th ed., international ed.: Boston, Mass.: Pearson, cop. 2010

Subject Code:	ES407c	**Course Title**	Applied Photonics
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Introduction: Review of basic optics, wave propagation, polarization, diffraction, Gaussian Beams, Electrooptic effect, electro-optic modulators and their design considerations, Acousto-optic effect, Raman Scattering and Bragg diffraction, acousto-optic modulators and deflectors. [10H]

Fibres: Principles of optical communication systems, optical sources and detectors, Optical fibres: mode of an optical fibre, multimode fibres, single mode fibres and their propagation characteristics, Dispersion management in optical fibres and link design considerations.[10H]

Integrated optics: Planar and channel waveguides, coupled and dielectric waveguides, dielectric backed waveguides, directional couplers, optical switch, electro-optic and acousto-optic waveguide devices. Display devices, holography and optical information processing. [10H]

Photonics: Introduction to Photonic crystals, Lithium Niobate Crystal, its lattice structure, polarization and anisotropy in the crystal, Photonic Band Gap effect, guided wave structure and components on Photonic Crystals, diffraction limit and constraints on physical dimensions. [10H]

Text/Reference books:

1. Photonic Crystals: Molding the Flow of Light, John D. Joannopoulos, Princeton University Press.
2. Optical Fibre Communications, Gerd Keiser, TMH, 2008.
3. IEEE Journal of Lightwave Technology, IEEE Photonics Journal.

Subject Code:	ES407d	**Course Title**	Operations Research
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz (15%), Mid-sem (35%) and End-sem (50%)		

Modeling with Linear Programming - Two-Variable LP Model, Graphical LP Solution, Solution of a Maximization Model, Solution of a Minimization Model, Selected LP Applications; **[6 H]**

The Simplex Method and Sensitivity Analysis - LP Model in Equation Form, Transition from Graphical to Algebraic Solution, The Simplex Method, Artificial Starting Solution, Special Cases in the Simplex Method, Sensitivity Analysis - Graphical and Algebraic Sensitivity Analysis; **[6 H]**

Duality and Post-Optimal Analysis - Definition of the Dual Problem, Primal-Dual Relationships, Economic Interpretation of Duality, Post-Optimal Analysis; **[6 H]**

Transportation Model and Its Variants - Definition of the Transportation Model, The Transportation Algorithm, The Assignment Model; **[6 H]**

Network Models - Minimal Spanning Tree Algorithm, Shortest-Route Problem, LP Formulation of the Shortest-Route Problem, Maximal flow model, LP Formulation of Maximal Flow Model, Critical Path (CPM) Computations, Construction of the Time Schedule, LP Formulation of CPM;. **[7 H]**

Integer Linear Programming - Integer Programming Algorithms, Branch-and-Bound (B&B) Algorithm, Cutting-Plane Algorithm, Traveling Salesperson Problem (TSP), Heuristic Algorithms, B&B Solution Algorithm, Cutting-Plane Algorithm; **[7 H]**

Deterministic Dynamic Programming - Recursive Nature of Computations in DP, Forward and Backward Recursion, Selected DP Applications. **[8 H]**

Text/Reference books:

1. Hamdy A. Taha Operations Research: An Introduction, Pearson.
2. Frederick S. Hiller, Gerald J. Lieberman, Introduction to Operations Research, McGraw Hill.
3. Ravindran, Phillips and Solberg, Operations Research: Principles and Practice, Wiley India.
4. Hillier and Liberman, Introduction to Operations Research: Concepts and Cases, McGraw-Hill.

Subject Code:	ES407f	**Course Title**	Social network Analysis
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme			

Modeling with Linear Programming - Two-Variable LP Model, Graphical LP Solution, Solution of a Maximization Model, Solution of a Minimization Model, Selected LP Applications; **[06 hr]**

The Simplex Method and Sensitivity Analysis - LP Model in Equation Form, Transition from Graphical to Algebraic Solution, The Simplex Method, Artificial Starting Solution, Special Cases in the Simplex Method, Sensitivity Analysis - Graphical and Algebraic Sensitivity Analysis; **[06 hr]**

Duality and Post-Optimal Analysis - Definition of the Dual Problem, Primal-Dual Relationships, Economic Interpretation of Duality, Post-Optimal Analysis; **[06 hr]**

Transportation Model and Its Variants - Definition of the Transportation Model, The Transportation Algorithm, The Assignment Model; **[06 hr]**

Network Models - Minimal Spanning Tree Algorithm, Shortest-Route Problem, LP Formulation of the Shortest-Route Problem, Maximal flow model, LP Formulation of Maximal Flow Model, Critical Path (CPM) Computations, Construction of the Time Schedule, LP Formulation of CPM; **[07 hr]**

Integer Linear Programming - Integer Programming Algorithms, Branch-and-Bound (B&B) Algorithm, Cutting-Plane Algorithm, Traveling Salesperson Problem (TSP), Heuristic Algorithms, B&B Solution Algorithm, Cutting-Plane Algorithm; **[07 hr]**

Deterministic Dynamic Programming - Recursive Nature of Computations in DP, Forward and Backward Recursion, Selected DP Applications. **[08 hr]**

Text/Reference books:

1. Hamdy A. Taha Operations Research: An Introduction, Pearson.
2. Frederick S. Hiller, Gerald J. Lieberman, Introduction to Operations Research, McGraw Hill.
3. Ravindran, Phillips and Solberg, Operations Research: Principles and Practice, Wiley India.
4. Hillier and Liberman, Introduction to Operations Research: Concepts and Cases, McGraw-Hill.

Subject Code:	HS405a	**Course Title**	Culture and Technology
Contact Hours	L- 3 T- 0 P- 0 GD-1	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid-Term (30%), Quiz II (10%), End-Term (50%)		

Culture, Technology and Innovation – **[8L]**

Culture a Technique- Remaking of the human Being, Technological advancement Vs. Culture, Four Cradles and Fertile Crescent, Science and Technology- an instrument of culture- invention of wheel and fire, Philosophy -an advancement in thought and Intuitions, Art and architecture, Inventions and discoveries- from hunting and food gathering to Mass scale manufacturing.

Age of Enlightenment **[5L]**

Advancement in Science and Technology- Pros and cons,Accomplishment of Science and Technology and status of Human society.

Age of Revolution **[5L]**

Industrialization and mutual dependency,Urbanization and Nuclear families, Growth of Classes Age of Internationalization **[8L]**

Growth of Liberalism,Growth of Nationalism and migration of Technology from source to, destinations miles apart,Nations at competition- Arms Race, Imperialism- Need identification and weathering of Culture

Age of World Civilization- **[10L]**

Limitations of Science and Technology,Limitations of Art and Civilization,Outbreak of hostilities- Two World Wars- contribution of Technology and loosening of cultural moorings.

Search for Stabilization- **[6L]**

Globalization and Proliferation of Science and Technology, Stereotype population and world- wide technology, Modernization, Commitment and Consciousness, New Power Relationship- Need for Culture driven Technology.

Text/Reference books:

1. World Civilizations: Their History and Their Culture VOL. A,B,C.
2. A Cultural History of India- A.L.Basham
3. The Heroes of History- Will Durant
4. Technopoly: The Surrender of Culture to Technology by Neil Postman
5. Culture and Technology Paperback – January 15, 2003by Andrew Murphie (Author), John Potts
6. Culture and Technology: A Primer by Jennifer Daryl Slack (Author),
7. The Cultural Studies Reader Paperback – Import, 9 Mar 2007by Simon During (Editor)

Subject Code:	EC419a	**Course Title**	RF and Microwave Engineering
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Waveguides and Resonators: Review of EM Theory: Wave propagation through waveguides - rectangular, circular, elliptical-cutoff frequency, modes, group and phase velocities. Power Transmission and losses in Waveguides. Excitation of various modes in Waveguides, Microwave cavities – Rectangular and Circular Cavity Resonators. Semi-circular Cavity Resonators, Q factor of a Cavity Resonators. **[12 H]**

Microwave Components: Microwave Hybrid Circuits –Waveguide Tees and Scattering Matrices. Magic Tee and Hybrid Rings (Rat-race circuits) and their Scattering matrices. Waveguide Corners, Bends and Twists, irises, windows, Directional couplers. Two-hole Directional Couplers, S-matrix of a Directional Coupler. Circulators and Isolators. **[12 H]**

Microwave Devices and Measurements: Microwave Transistor; Tunnel Diode; Varacter Diode; Schottky Diode; Gunn diode, IMPATT diodes. Klystron, Magnetron, Traveling Wave Tubes.Measurement of power, frequency and wavelength, Measurement of impedance, SWR, attenuation, Q of cavity and noise factor. **[10 H]**

Microwave Integrated circuits: MMIC, strip and microstrip lines, slot and coplanar lines, planar circuits, Passive elements, components and devices, Analytical methods associated with MIC theory, MMIC Fabrication Techniques, Printed Antennas, Future trend in MICs. **[6 H]**

1. *EM Wave and Radiating System by Jordan and Balmain*
2. *Foundations for Microwave Engineering by Robert E Collin*
3. *Microwave Devices and Circuits by Samuel Y Liao*
4. *Practical MMIC Design by Steve Marsh*

Subject Code:	EC419b	**Course Title**	Power Electronics
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	**Quiz I & II (15%), Midterm (25%), Assignments/Class Performance (10%), End term (50%) (Tentative, decided at the beginning of the semester in consultation with the students)**		

Introductions: Power semi semiconductor devices, Types of power electronic circuits and design of P Power electronics equipment, Applications of Power electronics. **[7 H]**

Semiconductor Diodes and Circuits: Diode Characteristics, Power Diode Types, Series and Parallel connected diodes, Diodes with different types of loads(R, RC, RL, LC, RLC Loads), Freewheeling diodes. **[7 H]**

Diode Rectifiers: Single phase half wave rectifier, Single phase full wave rectifier, Single phase full wave rectifier with RL Load, Three phase Bridge rectifier, Three phase Bridge rectifier with RL Load DC-DC Converters: Principles of stepdown chopper and operation, Principle of stepup chopper and operation, classification of choppers. **[7 H]**

Thyristors: Thyristor Characteristics, Thyristor Turn on and Turn off, Two-transistor model of Thyristor, Thyristor types, Series and Parallel operation of Thyristor Controlled Rectifiers: Principle of phase controlled converter operation, Single phase full-converters, Single phase semi- converter, Principle of three phase half wave Converters, Three phase full converters, Three phase Semi-converter. **[7 H]**

Inverters: Single phase series resonant inverter, Single phase bridge inverters, Three phase bridge inverters, Voltage control of inverters. **[5 H]**

AC Voltage Controllers: Principle of On-Off and phase controls, Single phase ac voltage controller with resistive load, Single phase ac voltage controller with inductive load, Three phase ac voltage controllers , Single phase Cyclo Converters, Three phase Cyclo Converters Some Applications. **[9 H]**

Text/Reference books:

1. M.H. Rashid, “Power Electronics: Circuits, Devices & Applications”; Prentice Hall (I) Pvt Ltd.
2. Singh M.D., Khanchandani K.B. "Power Electronics", 2nd Edition, Tata McGraw-Hill, 2007.
3. Sen P.C., “Power Electronics”, Tata McGraw-Hill, 2008.
4. Mohan, Undeland, Robbins, “Power Electronics”, 3rd edition, John Wiley & Sons, 2002.
5. Bose B.K., “Modern Power Electronics & AC Drives”, 1st edition, PHI, 2002.

Subject Code:	EC419b	**Course Title**	Advance Filter Design
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Module I: Introduction of DSP **[8 H]**

Discrete-time signals, sequence operations, sampling, Digital Signal Processing and its applications, filter and its applications, Discrete Fourier and Z-transforms, system function for linear shift- invariant systems, Fast Fourier Transform (FFT), fast convolution by FFT using the overlap-save or overlap-add methods, FFT algorithms in linear filtering and correlation.

Module II: Introduction of Digital Filter **[10 H]** Design of Infinite Impulse Response (IIR) digital filters by transformation from analog filters: Impulse Invariance, Bilinear Transformation, Matched Z-transforms, Design of LP, HP, BP, SP IIR Filters.

Design of Finite Impulse Response (FIR) digital filters by Windowing, Frequency Sampling, Design of optimum equi-ripple linear phase FIR filters, Design of LP, HP, BP, SP IIR Filters.

Module III: Advance methods of Filter Design **[10 H]**

Optimization Methods for IIR and FIR filter Design: Deczky's method for IIR filter design in the frequency domain, Pade approximation method, Least- squares design method in time domain, Implementation aspects: Quantization of parameters, Finite word-length, and Filter Structures.

Module IV: Computer Aproaches of Filter Design **[10 H]** Computer Aided Design of FIR and IIR digital filters, Design of Digital filters by Criterion Minimization, Computer Added Design of equireple FIR Filters, Digital IIR and FIR Filter Design Using MATLAB.

Module V: Application of Digital Filters **[4 H]**

Application of Digital Filters in Signal and Image processing, Biomedical signal processing, Speech Processing etc.

Text/Reference books:

1. S. K. Mitra, Digital Signal Processing: A Computer Based Approach. Tata McGraw Hill. McGraw Hill, 2006.
2. John G.Proakis, Dimitris G.Manobakis, Digital Signal Processing, Principles, Algorithms and Applications, Third edition, (2000) PHI
3. Digital Signal Processing Emmanuel C Ifeachor, Barrie W Jrevis, Pearson Education.

Subject Code:	ME419a	**Course Title**	Computer Integrated Manufacturing
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz (15%), Mid-sem (35%) and End-sem (50%)		

Introduction: Production Systems; Automation in Production Systems; Manual Labor in Production Systems; Automation Principles and Strategies **[3 H]**

Manufacturing Operations: Manufacturing Industries and Products; Manufacturing Operations; Production Facilities; Product/Production Relationships; Lean Production **[3 H]**

Manufacturing Models and Metrics: Mathematical Models of Production Performance; Manufacturing Costs **[3 H]**

Material Transport Systems: Introduction to Material Handling Equipment; Material Transport Equipment; Analysis of Material Transport Systems **[3 H]** Storage Systems: Storage System Performance and Location Strategies; Conventional Storage Methods and Equipment; Automated Storage Systems; Engineering Analysis of Storage Systems. **[3 H]**

Introduction to Manufacturing Systems: Components of a Manufacturing System; Classification of Manufacturing Systems; Overview of the Classification Scheme **[3 H]** Single-Station Manufacturing Cells: Single Station Manned Workstations; Single Station Automated Cells; Applications of Single Station Cells; Analysis of Single Station Cells **[3 H]** Manual Assembly Lines: Fundamentals of Manual Assembly Lines; Analysis of Single Model Assembly Lines; Line Balancing Algorithms; Mixed Model Assembly Lines; **[3 H]**

Workstation Considerations; Other Considerations in Assembly Line Design; Alternative Assembly Systems **[3 H]**

Automated Production Lines: Fundamentals of Automated Production Lines; Applications of Automated Production Lines; Analysis of Transfer Lines. **[2 H]**

Automated Assembly Systems: Fundamentals of Automated Assembly Systems; Quantitative Analysis of Assembly Systems. **[2 H]**

Cellular Manufacturing: Part Families; Parts Classification and Coding; Production Flow Analysis; Cellular Manufacturing; Applications of Group Technology; Quantitative Analysis in Cellular Manufacturing.**[3 H]**

Flexible Manufacturing Systems: What is a Flexible Manufacturing Systems; FMS Components; FMS Applications and Benefits; FMS Planning and Implementation Issues; Quantitative Analysis of Flexible Manufacturing Systems. **[3 H]**

Quality Programs for Manufacturing: Quality in Design and Manufacturing; Traditional and Modern Quality Control; Process Variability and Process Capability; Statistical Process Control; Six Sigma; The Six Sigma DMAIC Procedure; Taguchi Methods in Quality Engineering; ISO 9000. **[3 H]**

Inspection Principles and Practices: Inspection Fundamentals; Sampling vs. 100% Inspection; Automated Inspection; When and Where to Inspect; Quantitative Analysis of Inspection **[2 H]**

Text/Reference books:

[1] Computer Integrated Manufacturing by by James A. Rehg (Author), Henry W. Kraebber (Author)

Subject Code:	CS419a	**Course Title**	Computer Vision
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid term (25%), Quiz II (10%), End term (40%), Project (20%)		

Introduction: Introduction to Computer Vision, Image Formation and Representation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc.[3H]

Low-level processing: Image analysis, preprocessing, Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing [5H]

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT [7H]

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection[7H]

Object Recognition: Structural Approaches, Model-based Approaches, Appearance and Shape- based Approaches, Probabilistic Paradigms. [4H]

Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods [7H]

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation [4H]

Applications and Performance Evaluation Measures: CBIR, CBVR, Security and Surveillance (Activity Recognition, Biometrics etc.), Medical imaging, Document processing, image fusion, Super-resolution, Augmented Reality, Performance Evaluation Measures. [5H]

Text/Reference books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
4. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
5. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Subject Code:	CS419b	**Course Title**	Distributed Systems
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid term (30%), Quiz II (15%), End term (40%)		

Introduction, Architectures, Processes, Communication.	**[10 H]**
Naming, Synchronization, Consistency and Replication	**[10 H]**
Fault Tolerance, Security, Distributed Object-based Systems	**[10 H]**
Distributed File Systems, Distributed Web-based Systems	**[07 H]**
Distributed Coordination-based Systems	**[05 H]**

Text/Reference books:

A S Tanenbaum, “Distributed Systems: Principles and Paradigms”, PHI, 2007

Subject Code:	CS419c	**Course Title**	Quantitative Methods in Software Engineering
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid-term (20%), Quiz II (10%), End term (40%), Term Project (20%)		

Assessment in Software Engineering**,** Software Measurement and Metrics, Research Method in SE - Controlled Experiment, Case studies, Surveys, and others **[12 H]**
Controlled Experiments, Design of Experiments, Simulation Methods, Examples and Case Studies for Controlled Experimentations, Data Collection and Analysis, Validity and Interpretation **[12 H]** Case Studies and Surveys, Design and Execution, Data Collection, Data Analysis, Statistical Data Analysis, Validity and Interpretation **[12 H]**
Planning, Designing, Conducting Empirical Studies, Replication, Documentation, Review, Examples **[6 H]**

Text/Reference books:

1. Basics of Software Engineering Experimentation, Natalia Juristo and Ana M. Moreno, Kluwer, 2001.
2. Guide to Advanced Empirical Software Engineering, Forest Shull, Janice Singer, and Dag I.K. Sjøberg, Springer 2008

Subject Code:	EC420a	**Course Title**	Advanced Control Systems
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Introductions: Introduction and applications of Control Theory in different fields. **[1 H] State Variable Analysis and Design:** State Variable Representation, Conversion between State Variable Models to Transfer function and Vice-versa, Eigen Values, Eigen Vectors, Diagonalization, Solution of State Equations, Controllability and Observability, Pole placement by State feedback, Design of State Observer: Full order and Reduced order state observer, Compensator Design by Separation Principle Servo Design: Introduction of the Reference input by Feed-forward Control, State Feedback with integral Control **[8 H] Digital Control System**, The z-transform, Inverse z-transform, Pulse Transfer Function, z- and s- plane relationship, z-transform analysis of Sampled-data Control System, Stability analysis of Sampled-data Control System, **[8 H]**
Design of Feedback Control System: Preliminary consideration of Classical Design, Realization and Design of Basic Compensator, Design of PID controller **[8 H] Design of Digital Control System**: Z-plane Specifications of Control System Design, Digital Compensator Design using Frequency Response Plots, Digital Compensator design using Root locus plots, Design of Digital PID controller **[8 H] Optimal Control Systems:** Parameter Optimization, Optimal Control Problem: Transfer Function Approach, Optimal Control Problem: State Variable Approach **[5 H]**
Introduction to Adaptive Control(Model Reference Adaptive Control), **[4 H]**

Text/Reference books:

1. Digital Control and State Variable Methods by M Gopal, McGraw-Hill, 2003
   Control Systems Engineering by I J Nagrath and M Gopal, New age International, 2007

Subject Code:	EC420b	**Course Title**	VLSI Test and Testability
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Fundamental of VLSI Testing Basic of VLSI testing, Scope of testing and verification in VLSI design process, Issues in test and verification of complex chips, embedded cores and SOCs. **[12 H]**

Fault Modeling and Testing Fault models, fault detection and redundancy, fault equivalence and fault location, fault dominance, automatic test pattern generation, Design for testability, Scan design, Test interface and boundary scan. System testing and test for SOCs. Delay fault testing. **[12 H]**

Test automation and Design verification BIST for testing of logic and memories, Test automation, Design verification techniques based on simulation, analytical and formal approaches. **[10 H]**

Module 4 Functional and Timing verification

Functional verification, Timing verification, Formal verification, Basics of equivalence checking and model checking, Hardware emulation. **[8 H]**

Text/Reference books:

1. M. Abramovici, M. A. Breuer and A. D. Friedman, Digital System Testing and Testable Design, Jaico Publishing House, 1990.
2. T. Kropf, Introduction to Formal Hardware Verification, Springer Verlag, 2000.
3. Neil H. E. Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, Addison Wesley, Second Edition, 1993.
4. Neil H. E. Weste and David Harris, Principles of CMOS VLSI Design, Addison Wesley, Third Edition, 2004.
5. M. Bushnell and V. D. Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Kluwer Academic Publishers, 2000.

Parag K. Lala, Digital Circuit Testing and Testability, Academic Press, 1997

Subject Code:	EC420c	**Course Title**	Information Theory and Coding
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Review of probability theory, Entropy: marginal entropy, joint entropy, conditional entropy and the chain rule for entropy. Mutual information between ensembles of random variables. **[6 H]** Source Coding theorems: prefix, variable and fixed length codes. Channel models and channel capacity. Channel Coding theorem. **[9 H]**

Linear Block Codes: Generator and parity check matrices, Minimum Distance, Syndrome decoding, Bounds on minimum distance. [**9 H]**

Cyclic Code: Finite Fields, binary BCH codes, RS Codes. **[9 H]**

Convolutional Codes: Encoders, Trellis, Viterbi decoding. **[9 H]**

Text/Reference books:

1. Thomas M. Grover and Joy A. Thomas, "*Elements of Information Theory,"* Wiley.
2. John G. Proakis and Masoud Salehi, "*Digital Communications*," 5th edition, McGraw Hill.

Subject Code:	ME420b	**Course Title**	Mechanics of Composite Materials
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	(20%), Mid-sem(25%), Project (15%) and End-sem(40%)		

Introduction

Basic concepts and mechanical behaviour of laminated fiber-reinforced composite materials, applications to engineering structures, different types of fibers and matrices. **[8 H] Micromechanics** Prediction of elastic constants and strengths, mechanics of load transfer from matrix to fiber. **[8 H]**

Macromechanics

Theory of elasticity for anisotropic materials, constitutive law for laminae, transformation of stresses, strains and material properties. Constitutive law for laminates and significance of [A], [B] and [D] stiffness matrices, stress and strain analyses of laminates, failure criteria, hygrothermal stresses, bending of plane anisotropic beams, classical and first order theories of laminated composite plates, analysis of Sandwich Plates, buckling analysis of laminate composite plates, first order shear deformation theory, inter-laminar stresses and delamination. **[20 H]**

Several Aspects of Design

Composite tailoring and design issues, statics and elastic stability of initially curved and twisted composite beams, plates and sandwich structures. **[5 H]**

Text/Reference books:

[1] R M Jones (1999), "Mechanics of Composite Materials (2nd Ed)," Taylor and Francis, India.

[2] B D Agarwal, L J Broutman and K Chandrashekhara (2006), "Analysis and Performance of Fiber Composites (3rd Ed)," John Wiley and Sons, Inc., New Delhi, India.

[3] Autar K Kaw (2006), "Mechanics of Composite Materials (2nd Ed)," Taylor and Francis, USA.

[4] Reddy, J.N., Mechanics of Laminated Composite Plates and Shells – Theory and Analysis, CRC Press, 2nd Edition, 2004.

Subject Code:	CS420a	**Course Title**	Big Data Analytics
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Project/Quiz I (30%), Mid term (30%), End term (40%)		

Introduction: Introduction: Big Data Challenges [6L]

Big Data Collection: Data Cleaning and Integration, Hosted Data Platforms and the Cloud[6L] Big Data Storage Modern Databases, Distributed Computing Platforms, NoSQL, NewSQL [10L] Big Data Systems: Characteristics of Big Data and Dimensions of Scalability, Multicore Scalability, Security, User Interfaces for Data[10L]

Big Data Analytics: Getting Value out of Big Data, Machine Learning Tools, Fast Algorithms, Data Compression, Information Summarization [10L]

Text/Reference books:

1. EMC education services, "Data Science and Big data analytics", Willey India, 2015

2. Technical papers from major journals and major conferences on computing, networking, cloud computing.

Subject Code:	CS420b	**Course Title**	Principles of Programming Languages
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid-term (20%), Quiz II (10%), End term (40%), Term Assignments (20%)		

Introduction, Programming Languages, Syntax, Grammar, Ambiguity, Syntax and Semantics, Data Types (Primitive/Ordinal/Composite data types, Enumeration and sub-range types, Arrays and slices, Records, Unions, Pointers and pointer problems) **[10 H]** Expressions, Type conversion, Implicit/Explicit conversion, type systems, expression evaluation, Control Structures **[5 H]**

Binding and Types of Binding, Lifetime, Referencing Environment (Visibility, Local/Nonlocal/Global variables) , Scope (Scope rules, Referencing operations, Static/Dynamic scoping) **[5 H]**

Subprograms, signature, Types of Parameters, Formal/Actual parameters, Subprogram overloading, Parameter Passing Mechanisms, Aliasing, Eager/Normal-order/Lazy evaluation) , Subprogram Implementation (Activation record, Static/Dynamic chain, Static chain method, Display method, Deap/Shallow access, Subprograms as parameters, Labels as parameters, Generic subprograms, Separate/Independent compilation) **[12 H]**

Logic Programming, Predicate calculus, Clausal form, Resolution, PROLOG programming language, Facts and rules, Backtracking, Lists, Limitations of PROLOG) , Functional Programming (Lambda notation, Referential transparency, Functional forms, LISP and SCHEME programming languages, S-expression, Define and Eval functions) **[10 H]**

Text/Reference books:

1. Allen B. Tucker, Robert Noonan, Programming Languages: Principles and Paradigms, McGraw-Hill, 2006
2. Bruce J. MacLennan, Principles of Programming Languages: Design, Evaluation, and Implementation, 3rd Edition, Oxford University Press, 1999.
3. T.W.Pratt, M.V.Zelkowitz, Programming Languages, Design and Implementation, Prentice Hall, 4th Edition, 2001

Subject Code:	CS420d	**Course Title**	Randomized Algorithms
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Project/Quiz I (30%), Mid term (30%), End term (40%)		

Tools and Techniques: Basic probability theory; randomized complexity theory; game-theoretic techniques; Markov, Chebyshev, and moment inequalities; limited independence; coupon collection and occupancy problems; tail inequalities and Chernoff bounds; conditional expectation and martingales; Markov chains and random walks; stable distributions; probability amplification and derandomization. **[20L]**

Applications: sorting and searching; data structures; combinatorial optimization and graph algorithms; geometric algorithms and linear programming; approximation and counting problems ; metric embedding; online and streaming algorithms; nearest neighbors, and clustering; number-theoretic algorithms. **[22L]**

Text/Reference books:

1. Motwani and Raghavan. Randomized Algorithms, Cambridge University Press, 1995.
2. Mitzenmacher and Upfal. Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press, 1995.
3. William Feller. An introduction to Probability Theory and Its Applications, Volumes I and II, John Wiley, New York, 1968.
4. Patrick Billingsley. Probability and Measure, John Wiley and Sons, 1986.

Subject Code:	EC421a	**Course Title**	CMOS Memory System Design
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Introduction to SRAM memory **[10H]**

Overview, volatile memory, non-volatile memory, on-chip memory, on-chip memory types. Review of CMOS circuit design, sensing circuitry basics, write circuitry and other peripheral circuities, refresh, kickback, SRAM (Read and Write operation, 6T, 8T cell implementation etc.).

DRAM Memories **[10H]**

Introduction to DRAM, High speed DRAM architectures, open and folded arrays organizations, bandwidth, latency, and cycle time, power, timing circuits. DRAM Cells read and write operations, issues and challenges related to destructive read operations. Peripheral circuitries, row and column decoders.

FLSAH Memories **[10H]**

Operation of FLASH memories (FLASH array sensing and programming), Charge Pump, PROM, EPROM, EEROM, NAND and NOR flash memories.

Emerging Memories **[10H]**

Emerging devices for memories such as Memristor, and other memories (RRAM, PCRAM, STRAM etc)

Text/Reference books:

1. Semiconductor Memories: A Handbook of Design, Manufacture and Application, Betty Prince, Wiley, 2nd Edison, 1996.
2. DRAM Circuit Design: Fundamental and High-Speed Topics, Keeth, Baker, Johnson, and Lin, Wiley, IEEE 2007.
3. CMOS Circuit Design, Layout, and Simulation, Jacob Baker, Wiley-IEEE, Third Edition, 2010.
4. Semiconductor Memories: Technology, Testing, and Reliability, Ashok K. Sharma, Wiley- IEEE, 2013.

Subject Code:	EC421c	**Course Title**	Optical Communication
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)		

Optical Fibres:

Introduction to Modern Communication Trends, Optical Fibres: Ray and mode theories, V number, types of fibres, single mode, multimode, step and graded index fibres, attenuation and dispersion issues, fibre fabrication methods **[12H] Optical**

Sources:

Parameters of Optical sources for OFC, LED: direct and indirect band gap semiconductors, materials used for fabrication, fabrication techniques, Surface and edge emitting LEDs, Internal and External Quantum Efficiency, Laser Diodes: Fabry Perot cavities, modes in LDs, fabrication process, VCSELs, Lasing equations [**10H]**

Optical Detectors:

Photodetectors, PIN diodes, APDs, Phototransistors, Fibre Optic Receivers: Receiver noise, Receiver Configurations, Sensitivity Issues, etc. **[10H]**

Applications:

Design Considerations of an Optical Fibre Transmission System, Link Budget Equations, Digital Link Design, modulation techniques, EDFA, Advanced FO systems: POF systems, Long haul and very high data rate systems, WDM, DWDM **[8H]**

Text/Reference books:

1. *Optical Fibre Communications*, Gerd Keiser, TMH, 2008.
2. *Optical Fibre Communications: Principles and Practice*, John M Senior, Pearson education, 2009.
3. *Introduction to Fibre Optics,* Ajoy Ghatak and K. Thaygarajan, Cambridge university Press

Subject Code:	ME421c	**Course Title**	Quality, Reliability and Maintenance Engineering
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz (15%), Mid-sem (35%) and End-sem (50%)		

QUALITY: Quality conception, quality of design, quality of conformance, cost of quality and value of quality, quality objectives, role of Statistical Quality Control (SQC) for fulfilment of quality objectives; organisation for quality factors influencing quality. In control process and out of control process, causes of deviations, chance causes and assignable causes. **[8 H]**

CONTROL CHARTS: General theory, charts for variables and standard deviation, fraction defectives and number of defects per unit. Process capability studies, Non-conventional control charts. **[09 hr]**

ACCEPTANCE SAMPLING: Elementary concepts, sampling by attributes, single and double sampling plans, use of Dodge Roming and Military standard sampling tables, construction and use of O.C. curves, introduction to sampling by variates, continuous sampling plans. **[8 H]**

RELIABILITY: Introduction, failure rate curve, life testing, relationship between constant failure rate, mean life and other failure rates. O.C. curve for stipulated life; Producer and consumer risk in life testing, sampling plans, MIL-STD procedures for failure sequential life testing plans. Reliability study analysis, synthesis of system reliability, design for reliability, measurement of reliability. **[9 H]**

MAINTENACE ENGINEERING: Machine health monitoring, preventive and predictive maintenance; condition based maintenance; maintenance planning and scheduling; Application of latest techniques like fibre optics, signature analysis, thermography in maintenance engineering; failure analysis of vital components like bearings; seals; gears etc; Maintenance strategies and computer aided maintenance. **[8 H]**

Text/Reference books:

1. Reliability and Maintenance Engineering by RC Mishra
2. J. M. Juran& Frank M. Gryna : Quality Planning and Analysis Tata McGraw-Hill

Subject Code:	CS421a	**Course Title**	Image Reconstruction
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Mid term (30%), Quiz II (15%), End term (40%)		

One-dimensional signal processing, Fourier analysis, Line integrals and projections, Fourier slice theorem **[08 H]**

Reconstruction algorithms for parallel projections **[07 H]**

Reconstruction algorithms for fan beam projections **[07 H]**

Reconstruction algorithms for Cone beam projections geometries **[10 H]**

Algebraic reconstruction algorithms **[05 H]**

Optimization based reconstruction algorithms **[07 H]**

Text/Reference books:

G T Herman, “Image reconstruction from projections”, Springer-verlag, 2009

Subject Code:	CS421c	**Course Title**	Statistical Methods in Computer Science
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	BTech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid-term (20%), Quiz II (10%), End term (40%), Assignments (20%)		

Introduction to the probabilistic and statistical techniques used in modern computer systems. Basics of probability and statistical estimation. [10 H]

Graphical models, Mixture models and the EM algorithm, HMM, Kalman Filters, Bayesian Networks and Markov Networks, Variable elimination, junction trees and belief propagation [10 H]

Sampling-based inference, Probabilistic inference, statistical learning, learning Bayesian network, learning Markov models. [10 H]

Decision theory, Markov decision processes. Applications of probabilistic and statistical techniques to algorithms, speech/image processing, robotics**[**12H]

References:

1. D. Koller & N. Friedman, *Probabilistic Graphical Models: Principles and Techniques,* MIT Press
2. **Mari**, Jean-François and **Schott**, René, *Probabilistic and Statistical Methods in Computer Science* Springer, 2001

Subject Code:	EC422a	**Course Title**	Nanophotonics and Plasmonics
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (15%), Midterm (30%), Quiz II (15%), End term (40%)		

Introduction to Photonics: Electromagnetic waves; light; Maxwell equations; Wave equation; Modes, laser sources, semiconductor quantum wells, photo detectors, quantum dots, nanowires, Dielectric optical waveguides, directional coupler, Machzehnder interferometer, Optical microresonators etc. **[6 H]**

Photonic Crystals: Photonic bandgap (PGB). PBG structures, wave propagation, Construction methods, Applications: wave guides and photonic crystals fibres, optical microcavities, Photonic VLSI. **[8 H]**

Nanophotonics in metals: Electromagnetics of Metals, Electromagnetic Wave Propagation, Dielectric function and dispersion, Surface Plasmon polaritons, Single and multilayer systems, Exaction of surface Plasmon, plasmonic waveguides and resonators, localized surface plasmons, Nanoantennas. Metamaterials and Negative Index at Optical Frequencies,

Transmission through apertures and films: Theory of Diffraction by Sub-Wavelength Aperture, Extraordinary Transmission, Directional Emission via Exit Surface Patterning, Localized Surface Plasmons and Light Transmission Through Single Apertures, Emerging Applications of Extraordinary Transmission, Transmission of Light Through a Film Without Apertures. **[10 H] Simulation and Design:** Optical microresonators, guiding bending and splitting of light through

photonic crystals, microcavity based MUX and DEMUX, photonic crystal fiber, plasmonic waveguides and resonators, Nanoantennas, Extraordinary transmission, Bull's eye structures, Metamaterials. **[12 H]**

Text/Reference books:

1. Fundamentals and Applications by Stefen A. Maer
2. Nanophotonics with Surface Plasmon by Vladimir M. Salaev
3. Photonic crystals:Molding the flow of light by J.D. Joannopoulos
4. Integrated Photonics: fundamentals by G. Lifante

Subject Code:	EC422b	**Course Title**	Application of Signal and Image Processing
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (12.5%), Mid term (25%), Quiz II (12.5%), End term (50%)		

ECG: Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications. **[6 H]**

Speech Signals: The source-filter model of speech production,spectrographic analysis of speech. **[6 H]**

Speech Coding: Analysis-synthesis systems, channel vocoders, linear prediction of speech, linear prediction vocoders. **[5 H]**

Imaging Modalities: Survey of major modalities for medical imaging: ultrasound, X-ray, CT, MRI, PET, and SPECT. **[5 H]**

MRI: Physics and signal processing for magnetic resonance imaging. **[5 H]** Surgical Applications: A survey of surgical applications of medical image processing. Image Segmentation: statistical classification, morphological operators, connected components. **[5 H]** Application of Signal and Image Processing in power and control systems and mobile robot using physiological signals. [10H]

Text/Reference books:

1. Oppenheim, A. V., and R. W. Schafer, with J. R. Buck. Discrete-Time Signal Processing. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 1999. ISBN: 9780137549207.
2. Karu, Z. Z. Signals and Systems Made Ridiculously Simple. Huntsville, AL: ZiZi Press, 1995. ISBN: 9780964375215.
3. Duda, R., and P. Hart. Pattern Classification and Scene Analysis. New York, NY: John Wiley & Sons, 1973. ISBN: 9780471223610.
4. Clifford, G., F. Azuajae, and P. McSharry. Advanced Methods and Tools for ECG Data Analysis. Norwood, MA: Artech House, 2006. ISBN: 9871580539661.
5. Rabiner, L. R., and R. W. Schafer. Digital Processing of Speech Signals. Upper Saddle River, NJ: Prentice-Hall, 1978. ISBN: 9780132136037.
6. Lim, J. S. Two-Dimensional Signal and Image Processing. Upper Saddle River, NJ: Prentice Hall, 1989. ISBN: 9780139353222.
7. Gonzalez, R., and R. E. Woods. Digital Image Processing. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 2002. ISBN: 9780201180756.

Subject Code:	CS422a	**Course Title**	Natural Language Processing
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid-term (20%), Quiz II (10%), End term (40%), Project (20%)		

Basic Text Processing, Regular expression, sentence segmentation, word stemming. **[2]**
Language modeling problem, Hidden Markov models, N-gram models, parameter estimation, model evaluation, perplexity, smoothing. **[5]**
Text classification, Naïve Bayes and multinomial Naïve Bayes, Evaluation, Sentiment Analysis **[5]** POS Tagging problems, Viterbi Algorithm for HMM, NER**.** **[5]** The parsing problem, CFG and Probabilistic context-free grammars (PCFG), CKY Parsing algorithm, weaknesses of PCFGs, Lexicalized PCFG, **[5]**
Information Retrieval, Term-Document Incidence Matrices, The Inverted Index, Introducing Ranked Retrieval, Term Frequency Weighting, Inverse Document Frequency Weighting (10:16) , TF-IDF Weighting. **[8]**
Log-linear models, and their application to NLP problems like tagging, parsing **[10]**
Unsupervised and semi-supervised learning in NLP. **[2]**

Text/Reference books:

1. Jurafsky and Martin, *Speech and Language Processing* 2nd Edition, Prentice Hall
2. Chris Manning and Hinrich Schütze, *Foundations of Statistical Natural Language Processing*, MIT Press. Cambridge, MA: May 1999.

Subject Code:	CS422b	**Course Title**	Visual Cryptography & Data Hiding
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid-term (20%), Quiz II (10%), End term (40%), Project (20%)		

Introduction, Visual Secret Sharing (VSS), Definition and construction. Naor and Shamir's (k,n) VSS, Proof of correctness, Contrast and pixel expansion. Contrast bounds. **[10 H]** Visual Cryptography for multiple secrets, XOR based Visual Cryptography, Chaotic map based techniques, Colour image VSS. **[10 H]**
Data hiding schemes, Characteristics of data hiding schemes: Security, Payload, Imperceptibility, Reversible data hiding schemes, Random grid based methods**.** **[12 H]** Data Hiding Applications: Watermarking, Basic of watermarking schemes, Watermarking in images, audios and videos. **[10 H]**

Text/Reference books:

1. M. T. Raggo and C. Hosmer, Data Hiding: Exposing Concealed Data in Multimedia, Operating Systems, Mobile Devices and Network Protocols, Elsevier, 2012.

Subject Code:	CS422c	**Course Title**	Model Thinking
Contact Hours	L- 3 T- 0 P- 0	**Credit**	4
Programme	B.Tech	**Semester**	VIII
Pre-requisites	NIL		
Evaluation scheme	Quiz I (10%), Mid-term (20%), Quiz II (10%), End term (40%), Assignment (20%)		

Why Model & Segregation/Peer Effects, Aggregation & Decision Models, Thinking Electrons: Modeling People & Categorical and Linear Models **[10 H]**

Tipping Points & Economic Growth, Diversity and Innovation & Markov Processes, Lyapunov Functions & Coordination and Culture **[10 H]**

Path Dependence & Networks, Randomness and Random Walks & Colonel Blotto, Prisoners' Dilemma and Collective Action & Mechanism Design **[12 H]**

Learning Models: Replicator Dynamics & Prediction and the Many Model Thinker **[10 H]**

Text/Reference books:

1. Mikael Krogerus, Roman Tschäppeler, Jenny Piening, Philip Earnhart, The Decision Book - 50 Models for Strategic Thinking, W. W. Norton & Company, 2012
2. Alexander Osterwalder and Yves Pigneur, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Wiley, 2010.
3. Mikael Krogerus and Roman Tschäppeler, The Change Book: Fifty models to explain how things happen, Profile Books Ltd, Jan 2013