# I SEMESTER

## 15PM01 LINEAR SYSTEMS THEORY

**2 2 0 3**

**VECTOR SPACES:** Vector spaces, subspaces, linear independence, basis and dimension, row space, column space and null space, inner product space, orthonormal bases, Gram-Schmidt process, eigenvalues and eigenvectors, diagonalization. (7+7)

**LINEAR TRANSFORMATIONS:** Linear transformations, kernel and range, inverse linear transformations, matrices of linear transformations, quadratic forms, diagonalizing quadratic forms. (5+5)

**STATE SPACE LINEAR SYSTEMS:** State space linear systems, block diagrams, linearization of nonlinear systems. (2+2)

**SOLUTION TO STATE EQUATIONS:** Linear time variant (LTV) system, linear time invariant (LTI) system, solution to homogeneous system, solution to nonhomogeneous linear system, solving continuous time system. (4+4)

**SYSTEM STABILITY:** The concept of an equilibrium, Lyapunov stability, eigenvalue conditions for Lyapunov stability, Lyapunov stability theorem, BIBO stability, time domain conditions for BIBO stability, BIBO versus Lyapunov stability. (3+3)

**CONTROLLABILITY:** Controllable and reachable subspaces, reachability and controllability gramians**,** controllability matrix (LTI), controllable systems, eigenvector test for controllability, Lyapunov test for controllability. (3+3)

**OBSERVABILITY:** Motivation - output feedback, unobservable subspaces, unconstructible subspace, observability and constructability Gramians, observability tests. (3+3)

**MINIMAL REALIZATIONS:** Minimal realizations, Markov parameters, similarity of minimal realizations, order of a minimal SISO realization. (3+3)

**Total L: 30 + T: 30 = 60**

**REFERENCES:**


1. Howard Anton and Chris Rorres, “Elementary Linear Algebra: Applications Version”, John Wiley & Sons, New Delhi, 2010.
2. João and P Hespanha, “Linear Systems Theory”, Princeton University Press, Princeton, New Jersey, 2009.
3. Panos J Antsaklis and Anthony N Michel, “A Linear Systems Primer, Birkhäuser”, Boston, 2007.
4. Chen C T, “Linear System Theory and Design”, Oxford University Press, USA, 2009.
5. David C Lay, “Linear Algebra and Its Applications”, Pearson Education, New Delhi, 2013.


## 15PM02 CONCEPTS OF DIGITAL MANUFACTURING

**3 2 0 4**

**INTRODUCTION TO DIGITAL MANUFACTURING:** Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System. (3)

**CAD MODELING:** Design process and role of CAD, Types and applications of design models, Three dimensional modeling schemes, Wire frames and surface representation schemes, Solid modeling - Parametric modeling, Assembly modeling. (9)

**REVERSE ENGINEERING:** Need, Reverse engineering process, Reverse engineering hardware and software, Geometric model development. (5)

**COMPUTER AIDED MANUFACTURING:** Component modeling, Machine and tool selection, Defining process and parameters, Tool path generation, Simulation, Post processing. (6)

**CONCEPT MODELERS:** Introduction, Principle, Thermo jet printer, Sander's model market, 3-D printer, Genisys Xs printer, JP system 5, object quadra system-Rapid proto typing. (5)

**DIGITAL FACTORY AND VIRTUAL MANUFACTURING:** Introduction, Scope, Methods and Tools Used in Virtual Manufacturing, Benefits. Virtual factory simulation. (5)

**PRODUCT LIFE CYCLE MANAGEMENT:** Introduction, Types of Product Data, PLM systems, Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems. (6)

**INTERNET OF THINGS:** Introduction, Applications, IoT data management requirements, Architecture of IoT, Technological challenges, RFID and the Electronic Product Code (EPC) network, The web of things, Issues in implementing IoT. (6)

**TUTORIALSESSION:** 3D Modeling of Engineering components and assemblies in CAD software, Machining simulation using CAM software, Reverse Engineering using microscribe. (30)

**Total L: 45 + T: 30 = 75**

**REFERENCES:**


1. Ibrahim Zeid and Sivasubramanian R, "CAD/CAM - Theory and Practice", Tata McGraw Hill Education, 2011.
2. Vinesh Raja and Kiran J Fernandes, "Reverse Engineering- An Industrial Perspective", Springer-Verlag, 2008
3. Pham D T and Dimov S S, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping", Springer-Verlag, 2001.
4. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", Springer, 2005.
5. Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", Springer, 2004.
6. Adrian McEwan and Hakim Cassimally, "Designing the internet of things", Wiley, 2013.


## 15PM03 VIRTUAL REALITY SYSTEMS

**3 0 0 3**

**VIRTUAL REALITY AND VIRTUAL ENVIRONMENTS:** The historical development of VR: Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, benefits of Virtual reality. (4)

**HARDWARE TECHNOLOGIES FOR 3D USER INTERFACES:** Visual Displays Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces. (6)

**3D USER INTERFACE INPUT HARDWARE:** Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces. (5)

**SOFTWARE TECHNOLOGIES:** Database - World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment - VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and Cameras, Scripts, Interaction - Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR toolkits, Available software in the market (10)

**3D INTERACTION TECHNIQUES:** 3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Deign Guidelines - 3D Travel Tasks, Travel Techniques, Design Guidelines - Theoretical Foundations of Wayfinding, User Centered Wayfinding Support, Environment Centered Wayfinding Support, Evaluating Wayfinding Aids, Design Guidelines - System Control**,** Classification, Graphical Menus, Voice Commands, Gestrual Commands, Tools, Mutimodal System Control Techniques, Design Guidelines, Case Study: Mixing System Control Methods, Symbolic Input Tasks, symbolic Input Techniques, Design Guidelines, Beyond Text and Number entry (8)

**DESIGNING AND DEVELOPING 3D USER INTERFACES:** Strategies for Designing and Developing Guidelines and Evaluation. (2)

**ADVANCES IN 3D USER INTERFACES:** 3D User Interfaces for the Real World, AR Interfaces as 3D Data Browsers, 3D Augmented Reality Interfaces, Augmented Surfaces and Tangible Interfaces, Agents in AR, Transitional AR-VR Interfaces - The future of 3D User Interfaces, Questions of 3D UI Technology, 3D Interaction Techniques, 3D UI Design and Development, 3D UI Evaluation and Other Issues. (6)

**VIRTUAL REALITY APPLICATIONS:** Engineering, Architecture, Education, Medicine, Entertainment, Science, Training. (4)

**Total L: 45**

**REFERENCES:**


1. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.
2. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
3. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
4. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
5. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.
6. John Vince, "Virtual Reality Systems", Addison Wesley, 1995.
7. Howard Rheingold, "Virtual Reality: The Revolutionary Technology and how it Promises to Transform Society", Simon and Schuster, 1991.
8. William R Sherman and Alan B Craig, "Understanding Virtual Reality: Interface, Application and Design (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002.

## 15PM04 COMPUTER GRAPHICS FOR VIRTUAL REALITY I

**2 2 0 3**

**GRAPHICS SYSTEM AND MODELS:** Applications of Computer Graphics, Graphics System, Physical and Synthetic Images, Imaging Systems, Graphics Architectures. (4)
**OpenGL GRAPHICS PROGRAMMING:** The OpenGL API, Primitives and Attributes, Color, Control functions, Adding Interaction. VIEWING: Positioning of the Camera, Parallel Projections, Perspective Projections, OpenGL Projection Matrices. (5)

**GEOMETRIC OBJECTS AND TRANSFORMATIONS:** Scalars, Points and Vectors, Three-Dimensional Primitives, Coordinate Systems and Frames, Frames in OpenGL, Matrix and Vector Classes, Modeling a Colored Cube, Affine Transformations - Translation, Rotation and Scaling, Transformations in Homogeneous Coordinates, Concatenation of Transformations, Transformation Matrices in OpenGL, Interfaces to Three-Dimensional Applications, Quaternion. (6)

**VERTICES TO FRAGMENTS:** Basic Implementation Strategies, Four Major Tasks, Clipping - Line Clipping, Polygon Clipping, Clipping of Other Primitives, Clipping in Three Dimensions, Polygon Rasterization, Hidden-Surface Removal, Antialiasing, Display Considerations. (5)

**LIGHTING AND SHADING:** Light and Matter, Light Sources, The Phong Reflection Model, Computation of Vectors, Polygonal Shading, Approximation of a Sphere by Recursive Subdivision, Specifying Lighting Parameters, Implementing a Lighting Model, Shading of the Sphere Model, Per-Fragment Lighting, Global Illumination. (5)

**HIERARCHICAL MODELING:** Symbols and Instances, Hierarchical Models, A Robot Arm, Trees and Traversal, Use of Tree Data Structures, Other Tree Structures, Scene Graphs, Open Scene Graph. (5)

**TUTORIAL COMPONENT:**
1. Drawing basic 2D and 3D primitives in OpenGL.
2. Implementation of various parallel and perspective projections for simple 3D objects.
3. Implementation of 2D transformations: Translation, Scaling, Rotation, and Shearing
4. Implementation of 3D transformations: Translation, Scaling, and Rotation
5. Line clipping and Polygon Clipping using algorithms.
6. Implementation of hidden-surface removal.
7. Simulation of various lighting and shading models.
8. Construction of hierarchical models using trees and graphs.

**Note:** Algorithms in the Computer Graphics have to be implemented by the student using OpenGL.

**Total L: 30 + T: 30 = 60**

**REFERENCES:**

1. Edward Angel, “Interactive Computer Graphics: A Top-Down Approach Using OpenGL”, Addison-Wesley, 2009.
2. Foley James D, Van Dam, Feiner and Hughes, “Computer Graphics: Principles and Practice”, Pearson Education, 2002.
3. Donald Hearn and Pauline Baker, “Computer Graphics C Version”, Pearson Education, 2002.
4. David F Rogers, “Procedural Elements for Computer Graphics”, McGraw Hill, 1998.
5. OpenGL Architecture Review Board, “OpenGL Reference Manual: The Official Reference Document to OpenGL, Version 1.1”, Addison-Wesley, 1997.


## 15PM05 GEOMETRIC MODELING AND COMPUTER AIDED DESIGN

Vide Product Design and Commerce 15PD04

## 15PM55 / 15PD55 OBJECT COMPUTING AND DATA STRUCTURES LABORATORY

Vide Manufacturing Engineering 15PP55

**0 0 4 2**

## 15PM61 INDUSTRY VISIT & TECHNICAL SEMINAR

**0 0 2 1**

The student will make atleast two technical presentations on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation together with the observation in industry visits. A quiz covering the above will be held at the end of the semester.

**Total P: 30**

# II SEMESTER

## 15PM06 COMPUTER GRAPHICS FOR VIRTUAL REALITY II

**2 2 0 3**

**COLOR MODELS AND COLOR SUMMARY APPLICATIONS:** Properties of Light - Standard Primaries and the Chromaticity Diagram - Intuitive Color Concepts - RGB Color Model - CMY Color Model - HSV Color Model - Conversion between HSV and RGB Models - Conversion Between HSV and RGB Models - Color Selection and Applications. (5)

**DISCRETE TECHNIQUES:** Buffers - Digital Images - Writing into Buffers - Mapping Methods - Texture Mapping - Texture Mapping in OpenGL - Texture Generation - Environment Maps - Reflection Map - Bump Mapping - Compositing Techniques - Sampling and Aliasing. (5)

**ADVANCED RENDERING:** Going Beyond Pipeline Rendering - Ray Tracing - Building a Simple Ray Tracer - The Rendering Equation - Radiosity - RenderMan - Parallel Rendering - Volume Rendering - Isosurfaces and Marching Cubes - Mesh Simplification - Direct Volume Rendering - Image-Based Rendering. (6)

**FRACTALS:** Modeling - Sierpinski Gasket - Coastline Problem - Fractal Geometry - Fractal Dimension - Recursively defined curves - Koch curves - C curves - Dragons - Space filling curves - Turtle graphics - Grammar based models - Graftals - Volumetric Examples - k-midpoint subdivision - Fractal Brownian Motion - Fractal Mountains - Iteration in the Complex plane - Mandelbrot Set. (4)

**COMPUTER ANIMATION:** Design of Animation Sequences - General Computer - Animation - Functions - Raster Animations - Computer - Animation Languages - Key-Frame Systems - Motion Specifications, Kinematics & Dynamics. (4)

**VIRTUAL REALITY MODELLING LANGUAGE:** Introduction, exploring and building a world, building object, lighting, sound and complex shapes, animation and user interaction, colors, normals and textures, nodes references. Special Applications: Stereo display programming, multiport display systems, multi screen display system, fly mode navigation, walk through navigation, virtual track ball navigation. (6)

**TUTORIAL COMPONENT:**

1. Construct the primitives with different color models and simulate the conversion from one model to another.
2. Develop a new texture and apply various mapping on 3D objects.
3. Illustrate the aliasing and anti-aliasing techniques.
4. Implementation of ray tracing concepts with the collection of 3D models.
5. Generation of fractal curves and landscapes using algorithms.
6. Generation of Mandelbrot and Julia set fractals.
7. Develop an animation sequence to illustrate the concepts of kinematics and dynamics.
8. Build a 3D scene using VRML and explore it using various navigations. (30)

**Note:** Algorithms in the Computer Graphics have to be implemented by the student using OpenGL/VRML (Whichever is applicable)

**Total L: 30 + T: 30 = 60**

**REFERENCES:**


1. Edward Angel, “Interactive Computer Graphics: A Top-Down Approach Using OpenGL”, Addison-Wesley, 2009.
2. Donald Hearn and Pauline Baker, “Computer Graphics C Version”, Pearson Education, 2002.
3. Foley James D, Van Dam, Feiner and Hughes, “Computer Graphics: Principles and Practice”, Pearson Education, 2002.
4. David F Rogers, “Procedural Elements for Computer Graphics”, McGraw Hill, 1998.
5. Jed Hartman, Silicon Graphics Incorporated and Josie Wernecke, “The VRML 2.0 Handbook: The Official Guide to Constructing Virtual Worlds”, Addison-Wesley Longman, 1996.


## 15PM07 MODELING AND SIMULATION OF VIRTUAL SYSTEMS

**3 0 0 3**

**INTRODUCTION:** Building a VR system, 3D multi modal interaction, VR software in modeling and simulation of engineering systems - use of discrete event simulation. (4)

**MODELING:** Modeling an object, scene construction, reference frames, modeling of function and behavior, estimating the performance of system, LOD, tuning the system. (11)

**3D MULTI MODAL INTERACTION:** Structured Approach to Interaction / Interface Design, Metaphors, Interface Design, Multimodality, Case Studies. (12)

**SIMULATION:** Handling Collision, Collision Detection with Line Segments, Collision Among Polygonal Models, Bounding Volumes, Collision Among Bounding Volumes, Motion and Collision Response, Deformation, Motion Control, Forward and Inverse Kinematics. (12)

**CASE STUDIES:** Applications in engineering, medical, manufacturing, arts and entertainment. (6)

**Total L: 45**

**REFERENCES:**


1. Alan Craig, William Sherman and Jeffrey Will, "Developing VR Applications", Morgan Kaufmann Publishers, 2009.
2. Doru Talab and Angelos Amditis, "Product Engineering - Tools and Methods Based on Virtual Reality", Springer Publications, 2008.
3. Paolo Pedrazzoli, Marco Sacco, Anders Jonsson and Claudio R Boer, "Virtual Factory Framework: Key Enabler for Future Manufacturing", Springer US, 2007.
4. Stjepan Bogdan, Frank L Lewis, Zdenko Kovaic and Jose Mireles Jr, "Virtual Factory Modeling and Simulation", Springer London, 2006.
5. Gerard Jounghyun Kim, "Designing VR Systems", Springer-Verlag London Limited, 2005.


## 15PM08 PRODUCT LIFECYCLE MANAGEMENT

vide Product Design and Commerce 15PD06

## 15PM09 MATHEMATICAL MODELING AND COMPUTER AIDED ENGINEERING

**3 2 0 4**

**INTRODUCTION:** Problems in Engineering-Structural - Fluid flow and Heat transfer with their relevance in product development - examples - Need for computer aided engineering. (3)

**PARTIAL DIFFERENTIAL EQUATIONS:** Elliptic, parabolic and hyperbolic - physical significance - Solution techniques. (5)

**NUMERICAL METHODS TO SOLVE PDEs:** Central differences, Crank-Nicolson and ADI methods - examples - Stability and error of numerical schemes. (6)

**VARIATIONAL CALCULUS:** Introduction, Solutions selected differential equations by variational methods, Rayleigh - Ritz method - Introduction to Finite element method. (6)

**FINITE ELEMENT METHOD:** Concepts, nodes, elements, connectivity, Coordinate systems, shape functions, stiffness matrix, Global stiffness matrix, Isoparametri elements solution methods – Examples- Use of software . (8)

**FLUID FLOW:** Introduction to computational fluid dynamics (finite difference, finite element techniques) - Formulation of fluid flow problems (simple cases only) - Navier-Stokes equation - solution techniques - examples, solution of fluid flow problems using software. (6)

**HEAT TRANSFER:** Derivation of energy equation in general form - Solutions using numerical methods (finite difference and finite element techniques), solutions using FEA and CFD techniques for conductive and convective heat transfer problems. (8)

**INTRODUCTION TO MULTI-PHYSICS PROBLEMS:** Electrophoresis, electro-osmosis, lab-on – chip used in biotechnology Use of software. (3)

**TUTORIAL COMPONENT:** (30)

**Total L: 45 + T: 30 = 75**

**REFERENCES:**


1. Reddy J N, "An Introduction to the Finite Element Method", Tata McGraw Hill, 2006.
2. Singerasu S Rao, "The Finite Element Method in Engineering", Butterworth Heinemann, 2005.
3. Curtis F Gerald Patrick O Wheatley, "Applied Numerical Analysis", Pearson, 2004.
4. Muralidhar K and Sundararajan T, "Computational Fluid Flow and Heat Transfer", Narosa Publications, 2003.
5. Patankar and Suhas V, "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 1980.
6. Elsgolts L, "Differential Equations and the Calculus of Variations", MIR Publishers, 1973.

## 15PM10 SCIENTIFIC AND ENGINEERING DATA VISUALIZATION

**3 0 0 3**

**VISUALISATION** - Scientific and engineering perspective - Impact of Visualisation in product design, an overview of computer graphics for visualization –Types of data for visual;isation, Introduction to tensors. role of preprocessor , solver and post processor in solving engineering problems (4)

**OVERVIEW OF MASSIVE DATA VISUALIZATION:** Simplification methods, Multi-resolution methods, External memory methods, Visual scalability. (4)

**SCALAR VISUALISATION TECHNIQUES:** Visualisation Goals, Representation of mesh and results data, mapping analysis results to Visualisations, One dimensional, two dimensional and three dimensional Scalar fields - Element face colour coding - contour display - isosurface techniques - Marching Cubes algorithm - Particle sampling. (10)

**VISUALIZATION OF FLOW DATA:** Visualization mappings of flow data, Vector mapping - elementary icons - particle traces - streaklines, streamlines - streamribbons and streamtubes - global icons - Tensor mappings - elementary icons - global icons. (10)

**CONTINUUM VOLUME DISPLAY:** Volume rendering Terminology, Surface and Volume rendering techniques, Optimisation. (7)

**APPLICATIONS OF ENGINEERING VISAULISATION:** Case studies created in the laboratory (5)

**FUTURE TRENDS:** Trends in Computing Hardware, Animation, Video and multi-media, software trends in Visualisation. (5)

**Total L: 45**

**REFERENCES:**


1. Torsten Möller and Bernd Hamann Robert D Russell, “Mathematical Foundations of Scientific Visualization, Computer Graphics and Massive Data Exploration”, Springer-Verlag Berlin Heidelberg, 2009.
2. Helen Wright, “Introduction to Scientific Visualization”, Springer, 2007.
3. Richard S Gallagher, “Computer Visualization: Graphics Techniques for Engineering and Scientific Analysis”, CRC Press, CRC Press LLC, 1994.


## 15PM51 VIRTUAL MODELING AND SIMULATION LABORATORY

**0 0 4 2**

In this course, students will be provided with an orientation programme on the following equipment/software for a duration of 20 hours. After this orientation, each student is expected to formulate and complete an activity of interest which has to be derived from the orientation programme under the guidance of a faculty. The details like background, problem definition, state of technology/knowledge in that area by a good literature review (5 latest papers), objectives, methodology, equipment that can be used (from the orientation programme), results from the experiments and their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. This work is evaluated for the credit assigned. Expected hours needed for this work is 40 hours.

**Topics for orientation programme**

1. Introduction to virtual reality hardware. (Projectors, Gloves, Glasses and other Peripherals.)
2. Introduction to VR software. (Software architecture, Components, Third party products.)
3. Conversion of CAD models into VR models.
4. Adding behavior to CAD models.
5. Use of VR hardware peripherals (Glass, Glove etc.) for immersive effect.

**Total P: 60**

# III SEMESTER

## 15PM52 VIRTUAL PROTOTYPING AND DESIGN LABORATORY

**0 0 4 2**

In this course, students will be provided with an orientation programme on the following equipment/software for a duration of 20 hours. After this orientation, each student is expected to formulate and complete an activity of interest which has to be derived from the orientation programme under the guidance of a faculty. The details like background, problem definition, state of technology/knowledge in that area by a good literature review (5 latest papers), objectives, methodology, equipment that can be used (from the orientation programme), results from the experiments and their interpretation with respect to the assumptions/background

and a formal conclusion are expected in the report which is to be submitted at the end of the semester. This work is evaluated for the credit assigned. Expected hours needed for this work is 40 hours.

**Topics for orientation programme**

1. Creation of assemblies of products in VR.
2. Conversion of assemblies to VR models.
3. Creation of digital mockup addition of behavior.
4. Ergonomic and aesthetic studies.
5. Creation of a full fledged immersive environment for product / system evaluation.

**Total P: 60**

### 15PM71 PROJECT WORK - I

**0 0 6 3**

1. Identification of a real life problem in thrust areas
2. Developing a mathematical model for solving the above problem
3. Finalisation of system requirements and specification
4. Proposing different solutions for the problem based on literature survey
5. Future trends in providing alternate solutions
6. Consolidated report preparation

## IV SEMESTER

### 15PM72 PROJECT WORK - II

**0 0 28 14**

**The project work involves the following:**

**I. Preparing a project - brief proposal including**

1. Problem Identification
2. A statement of system / process specifications proposed to be developed (Block Diagram / Concept tree)
3. List of possible solutions including alternatives and constraints
4. Cost benefit analysis
5. Time Line of activities

**II. A report highlighting the design finalization [based on functional requirements and standards (if any)]**

**III. A presentation including the following:**

1. Implementation Phase (Hardware / Software / both)
2. Testing and Validation of the developed system
3. Learning in the Project

**IV. Consolidated report preparation**

## ELECTIVE THEORY COURSES

### 15PM21 SIMULATION AND MODELLING TECHNIQUES

**2 2 0 3**

**INTRODUCTION TO SIMULATION:** Advantages and disadvantages of simulation, areas of application, systems and system environment, components of a system, discrete and continuous system, model of a system, types of models. (4)

**RANDOM NUMBER GENERATION:** Properties of random numbers, Techniques for generating random numbers, linear congruential method, combined linear congruential generators, random number streams, midsquare method, feedback shift register generators, tests for random numbers , frequency tests - the Kolmogorov_Smirnov test, the Chi-square tests. (4)

**RANDOM VARIATE GENERATION:** Inverse transform technique, exponential distribution, uniform distribution, Weibull distribution. empirical continuous distributions, empirical discrete distribution, discrete uniform distribution, geometric distribution, acceptance-rejection technique, Poisson distribution, gamma distribution, discrete transformation for the normal and lognormal distributions, convolution method. (7)

**INPUT- OUTPUT MODELLING:** Data collection, identifying the distribution with data, parameter estimation, goodness of fit tests. Verification and validation, verification of simulation models, calibration and validation of models. Types of simulations with respect to output analysis, Stochastic nature of output data, measures of performance and their estimation, output analysis of terminating simulations. (6)

**SIMULATION OF QUEUEING SYSTEMS:** Simulation of a single server queue, simulation of a two server queue, simulation of more general queues. (3)

**INVENTORY CONTROL:** Elements of inventory theory, more complex inventory models, simulation of inventory control. (2)

**SIMULATION LANGUAGES:** GPSS, SIMSCRIPT, SIMULA, SIMUL 8 . (2)

**CASE STUDIES:** Simulation of manufacturing and material - handling system, simulation of computer systems, simulation of computer networks. (2)

**TUTORIAL COMPONENT:** (30)

**Total L: 30 + T: 30 = 60**

**REFERENCES:**


1. Jerry Banks, John S Carson, Barry L Nelson, David M Nicol and Shahabudeen P, "Discrete -Event System Simulation", Pearson, New Delhi, 2011.
2. Averil M Law, "Simulation Modeling and Analysis", Tata-McGraw Hill, New Delhi, 2011.
3. Narsingh Deo, "System Simulation with Digital Computer", PHI Learning, New Delhi, 2011.
4. Feurzeig**,** Wallace**,** Roberts and Nancy, "Modeling and Simulation in Science and Mathematics Education", Springer – Verlag,Newyork,1999.
5. Andrew F Seila, Vlatko Ceric, Pandu R and Tadikamalla, "Applied Simulation Modeling", Thomson Learning, University of California, 2003.


## 15PM22 HUMAN COMPUTER INTERACTION

**3 0 0 3**

**USABILITY OF INTERACTIVE SYSTEMS:** Goals and Measures - Motivations, Universal Usability, Goals for Profession, Guidelines, Principles and Theories. (4)

**DEVELOPMENT PROCESSES:** Managing Design Processes - Organizational Design to Support Usability - The Four Pillars of Design - Development Methodologies - Ethnographic Observation - Participatory Design, Scenario Development, Social Impact Statement for Early Design Review, Legal Issues. (6)

**EVALUATING INTERFACE DESIGNS:** Introduction - Expert Reviews - Usability Testing and Laboratories - Survey Instruments, Acceptance Tests - Evaluation During Active Use - Controlled Psychologically Oriented Experiments. (5)

**INTERACTION STYLES:** Direct Manipulation and Virtual Environments - Examples of Direct Manipulation, Discussion of Direct Manipulation-3D Interfaces, Teleportation, Virtual and Augmented Reality. Overview of Menu Selection, Form Fill-in and Dialog Boxes - Command and Natural Languages. (7)

**COLLABORATION AND SOCIAL MEDIA PARTICIPATION:** Introduction: Goals of Collaboration and Participation, overview of Asynchronous and Synchronous Distributed Interfaces. (5)

**DESIGN ISSUES:** Quality of Service, Introduction: Models of Response - Time Impacts, Expectations and Attitudes, User Productivity, Variability in Response Time, Frustrating Experiences - Balancing Function and Fashion, Error Messages, Nonanthropomorphic Design, Display Design, Web Page Design. (6)

**INFORMATION SEARCH:** Searching in Textual Documents and Database Querying, Multimedia Document Searches, Advanced Filtering and Search Interfaces. Information Visualization, Introduction: Data Type by Task Taxonomy, Challenges for Information Visualization. (6)

**CASE STUDY:** Human computer interaction in industrial applications. (6)

**Total L: 45**

**REFERENCES:**


1. Ben Shneiderman and Catherine Plaisant, "Designing the User Interface: Strategies for Effective Human-Computer Interaction", Addison-Wesley, 2010.
2. Alan Dix, Janet Finlay, Gregory Abowd and Russell Beale, "Human-Computer Interaction", Prentice Hall, New Delhi, 2004.

3. John M Carroll, “Human Computer Interaction in the New Millennium”, Pearson Education, 2002.
4. Hackson J T and Redish J C, “User and Task Analysis for Interface Design”, John Wiley and Sons, New York, 1998.

**15PM23 OBJECT ORIENTED ANALYSIS AND DESIGN**

vide Product Design and Commerce 15PD25

**15PM24 MECHATRONICS SYSTEM**

vide Manufacturing Engineering 15PP30

**15PM25 DATABASE MANAGEMENT SYSTEMS**

vide Product Design and Commerce 15PD21

**15PM26 ENTERPRISE COMPUTING**

vide Product Design and Commerce 15PD23

**15PM27 IMAGE PROCESSING AND MACHINE VISION**

vide Manufacturing Engineering 15PP29

## ONE CREDIT COURSES

**For the detailed Syllabi of all the one credit courses offered by Production Engineering department which are listed in this programme scheme refer to the syllabi of M.E Manufacturing Engineering programme.**

**For the detailed syllabi of the electives and one credit courses offered by other departments refer to the syllabi of M.E- Automotive Engineering offered by Automobile Engineering Department.**