Curriculum for Undergraduate Degree (B.Tech.) in Artificial Intelligence and Machine Intelligence (w.e.f. AY: 2021-22)

Part III: Detailed Curriculum

Seventh Semester

Course Name:	**Social Network Analysis**			
Course Code:	PE-AIML70A	**Category:**	Professional Elective Course	
Semester:	Seventh	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Concepts of Computer Network, Data Mining and Internet	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To understand the concept of semantic web and related applications.
2	To learn knowledge representation using ontology.
3	To understand human behaviour in social web and related communities.
4	To learn visualization of social networks.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Semantic Web:** Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis.	7L
2	**Modeling, Aggregating And Knowledge Representation:** Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language - Modeling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships -	8L

	Aggregating and reasoning with social network data - Advanced representations.	
3	**Extraction And Mining Communities In Web Social Networks:** Extracting evolution of Web Community from a Series of Web Archive - Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting communities social network infrastructures and communities - Decentralized online social networks - Multi-Relational characterization of dynamic social network communities	7L
4	**Predicting Human Behaviour And Privacy Issues:** Understanding and predicting human behaviour for social communities - User data management - Inference and Distribution - Enabling new human experiences - Reality mining - Context - Awareness - Privacy in online social networks - Trust in online environment - Trust models based on subjective logic - Trust network analysis - Trust transitivity analysis - Combining trust and reputation - Trust derivation based on trust comparisons - Attack spectrum and countermeasures	7L
5	**Visualization And Applications Of Social Networks:** Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks.	7L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Develop semantic web related applications.
2	Represent knowledge using ontology.
3	Predict human behaviour in social web and related communities.
4	Visualize social networks.

Learning Resources:	
1	"Social Networks and the Semantic Web" by Peter Mika, First Edition, Springer 2007.
2	"Handbook of Social Network Technologies and Applications" by Borko Furht, 1st Edition, Springer, 2010.

Course Name:	**Computer Vision**		
Course Code:	PE-AIML701B	**Category:**	Professional Elective Course
Semester:	Seventh	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Programming, Mathematic course
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To implement fundamental image processing techniques required for computer vision
2	Understand Image formation process
3	Extract features form Images and do analysis of Images
4	To develop applications using computer vision techniques

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Overview, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis	3L
2	Edge detection, Edge detection performance, Hough transform, corner detection	6L
3	Segmentation, Morphological filtering, Fourier transform	3L
4	Feature extraction, shape, histogram, color, spectral, texture, using CVIP tools, Feature analysis, feature vectors, distance /similarity measures, data preprocessing	9L
5	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, and Non-parametric methods.	9L
6	Recent trends in Activity Recognition, computational photography, Biometrics	6L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Implement fundamental image processing techniques required for computer vision
2	Apply Image formation process
3	Extract features form Images and do analysis of Images
4	Develop applications using computer vision techniques

Learning Resources:	
1	Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, New York, 2nd edition, 2022
2	Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2016
3	R. B. Fisher, T. P. Breckon, K. Dawson-Howe, A. Fitzgibbon, C. Robertson, E. Trucco, C. K. I. Williams, "Dictionary of Computer Vision and Image Processing", Second Edition, John Wiley & Sons Ltd

Course Name:	**Quantum Computing**		
Course Code:	PE-AIML701C	**Category:**	Professional Elective Course
Semester:	Seventh	**Credit:**	3.0
L-T-P:	3-0-0	**Pre-Requisites:**	Basic understanding of Quantum Theory, Linear Algebra, Theory of Computation
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Inculcate the idea of Quantum Computing and its inevitability in the near future.
2	Develop a basic idea on Qubit, Quantum gates, Quantum Cryptography and appreciate the power of parallel computing with few quantum algorithms.
3	Get hands-on experience in building quantum circuits using IBM's Qiskit.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Vector and Operators:** ✓ The Motivation: Shannon's Information theory & its connection to Entropy ✓ Concept of Vector Spaces. ✓ Basis & dimensions ✓ Linear Combination of Vectors: Representing a quantum state by a vector ✓ Uniqueness of a spanning set, Inner Product(its relation to the vector dot product), Orthonormality, Gram-Schmidt orthogonalization, Bra-ket formalism and its usefulness, the Cauchyschwarz Inequality. ✓ Outer Products, The Closure Relation ✓ Concept of Operators in Quantum Mechanics and their representation using matrices, Hermitian &Unitary operators ✓ Concept of Eigen values & Eigen Vectors and the span of vector space, Spectral Decomposition, Trace of an operator, important properties of Trace, Expectation Value of Operator, Projection Operator, Positive Operators	10L
2	**Tensor Products:** ✓ Representing Composite States in Quantum Mechanics, Tensor products of column vectors, operators and tensor products of matrices ✓ Concept of Pure and Mixed State ✓ Density Operator: Its usefulness ✓ Density Operator of Pure & Mixed state, Key Properties, Characterizing Mixed State	7L
3	**The Building Block:** ✓ Concept of Qubit: its difference with a conventional Bit. Bloch vector & Qubit. ✓ Pauli spin matrices, Quantum Gates: Pauli matrices as Phase & NOT gates. ✓ Irreversibility of classical gates, Introduction to Hadamard, CNOT and Toffoli gates with their truth tables. ✓ Entangled states: Its concept and mechanism of creation using quantum gates. Quantum teleportation using entanglement.	8L
4	**Parallel computing:** ✓ Deutsch Jozsa algorithm	6L

	✓ Unstructured search using Grover's algorithm. ✓ Quantum key distribution: The future of Cryptography	
5	**Hands-on:** ✓ Recent trends in Quantum Computing ✓ Learning to use IBM's Qiskit to build quantum circuits ✓ Utility of GPU's in Quantum Computing (eg. Google Colab, IBM Watson etc.)	7L
Total		**38L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Relate vectors to physical states of system and matrices to operators.
2	Examine the application of various quantum gates on qubit.
3	Discover the power of parallel computing using quantum algorithms.
4	Construct simple quantum circuits by IBM's Qiskit.

Learning Resources:	
1	'Quantum Computing without Magic' by Zdzislaw Meglicki
2	'Quantum Computing Explained' by David Mc Mahon
3	'Quantum Computer Science' by Marco Lanzagorta and Jeffrey Uhlmann
4	'An Introduction to Quantum Computing' by Phillip Kaye, Raymond Laflamme and Michele Mosca.
5	https://qiskit.org/textbook/preface.html

Course Name:	**Multi Agent System**		
Course Code:	PE-AIML701D	**Category:**	Professional Elective Course
Semester:	Seventh	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Machine learning, Game Theory
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To introduce the student to the concept of an agent and multi-agent systems, and the main applications for which they are appropriate;
2	To introduce the main issues surrounding the design of intelligent agents;
3	To introduce the main issues surrounding the design of a multi-agent society.
4	To introduce a contemporary platform for implementing agents and multi-agent systems

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** what is an agent? agents and objects; agents and expert systems; agents and distributed systems; typical application areas for agent systems.	4L
2	**Intelligent Agents:** the design of intelligent agents - reasoning agents (e.g. Agent O), agents as reactive systems (e.g. subsumption architecture); hybrid agents (e.g. PRS); layered agents (e.g. Interrap) a contemporary (Java-based) framework for programming agents (e.g. the Jack language, the JAM! system)	6L
3	**Multi-Agent Systems:** Classifying multi-agent interactions - cooperative versus non-cooperative; zero-sum and other interactions; what is cooperation? how cooperation occurs - the Prisoner's dilemma and Axelrod's experiments	6L
4	**Interactions between self-interested agents**: auctions & voting systems; negotiation;	3L
5	**Interactions between benevolent agents:** cooperative distributed problem solving(CDPS), partial global planning; coherence and coordination;	3L
6	**Foundations of game theory**: algorithmic issues; Notions of equilibrium; Bayesian games	6L
7	**Financial and prediction markets**: Algorithmic market-making	3L
8	**Learning in multi-agent systems**: Collective wisdom and peer production	3L
9	**Interaction languages and protocols:** speech acts, KQML/KIF, the FIPA framework.	6L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Analyze the notion of an agent, how agents are distinct from other software paradigms
2	Explain the key issues of constructing agents capable of intelligent autonomous action
3	Explain the key issues in designing societies of agents that can effectively cooperate in order to solve problems
4	Analyze the main application areas of agent-based solutions, and be able to develop a meaningful agent-based system using a contemporary agent development platform

Learning Resources:	
1	"Multiagent Systems" - Y. Shoham and K. Leyton-Brown. Cambridge University Press.
2	"Algorithmic Game Theory" - N. Nisan, T. Roughgarden, E. Tardos and V.V. Vazirani, eds. Cambridge University Press
3	"Multiagent Systems" - G. Weiss (ed) MIT Press 2013
4	"Networks, Crowds and Markets" - D. Easley and J. Kleinberg, Cambridge University Press 2010

Course Name:	**E-Commerce and ERP**		
Course Code:	PE-AIML702A	**Category:**	Professional Elective Course
Semester:	Seventh	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of web and general commerce
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To focus on a strong emphasis upon practices of theory in Applications and Practical oriented approach of E-Commerce Business
2	To provide a contemporary and forward-looking on the theories and practices of Enterprise Resource Planning Technology
3	To train the students to develop the basic understanding of how ERP enriches the business organizations in achieving a multidimensional growth
4	To aim at preparing the students technologically competitive and make them ready to self-upgrade with the respective technical skills

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction**: Overview, definitions, advantages & disadvantages of e-commerce over traditional commerce, threats of e-commerce, managerial prospective, rules & regulations for controlling e-commerce, cyber laws.	2L
2	**Business to Business E-commerce:** **Technologies:** Relationship Between E-Commerce & Networking, Different Types of Networking Commerce, Internet, Intranet & Extranet, EDI Systems Wireless Application Protocol: Definition, Hand Held Devices, Mobility & Commerce, Mobile Computing, Wireless Web, Web Security, Infrastructure Requirement For E-Commerce. **Business Models of E-commerce:** Financial, Marketing, Personnel, Production, Materials Information System, DSS, EIS, KMS, GIS, International Information System. **E-strategy:** Security, Testing, Error detection, Controls, IS Vulnerability, Computer Crimes, Securing the Web, Intranets and Wireless Networks, Software Audit, Ethics in IT.	9L
3	**FOUR C'S: (Convergence, Collaborative Computing, Content Management & Call Center):** Convergence: Technological Advances in Convergence – Types, Convergence and its implications, Convergence & Electronic Commerce. Collaborative Computing: Collaborative product development, contract as per CAD, Simultaneous Collaboration, Security. Content Management: Definition of content, Authoring Tools & Content Management, Content-partnership, repositories, convergence, providers, Web Traffic & Traffic Management; Content Marketing. Call Center: Definition, Need, Tasks Handled, Mode of Operation, Equipment, Strength & Weaknesses of Call Center, Customer Premises Equipment (CPE).	6L
4	**Related Issues in E-Commerce:** **Supply Chain Management:** E–logistics, Supply Chain Portal, Supply Chain Planning Tools (SCP Tools), Supply Chain Execution (SCE), SCE - Framework, Internet's effect on Supply Chain Power. **E-Payment Mechanisms:** Payment through card system, E-Cheque, E-Cash, E-Payment Threats & Protections. **E-Marketing:** Home-shopping, E-Marketing, Tele-marketing **Electronic Data Interchange (EDI):** Meaning, Benefits, Concepts, Application, EDI Model	7L
5	**Risk of E-commerce:** Overview, Security for E-Commerce, Security Standards, Firewall, Cryptography, Key Management, Password Systems, Digital Certificates, Digital signatures.	4L

6	**Enterprise Resource Planning (ERP):** Features, capabilities and Overview of Commercial Software, re-engineering work processes for IT applications, Business Process Redesign, Knowledge engineering and data warehouse. Business Modules: Finance, Manufacturing (Production), Human Resources, Plant Maintenance, Materials Management, Quality Management, Sales & Distribution ERP Package. ERP Implementation. ERP Market Place: SAPAG, PeopleSoft, BAAN, JD Edwards, Oracle Corporation. ERP-Present and Future: Enterprise Application Integration(EAI), ERP and E-Commerce, ERP and Internet, Future Directions in ERP	10L
Total		**38L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify the various technologies used in e-commerce, and become familiar with important business, legal, security and ethical issues.
2	Explain the key components of Electronic Commerce such as e-marketplace, EDI, supply chain and Collaborative Commerce, customer relationship management, EC security and ePayment schemes.
3	Describe the contemporary ecommerce concepts, terminologies, the processes and management decisions that are involved in launching, operating and managing business activity on the World Wide Web.
4	Use the application software skills such as database creation, web page designing etc. to solve the real world business problems.

Learning Resources:	
1	E-Commerce, M.M. Oka, EPH
2	Kalakotia, Whinston : Frontiers of Electronic Commerce , Pearson Education.
3	Bhaskar Bharat : Electronic Commerce - Technologies &Applications.TMH
4	Enterprise Resource Planning – A Managerial Perspective by D P Goyal, Tata McGraw Hill Education, 2011
5	Enterprise Resource Planning by Ashim Raj Singla, Cengage Learning, 2008.
6	Enterprise Resource Planning, 2nd Edition by Alexis Leon, Tata McGraw Hill Education, 2008
7	Global E-Commerce, J. Christopher & T.H.K. Clerk, University Press

Course Name:	**Information and Coding Theory**		
Course Code:	PE-AIML702B	**Category:**	Professional Elective Course
Semester:	Seventh	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	ES-IT401(Discrete Mathematics)
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To be familiar with source coding and channel coding
2	To have knowledge about linear codes and its application for error correction
3	To understand the cyclic codes and its application
4	To be familiar with BCH codes and its application
5	To know convolutional codes and their application

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Source Coding:** Uncertainty and information, average mutual information and entropy, information measures for continuous random variables, source coding theorem, Huffman codes.	6L
2	**Channel Capacity And Coding:** Channel models, channel capacity, channel coding, information capacity theorem, The Shannon limit.	6L
3	**Linear And Block Codes For Error Correction:** Matrix description of linear block codes, equivalent codes, parity check matrix, decoding of a linear block code, perfect codes, Hamming codes.	7L
4	**Cyclic Codes:** Polynomials, division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, Golay codes.	7L
5	**BCH Codes:** Primitive elements, minimal polynomials, generator polynomials in terms of minimal polynomials, examples of BCH codes.	6L
6	**Convolutional Codes :** Tree codes, trellis codes, polynomial description of convolutional codes, distance notions for convolutional codes, the generating function, matrix representation of convolutional codes, decoding of convolutional codes, distance and performance bounds for convolutional codes, examples of convolutional codes, Turbo codes, Turbo decoding	8L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Apply their knowledge to source coding and channel coding
2	Apply their knowledge about linear codes for error correction
3	Apply their knowledge of cyclic codes and BCH codes to different application
4	Apply their idea about different convolutional codes for coding and decoding

Learning Resources:	
1	"Information theory, coding and cryptography" - Ranjan Bose, TMH.
2	"Information and Coding" - N Abramson, McGraw Hill.
3	"Introduction to Information Theory" - M Mansurpur, McGraw Hill
4	"Information Theory" - R B Ash, Prentice Hall
5	"Error Control Coding" - Shu Lin and D J Costello Jr, Prentice Hall.

Course Name:	**Internet of Things**			
Course Code:	PE-AIML702C	**Category:**	Professional Elective Courses	
Semester:	Seventh	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Programming for problem solving and basic knowledge of Computer Network.	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To understand the terminology, technology and its applications
2	To understand the concept of M2M (machine to machine) with necessary protocols
3	To learn the Python Scripting Language and the Raspberry PI platform, used in many IoT devices and applications.
4	To understand the implementation of web based services on IoT devices.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Internet of Things:** Definition and characteristics of IoT, Physical design of IoT-Things in IoT, IoT Protocols, Logical Design of IoT- IoT communication models, IoT Communication APIs, IoT enabled technologies-Wireless sensor networks, Cloud computing, Big data analytics, Communication protocols, Embedded systems, IoT levels and deployment templates.	10L
2	**IoT and M2M Introduction**, M2M-Difference between IoT and M2M, SDN and NFV for IoT Software Defined Networking, Network Function Virtualization. Difference between SDN and NFV for IoT. Basics of IoT System Management with NETCOZF.	6L
3	**Introduction to Python:** Language features of Python, Data types, Data structures, Control of flow, functions, modules, packaging, file handling, data/time operations, classes, Exception handling. Different Python packages.	6L
4	**IoT Physical Devices and Endpoints:** Introduction to Raspberry PI-Interfaces (serial, SPI, I2C). Programming-- Python program with Raspberry PI with focus of interfacing external gadgets, controlling output, reading input from pins.	6L
5	**IoT Physical Servers and Cloud Offerings:** Introduction to Cloud Storage models and communication APIs. Webserver – Web server for IoT, Cloud for IoT, Python web application framework. Designing a RESTful web API.	8L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the definition and usage of the term "Internet of Things" in different contexts
2	Explain the key components that make up an IoT system.
3	Differentiate between the levels of the IoT stack and be familiar with the key technologies and protocols employed at each layer of the stack.
4	Build and test an IoT system involving prototyping, programming and data analysis.

Learning Resources:	
1	Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015.
2	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Pearson Education, 2017.
3	Internet of Things, K.G. Srinivasa , G.M. Siddesh, R.R. Hanumantha, CENGAGE Leaning India, 2018
4	Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2016.
5	Internet of Things (A Hands-on-Approach), Arshdeep Bahga and Vijay Madisetti, VPT, 2014.
6	Internet of Things: Architecture and Design Principles, Raj Kamal , McGraw Hill Education,2017

Course Name:	**Digital Signal Processing**		
Course Code:	PE-AIML702D	**Category:**	Professional Elective Course
Semester:	Seventh	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To make students capable to evaluate the spectrum of different discrete time domain signals
2	To make students familiar with the design mechanism of basic Digital filters
3	To make students aware about LTI systems and its design implications

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Discrete Time domain signals and systems:** Classification of discrete time signals, mathematical operation of discrete time signals, Unit impulse, Unit Step and Ramp signals, Time shifting, Time Scaling, Time reversal operation of Discrete Time Domain Signals	7L

2	**Linear and Circular Convolution:** Liner convolution of discrete signals, Inverse system and De-convolution, Circular convolution, impulse and step response of LSI system, Overlap add method and overlap save method	8L
3	**Z-transform and its application in system design:** Z-transform and properties of ROC, Inverse **Z**-transform, System transfer function and impulse response, Inverse Z-transform by using partial fraction method, Cauchy integral method, Long Division method. System realization using Direct-1,Direct-2, Cascade and parallel method,	8L
4	**Fourier transformation of discrete signals:** Introduction to Discrete Fourier Transform (DFT), Spectrum development using DFT, Concept of IDFT, Twiddle factor, Introduction to Fast Fourier Transform (FFT), Radix-2 FFT algorithm, Decimation in time FFT and Decimation in frequency FFT algorithm	9L
5	**IIR and FIR Filters:** S-plane to **Z**-plane conversion using Impulse invariant method and Bilinear transform. Butterworth low pass, High pass, and Band pass Filter Design. Gibbs Phenomena, Introduction of FIR filters, Different Windows for FIR Filters such as Rectangular, Triangular, Hamming, Hanning Window	8L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Represents Signal mathematically in Continuous and discrete time and frequency domain
2	Get the response of an LSI system to different signals
3	Design of different types of digital filters for applications

Learning Resources:	
1	Proakis and Manolakis, Digital Signal Processing and applications, Pearson
2	Openhiem & Scaffer - Digital Signal Processing – Pearson India
3	A.Nagoorkani – Digital Signal Processing - TMH
4	V.Udayshankara—Modern Digital Signal Processing , 2/e , PHI

Course Name:	**Computer Aided Design**			
Course Code:	OE-ME701A	**Category:**	Open Elective Course	
Semester:	Seventh	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Concepts of Computing and Graphics Design	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To understand fundamental concepts of computer graphics and its tools in a generic framework.
2	To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
3	To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids
4	To provide clear understanding of CAD systems for 3D modeling and viewing.
5	To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction To Computer Graphics Fundamentals:** Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software. Output primitives: Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm. Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations- Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.	8L
2	**Curves And Surfaces Modeling:** Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic	7L

	surfaces: Hermite bicubic surface- Bezier surface and B-Spline surface- surface manipulations.	
3	**NURBS And Solid Modeling:** NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.	7L
4	**Visual Realism:** Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring. Animation - Conventional, Computer animation, Engineering animation - types and techniques.	7L
5	**Assembly Of Parts And Product Life Cycle Management:** Assembly modeling – Design for manufacture – Design for assembly – computer aided DFMA - inferences of positions and orientation - tolerances analysis –Center of Gravity and mass property calculations - mechanism simulation. Graphics and computing standards - Data Exchange standards. Product development and management – new product development –models utilized in various phases of new product development – managing product life cycle.	7L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Solve 2D and 3D transformations for the basic entities like line and circle.
2	Formulate the basic mathematics fundamental to CAD system.
3	Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4	Create geometric models through animation and transform them into real world systems.
5	Simulate assembly of parts using Computer-Aided Design software.

Learning Resources:	
1	"Product design and manufacturing " by A. K. Chitale and R.C. Gupta, PHI learning private limited, 6th Edition, 2015.
2	"Assembly Automation and Product Design" by G. Boothroyd, Marcel Dekker, New York, 1997.
3	"Mathematical Elements for Computer Graphics" by David Rogers and James Alan Adams, 2nd Edition, Tata McGraw-Hill edition.2003
4	"Computer Graphics C Version" by Donald D Hearn and M. Pauline Baker, Prentice Hall, Inc., 2nd Edition, 1996.

5	"Mastering CAD/CAM" by Ibrahim Zeid, McGraw Hill, 2nd Edition, 2006
6	"Principles of Interactive Computer Graphics" by William M Newman and Robert F. Sproull, McGraw Hill Book Co. 1stEdition, 2001.

Course Name:	**Bio Informatics**			
Course Code:	OE-CS701B	**Category:**	Open Elective Course	
Semester:	Seventh	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Knowledge of Biology & Database	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To exposed to the need for Bioinformatics technologies.
2	To be familiar with the modeling techniques..
3	To exposed to Pattern Matching and Visualization.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Need for Bioinformatics technologies – Overview of Bioinformatics technologies Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics – Biological Data Integration System.	8L
2	**Introduction to Molecular Biology:** Concepts of Cell, tissue, types of cell, components of cell, organelle. Functions of different organelles. Concepts of DNA: Basic Structure of DNA; Double Helix structure; Watson and crick model. Exons and Introns and Gene Concept. Concepts of RNA : Basic structure, Difference between RNA and DNA. Types of RNA. Concept of Protein: Basic components and structure. Introduction to Central Dogma: Transcription and Translation Introduction to Metabolic Pathways	12L
3	**Sequence Databases:** Introduction to Bioinformatics. Recent challenges in Bioinformatics. Protein Sequence Databases, DNA sequence databases. sequence database search programs like BLAST and FASTA. NCBI different modules: GenBank; OMIM, Taxonomy browser, PubMed.	12L

4	**DNA Mapping and Assembly:** Size of Human DNA, Copying DNA: Polymerase Chain Reaction (PCR), Hybridization and Microarrays, Cutting DNA into Fragments, Sequencing Short DNA Molecules, Mapping Long DNA Molecules. DeBruijn Graph. Sequence Alignment: Introduction, local and global alignment, pair wise and multiple alignment, Dynamic Programming Concept. Alignment algorithms: Needleman and Wunsch algorithm, Smith-Waterman.	6L
Total		**38L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Develop models for biological data
2	Apply pattern matching techniques to bioinformatics data – protein data genomic data.
3	Apply micro array technology for genomic expression study

Learning Resources:	
1	Bioinformatics Technologies by Yi-Ping Phoebe Chen (Ed). First Indian Reprint, Springer Verlag, 2007
2	Bio Informatics Computing by Bryan Bergeron, Pearson Education
3	Introduction to Bioinformatics by Arthur M Lesk Oxford University Press
4	Bioinformatics for Beginners by Supratim Chaudhury Elsevier.
5	Bioinformatics Algorithms: An Active Learning Approach, Volume 1 by Phillip Campeau Active Learning Publishers
6	Algorithms in Bioinformatics: A Practical Introduction by Wing-Kin Sung CRC Press

Course Name:	**Robotics**		
Course Code:	OE-ME701D	**Category:**	Open Elective Course
Semester:	Seventh	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Knowledge of Engg. Mechanics & Programming
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To understand the functions of the basic components of a Robot.
2	To study the use of various types of End of Effectors and Sensors.
3	To learn Robot safety issues and economics.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Robotic Paradigm:** Introduction - Overview of the Three Paradigms – social implications of robotics – history of robotics – tele operation – seven areas of AI – Hierarchical Paradigm – attributes – representative architectures – advantages and disadvantages – programming considerations.	8L
2	**Robot Drive Systems and End Effectors:** Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors. Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.	10L
3	**Sensors and Machine Vision:** Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors – Piezo Electric Sensor, LVDT, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors , Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification.	10L
4	**Implementation and Robot Economics:** Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations – Economic Analysis of Robot.	5L
5	**Basic of Robot Programming:** Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effectors commands and simple Programs	5L
Total		**38L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the basic engineering knowledge for the design of robotics
2	Apply programming techniques to Robotic Movement.
3	Explain the computation methodology with dynamics of Robots.

Learning Resources:	
1	Introduction to AI Robotics by Robin R. Murphy. A Bradford Book, MIT Press.
2	Robotic Engineering-An Integrated Approach by R.D Klafter, T.A Chmielewski and Negin, Prentice Hal
3	Industrial Robotics -Technology Programming and Applications by M.P Groover, McGraw Hill
4	Robotics and Industrial Automation by R.K Rajput, S.Chand and Company.
5	Robotics Technology and Flexible Automation by S.R Deb Tata McGraw Hill Book Co
6	Robotics Control, Sensing, Vision and Intelligence by K.S Fu, R.C. Gonzalz and Lee McGraw Hill Book Co
7	Robotics and Image Processing by P.A Janakiraman Tata McGraw Hill

Course Name:	**Compiler Design**			
Course Code:	OE-CS701D	**Category:**	Open Elective Course	
Semester:	Seventh	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of programming language	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To understand the different stages in the compilation process.
2	Identify different methods of lexical analysis.
3	Design top-down and bottom-up parsers.
4	Identify synthesized and inherited attributes.
5	Develop syntax directed translation schemes.
6	Develop algorithms to generate coding for a target machine.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Compiling:** Compilers, Analysis of the source program, The phases of the compiler, Cousins of the compiler.	3L
2	**Lexical Analysis:** The role of the lexical analyzer, Tokens, Patterns, Lexemes, Input buffering, Specifications of a token, Recognition of a tokens, Finite automata, From a regular expression to an NFA, From a regular expression to NFA, From a regular expression to DFA, Design of a lexical analyzer generator (Lex).	4L
3	**Syntax Analysis:** The role of a parser, Context free grammars, Writing a grammar, Top down Parsing, No recursive ,Predictive parsing(LL), Bottom up parsing, Handles, Viable prefixes, Operator precedence parsing, LR parsers (SLR, LALR), Parser generators (YACC). Error Recovery strategies for different parsing techniques.	9L
4	**Syntax Directed Translation:** Syntax director definitions, Construction of syntax trees, Bottom-up evaluation of S attributed definitions, L attributed definitions, Bottom-up evaluation of inherited attributes.	5L
5	**Type Checking:** Type systems, Specification of a simple type checker, Equivalence of type expressions, Type conversions	3L
6	**Runtime Environments:** Source language issues (Activation trees, Control stack, scope of declaration, Binding of names), Storage organization (Subdivision of run-time memory, Activation records), Storage allocation strategies, Parameter passing (call by value, call by reference, copy restore, call by name), Symbol tables, dynamic storage allocation techniques.	4L
7	**Intermediate code generation:** Intermediate languages, Graphical representation, Three-address code, Implementation of three address statements (Quadruples, Triples, Indirect triples).	3L
8	**Code optimization:** Introduction, Basic blocks & flow graphs, Transformation of basic blocks, Dag representation of basic blocks, The Principle sources of optimization, Loops in flow graph, Peephole optimization.	3L
9	**Code generations:** Issues in the design of code generator, a simple code generator, Register allocation & assignment.	2L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain grammar specification and develop the lexical analyzer.
2	Design a given parser specification, design top down and bottom up parser.
3	Develop syntax directed translation schemes.
4	Develop algorithms to generate code for a target machine.

Learning Resources:	
1	Aho, Sethi, Ullman - "Compiler Principles, Techniques and Tools" - Pearson Education.
2	Holub - "Compiler Design in C" - PHI.

Course Name:	**Project Management and Entrepreneurship**		
Course Code:	HM-HU702	**Category:**	Humanities and Social Sciences including Management Course
Semester:	Seventh	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of Business and software projects
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To explain concepts of Entrepreneurship and build an understanding about business situations in which entrepreneurs act.
2	To analyze the various aspects, scope and challenges under an entrepreneurial venture.
3	To explain classification and types of entrepreneurs and the process of entrepreneurial project development.
4	To discuss the steps in venture development and new trends in entrepreneurship.
5	Describe the process of Software Project Management.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**ENTREPRENEURSHIP:** Introduction: Meaning and Concept of Entrepreneurship, Innovation and entrepreneurship, Contributions of entrepreneurs to the society, risk-opportunities perspective and	2L

	mitigation of risks.	
2	Entrepreneurship – An Innovation: Challenges of Innovation, Steps of Innovation Management, Idea Management System, Divergent v/s Convergent Thinking, Qualities of a prospective Entrepreneur	2L
3	Idea Incubation: Factors determining competitive advantage, Market segment, blue ocean strategy, Industry and Competitor Analysis (market structure, market size, growth potential), Demand-supply analysis	4L
4	Entrepreneurial Motivation: Design Thinking - Driven Innovation, TRIZ (Theory of Inventive Problem Solving), Achievement motivation theory of entrepreneurship – Theory of McClelland, Harvesting Strategies	2L
5	Information: Government incentives for entrepreneurship, Incubation, acceleration. Funding new ventures – bootstrapping, crowd sourcing, angel investors, Government of India's efforts at promoting entrepreneurship and innovation – SISI, KVIC, DGFT, SIDBI, Defense and Railways	4L
6	Closing the Window: Sustaining Competitiveness, Maintaining Competitive Advantage, the Changing Role of the Entrepreneur.	2L
7	Applications and Project Reports Preparation	4L
8	**PROJECT MANAGEMENT:** Definitions of Project and Project Management, Issues and Problems in Project Management, Project Life Cycle - Initiation / Conceptualization Phase, Planning Phase, Implementation / Execution Phase, Closure / Termination Phase	4L
9	Project Feasibility Studies – Pre-Feasibility and Feasibility Studies, Preparation of Detailed Project Report, Technical Appraisal, Economic/Commercial/Financial Appraisal including Capital Budgeting Process, Social Cost Benefit Analysis	2L
10	Project Planning – Importance of Project Planning, Steps of Project Planning, Project Scope, Work Breakdown Structure (WBS) and Organization Breakdown Structure (OBS), Phased Project Planning	2L
11	Project Scheduling and Costing – Gantt chart, CPM and PERT Analysis, Identification of the Critical Path and its Significance, Calculation of Floats and Slacks, Crashing, Time Cost Trade-off Analysis, Project Cost Reduction Methods.	6L
12	Project Monitoring and Control – Role of Project Manager, MIS in Project Monitoring, Project Audit	2L
13	Case Studies with Hands-on Training on MS-Project	4L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify the type of entrepreneur and the steps involved in an entrepreneurial venture.
2	Explain the role of project management including planning, scheduling, cost estimation, risk management, etc
3	Describe various steps involved in starting a venture and to explore marketing methods & new trends in entrepreneurship.
4	Demonstrate Entrepreneurial skills and management function of a company.

Learning Resources:	
1	Innovation and Entrepreneurship by Drucker, P.F.; Harper and Row
2	Business, Entrepreneurship and Management: Rao, V.S.P. ;Vikas
3	Entrepreneurship: Roy Rajeev; OUP.
4	Text Book of Project Management: Gopalkrishnan, P. and Ramamoorthy, V.E.; McMillan
5	Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.; PHI
6	Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.; MGH

Course Name:	**Project-III**		
Course Code:	PW-AIML781	**Category:**	Sessional Course
Semester:	Seventh	**Credit:**	6
L-T-P:	0-0-12	**Pre-Requisites:**	Knowledge of engineering, science and management subjects
Full Marks:	100		
Examination Scheme:	Semester Examination: 20		Continuous Assessment: 80

Course Objectives:	
1	In depth knowledge gain in the domain of the assigned topic.
2	To be able to finalize the approach to the problem of the assigned topic.
3	To be able to prepare an Action Plan for conducting the investigation, including team work.
4	To be able to do Detailed Analysis/Modelling/Simulation/Problem solving/Experiment as needed.
5	To perform Development of product/process, testing, results, conclusions and future scope analysis.

Course Outcomes:	
After completion of the course, students will be able to:	
1	Prepare a report in the standard format.
2	Ready for Seminar Presentation before any standard body.
3	Prepare a paper for Conference presentation/Publication in Journals.