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

Part III: Detailed Curriculum

Eighth Semester

Course Name:	**Natural Language Processing**		
Course Code:	PE-AIML801A	**Category:**	Professional Elective Course
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	OE-AIML701D (Compiler Design)
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To grasp the significance of natural language processing in solving real-world problems.
2	To map the appropriate processing technique to a problem and implement the technique.
3	To demonstrate required design skills for large collection sets.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Regular Expressions and Automata (Recap) - Introduction to NLP, Regular Expression, Finite State Automata, Tokenization - Word Tokenization, Normalization, Sentence Segmentation, Named Entity Recognition, Multi Word Extraction, Spell Checking – Bayesian Approach, Minimum Edit Distance, Morphology - Morphology – Inflectional and Derivational Morphology, Finite State Morphological Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite State Transducers, Orthographic Rules and Finite State Transducers, Porter Stemmer.	11L
2	Language Modeling Introduction to N-grams, Chain Rule, Smoothing – Add-One Smoothing, Witten-Bell Discounting; Backoff, Deleted Interpolation, N-grams for Spelling and Word Prediction, Evaluation of language models. Hidden Markov Models and POS Tagging	8L

	Markov Chain, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Part of Speech Tagging – Rule based and Machine Learning based approaches, Evaluation.	
3	Text Classification Text Classification, Naïve Bayes' Text Classification, Evaluation, Sentiment Analysis – Opinion Mining and Emotion Analysis, Resources and Techniques. Context Free Grammar Context Free Grammar and Constituency, Some common CFG phenomena for English, Top-Down and Bottom-up parsing, Probabilistic Context Free Grammar, Dependency Parsing	8L
4	Computational Lexical Semantics Introduction to Lexical Semantics – Homonymy, Polysemy, Synonymy, Thesaurus – WordNet, Computational Lexical Semantics – Thesaurus based and Distributional Word Similarity, Information Retrieval Boolean Retrieval, Term document incidence, The Inverted Index, Query Optimization, Phrase Queries, Ranked Retrieval – Term Frequency – Inverse Document Frequency based ranking, Zone Indexing, Query term proximity, Cosine ranking, Combining different features for ranking, Search Engine Evaluation, Relevance Feedback.	9L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe the fundamental concepts and techniques of natural language processing.
2	Distinguish among the various techniques of NLP, taking into account the assumptions, strengths, and weaknesses of each.
3	Use appropriate descriptions, visualizations, and statistics to communicate the problems and their solutions.
4	Analyze large volume text data generated from a range of real-world applications.

Learning Resources:	
1	"Speech and Language Processing", Jurafsky and Martin, Pearson Education.
2	"Foundation of Statistical Natural Language Processing", Manning and Schutze, MIT Press.
3	"Multilingual Natural Language Processing Applications from Theory to Practice" : Bikel, Pearson.

Course Name:	**Software Engineering**		
Course Code:	PE-AIML801B	**Category:**	Professional Elective Course
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of Computer Programming.
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Introduction to Software Engineering Principles and activities involved in building large software programs.
2	Describe the process of Software Project Management.
3	Fundamental concepts of Software Testing.
4	To develop the ability to Functional and Object oriented design using UML.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**System Analysis and Process Models:** Overview of System Analysis & Design, Business System Concept, System Development Life Cycle, and Software Development process models: Waterfall Model, Prototyping Model, Spiral Model, Feasibility Analysis, Technical Feasibility, Cost-Benefit Analysis, and Requirement Engineering.	8L
2	**System Design:** Context diagram and DFD, Cohesion, Coupling, Problem Partitioning, Top-Down and Bottom-Up design; Decision tree, decision table and structured English; Functional vs. Object- Oriented approach.	6L
3	**Software Project Management:** Project Management Process, Planning, LOC, Function Point, Project Estimation Techniques, COCOMO, Staffing Level Estimation, Project Scheduling, Software Quality Assurance, Software Configuration Management, Risk Management, Project Monitoring and Control.	8L
4	**Software Coding and Testing:** Coding Standard, Guidelines and Review. Levels of Testing, Black Box and White Box Testing, Integration Testing, System Testing, Performance Testing, Test case Specification, Reliability Assessment, Validation & Verification Metrics, and Debugging.	8L

5	**Object Modeling and Design:** Static and dynamic models, why modeling, UML diagrams-Use Case Diagram, Class diagram, interaction diagram, collaboration diagram, sequence diagram, state chart diagram, activity diagram, implementation diagram.	8L
Total		**38L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify software process model and main aspects of software engineering.
2	Explain the role of project management including planning, scheduling, cost estimation, risk management, etc
3	Design software test cases and study software in object oriented paradigm using UML diagram.

Learning Resources:	
1	Pressman, Software Engineering : A practitioner's approach– (TMH)
2	Rajib Mall, Software Engineering- (PHI)
3	Pankaj Jalote, Software Engineering- (Wiley-India)
4	Agarwal and Agarwal, Software Engineering – (PHI)
5	Sommerville, Software Engineering – Pearson
6	Martin L. Shooman, Software Engineering – TMH
7	Grady Booch, James Rumbaugh, Ivar Jacobson, the unified modeling language User guide, Pearson education, New York

Course Name:	**Geographic Information System**			
Course Code:	PE-AIML801C	**Category:**	Professional Elective Course	
Semester:	Eighth	**Credit:**	3	
L-T-P:	3 - 0 - 0	**Pre-Requisites:**	Nil	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To introduce the student about the major concepts involved in Geographic Information Systems.
2	To familiarize the students with GIS application areas.
3	To familiarize the students with Technology & Instruments involved in GIS.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction and Overview of Geographic Information Systems Definition of a GIS, features and functions; why GIS is important; how GIS is applied; GIS as an Information System; GIS and cartography; contributing and allied disciplines; GIS data feeds; historical development of GIS.	4L
2	GIS and Maps, Map Projections and Coordinate Systems Maps and their characteristics (selection, abstraction, scale, etc.); automated cartography versus GIS; map projections; coordinate systems; precision and error.	5L
3	Data Sources, Data Input, Data Quality and Database Concepts Major data feeds to GIS and their characteristics: maps, GPS, images, databases, commercial data; locating and evaluating data; data formats; data quality; metadata. Database concepts and components; flat files; relational database systems; data modeling; views of the database; normalization; databases and GIS	6L
4	Spatial Analysis Questions a GIS can answer; GIS analytical functions; vector analysis including topological overlay; raster analysis; statistics; integrated spatial analysis	4L
5	Making Maps Parts of a map; map functions in GIS; map design and map elements; choosing a map type; producing a map formats, plotters and media; online and CD-ROM distribution; interactive maps and the Web	7L
6	Implementing a GIS Planning a GIS; requirements; pilot projects; case studies; data management; personnel and skill sets; costs and benefits; selecting a GIS package; professional GIS packages; desktop GIS; embedded GIS; public domain and low cost packages.	5L
7	Technology & Instruments involved in GIS & Remote Sensing GIS applications; GIS application areas and user segments; creating custom GIS software applications; user interfaces; case studies. Future data; future hardware; future software; Object-oriented concepts and GIS; future issues – data ownership, privacy, education; GIS career options and how to pursue them.	9L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe Geographic Information Systems
2	Explain different Technology & Instruments involved in GIS
3	Explain GIS application areas

Learning Resources:	
1	"Principles of geographical information systems", P. A. Burrough and R. A. Mcdonnel, Oxford.
2	"Remote sensing of the environment" , J. R. Jensen, Pearson
3	"Exploring Geographic Information Systems", Nicholas Chrismas, John Wiley & Sons.
4	"Getting Started with Geographic Information Systems", Keith Clarke, PHI.
5	"An Introduction to Geographical Information Systems", Ian Heywood, Sarah Cornelius, and Steve Carver. Addison-Wesley Longman.

Course Name:	**Economic Policies in India**		
Course Code:	OE-HU801C	**Category:**	Management Science and Humanities
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To familiarize the students with the present features of the Indian Economy and Economic Planning.
2	To acquaint students with the major policy regimes of government to resolve problems in agriculture, industry and service sector of India.
3	To provide the students a basic knowledge of financial institutions and to acquaint them with major financial services in India.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Economic Development and its Determinants: Approaches to economic development and its measurement – sustainable development; Role of State, market and other institutions; Indicators of development – PQLI, Human Development Index (HDI), gender development indices.	4L
2	Planning in India**:** Objectives and strategy of planning; Failures and achievements of Plans; Developing grass-root organizations for development – Panchayats, NGOs and pressure groups. Broad demographic features of Indian population; rural-urban migration; Urbanization and civic amenities; Poverty and Inequality	6L
3	Energy; social infrastructure – education and health; Environment; Regional imbalance; Issues and policies in financing infrastructure development. Institutional Structure – land reforms in India; Technological change in agriculture – pricing of agricultural inputs and output; industry; Agricultural finance policy; Agricultural Marketing and Warehousing; Issues Terms of trade between agriculture and in food security – policies for sustainable agriculture.	8L
4	Industrial policy; Public Sector enterprises and their performance; Problem of sick units in India; Privatization and disinvestment debate; Growth and pattern of industrialization; Small-scale sector; Productivity in industrial sector; Exit policy – issues in labour market reforms; approaches for employment generation. Public Finances Fiscal federalism – Centre-State financial relations; Finances of central government; Finances of state governments; Parallel economy; Problems relating to fiscal policy; Fiscal sector reforms in India.	8L
5	Money, Banking and Prices Analysis of price behavior in India; Financial sector reforms; Interest rate policy; Review of monetary policy of RBI; Money and capital markets; Working of SEBI in India.	4L
6	External Sector Structure and direction of foreign trade; Balance of payments; Issues in export-import policy and FEMA; Exchange rate policy; Foreign capital and MNCs in India; The progress of trade reforms in India. Economic Reforms Rationale of internal and external reforms; Globalization of Indian economy; WTO and its impact on the different sectors of the economy; Need for and issues in good governance; Issues in competition and safety nets in Indian economy.	6L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the Demographic Features, Poverty and Inequality and evaluate the role of fiscal and monetary policies is bringing about economic stability.
2	Evaluate the role of financial institutions in India.
3	Analyse the role of different sectors in the economy.

Learning Resources:	
1	Ahluwalia, I. J. and I. M. D Little (Eds.) (1999), India's Economic Reforms and Development (Essays in honour of Manmohan Singh), Oxford University Press, New Delhi.
2	Bardhan, P. K. (9th Edition) (1999), The Political Economy of Development in India, Oxford University Press, New Delhi.
3	Bawa, R. S. and P. S. Raikhy (Ed.) (1997), Structural Changes in Indian Economy, Guru Nanak Dev University Press, Amritsa
4	Brahmananda, P. R. and V. R. Panchmukhi (Eds.) (2001), Development Experience in the Indian Economy: Inter-State Perspectives, Book well, Delhi.
5	Chakravarty, S. (1987), Development Planning: The Indian Experience, Oxford University Press, New Delhi.
6	Dantwala, M. L. (1996), Dilemmas of Growth: The Indian Experience, Sage Publications, New Delhi.
7	Datt, R. (Ed.) (2001), Second Generation Economic Reforms in India, Deep & Deep Publications, New Delhi.
8	Government of India, Economic Survey (Annual), Ministry of Finance, New Delhi.
9	Jain, A. K. (1986), Economic Planning in India, Ashish Publishing House, New Delhi.

Course Name:	**Soft Skill and Interpersonal Communication**		
Course Code:	OE-HU801J	**Category:**	Management Science and Humanities
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic language softskills
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Apply the strategies for Group Discussion on diverse topics.
2	Build personal Interview skills
3	Build 'Presentation Skills' with emphasis on Group Dynamics.
4	To develop a positive Personality which is more attuned to Corporate Life
5	Develop Employability quotient

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	1. Soft Skills: An Introduction – Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development. 2. Self-Discovery: Discovering the Self; Setting Goals; Beliefs, Values, Attitude, Virtue. 3. Positivity and Motivation: Developing Positive Thinking and Attitude; Driving out Negativity; Meaning and Theories of Motivation; Enhancing Motivation Levels.	12L
2	1.Interpersonal Communication: Interpersonal relations; communication models, process and barriers; team communication; developing interpersonal relationships through effective communication; listening skills; essential formal writing skills; corporate communication styles – assertion, persuasion, negotiation. 2. Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking. 3. Group Discussion: Importance, Planning, Elements, Skills assessed; Effectively disagreeing, Initiating, Summarizing and Attaining the Objective. 4. Non-Verbal Communication: Importance and Elements; Body Language. 5. Teamwork and Leadership Skills: Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills.	12L
3	1. Interview Skills: Interviewer and Interviewee – in-depth perspectives. Before, During and After the Interview. Tips for Success. 2. Presentation Skills: Types, Content, Audience Analysis, Essential Tips – Before, During and After, Overcoming Nervousness. 3. Etiquette and Manners – Social and Business. 4. Time Management – Concept, Essentials, Tips. 5. Personality Development – Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.	12L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Develop and exhibit a positive personality and nurture a deep understanding of personal motivation
2	Develop an understanding of and practice personal and professional responsibility
3	Demonstrate knowledge of personal beliefs and values and a commitment to continuing personal reflection and reassessment
4	Demonstrate strong verbal and non- verbal communication skills and become employable
5	Develop strategies for facing interviews and making presentations.
6	Develop and exhibit a positive personality and nurture a deep understanding of personal motivation

Learning Resources:	
1	How to Win Friends and Influence People. Dale Carnegie
2	Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011
3	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
4	Kulbhushan Kumar, R S Salaria, Effective Communication Skills, Khanna Publishing House, Delhi.
5	Failing Forward: Turning Mistakes into Stepping Stones for Success, John C Maxwell
6	Getting things Done - The Art of Stress-free productivity by David Allen
7	Soft Skills: Key to success in Workplace and Life, Meenakshi Raman and Shalini Upadhyay
8	50 Mantra's of Personality Development, Arti Gurav.
9	The 10X Rule: The Only Difference between Success and Failure. Grant Cardone
10	Make The Most of Your Mind. Tony Buzan.

Course Name:	**Cyber Law & Ethics**			
Course Code:	OE-CS801F	**Category:**	Open Elective Course	
Semester:	Eighth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Programming Skill & Cyber Awareness	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To develop an understanding of modern network architectures from a design and performance perspective.
2	To Implement cyber security solutions.
3	To be able to use cyber security, information assurance, and cyber/computer forensics software/tools

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction of Cybercrime: What is cybercrime? Forgery, Hacking & Ethical Hacking, Software Piracy, Computer Network intrusion. Category of Cybercrime: how criminals plan attacks, passive attack, Active attacks, cyber stalking, Introduction to Cyber Forensics	6L
2	Introduction to Cyber Security, Importance and challenges in Cyber Security, Cyberspace, Cyber threats, Cyber warfare, Cyber Terrorism, Cyber Security of Critical Infrastructure, Cyber security - Organizational Implications	8L
3	Cybercrime Mobile & Wireless devices: Security challenges posted by mobile devices, Cryptographic security for mobile devices, Attacks on mobile/cell phones, Theft, Virus, Bluetooth; Different viruses on laptop	8L
4	Hackers and Cyber Crimes: Types of Hackers, Hackers and Crackers, Cyber-Attacks and Vulnerabilities, Tools and Methods used in Cyber crime: Proxy servers, password checking, Random checking, Trojan Horses and Backdoors; DOS & DDOS attacks; SQL injection: buffer over flow	8L
5	Phishing & Identity Theft: Phishing methods, ID Theft; Online Identity method. Cybercrime & Cyber security: Legal aspects, Indian laws, IT act, Public key certificate Cyber Ethics and Laws: Introduction to Cyber Laws, E-Commerce and E-Governance, Certifying Authority and Controller, Offences under IT Act, Computer Offences and its penalty under IT Act 2000.	8L
Total		**38L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the basic concepts of Cyber Security
2	Implement mechanism for access control & authentication
3	Describe Risk management concepts & Cyber Laws

Learning Resources:	
1	"Cyber security" by Nina Gobole & Sunit Belapune; Pub: Wiley India.
2	Information Security & Cyber Laws, Gupta & Gupta, Khanna Publishing House (AICTE Recommended - 2018).
3	"Information Security and Cyber Laws", Pankaj Agarwal
4	Enterprise Cyber Security -How to Build a Successful Cyberdefense Program Against Advanced Threats, A-press by Donaldson, S.Siegel, S.Williams, C.K.Aslam.
5	"Hacking the Hacker", by Roger Grimes, Wiley
6	"Cyber Law By Bare Act", Govt Of india, It Act 2000

Course Name:	**Organisational Behaviour**		
Course Code:	OE-HU801H	**Category:**	Management Science and Humanities Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	To know the existence of organization as a place for human livelihood
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 5

Course Objectives:	
1	To help the students to develop cognizance of the importance of human behavior and how to align it with basic organizational theories
2	To enable students to describe how people behave under different conditions and understand why people behave as they do
3	To provide the students to analyze specific strategic human resources demands for future action
4	To enable students to synthesize related information and evaluate options for the most logical and optimal solution such that they would be able to predict and control human behaviour and improve results

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction of Organizational Behavior**: Introduction, definition, historical development, An OB model; contributing disciplines, challenges and opportunities.	3L
2	**Foundations of Individual Behavior**: Individual behavior; Intellectual abilities, Physical ability, the role of disabilities. Personality: Meaning, formation, determinants, traits of personality, big five and MBTI, personality attributes influencing OB. Attitude: Formation, components of attitudes, relation between attitude and behavior; Learning; Perception: Process of perception, factors influencing perception, link between perception and individual decision-making; Transactional Analysis: An Introduction to Transactional Analysis; Johari window.	8L
3	**Group Dynamics and Team Development**: Group dynamics - definition and importance, types of groups, group formation, group development, group composition, group performance factors; Principle-centered-approach to team development	6L
4	**Motivation**: Meaning, theories of motivation-needs theory, two factor theory, Theory X and Y, application of motivational theories. Job satisfaction. Case Study analysis. **Leadership**: Meaning, styles of leadership, leadership theories, trait theory, behavioral theories, managerial grid, situational theories.	8L
5	**Power and Authority** :Definition of Power –Types of Power; Power and Politics in Organization; Organizational Stress ; Conflict: Nature of Conflict & Conflict Resolution; Case Study Analysis	5L
6	**Organizational Change and Development**: Planned Change & OB Techniques; Organizational Development; Organizational Culture: Meaning & Definition, Contemporary Models of Culture and Organizational Effectiveness; Cross Cultural Management	6L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate the applicability of the concept of organizational behavior to understand the behavior of people in the organization
2	Demonstrate the applicability of analyzing the complexities associated with management of individual behavior in the organization.
3	Analyze the complexities associated with management of the group behavior in the organization
4	Demonstrate how the organizational behavior can integrate in understanding the

	motivation (why) behind behavior of people in the organization.

Learning Resources:	
1	Robbins, S.P. Judge, T.A. & Sanghi, S.: Organizational Behaviour, Pearson
2	Luthans, Fred: Organizational Behaviour, McGraw Hill
3	Newstrom J.W. & Devis K.: Organizational Behavior, McGraw Hill
4	Aswathappa ,K : Organisational Behaviour , Himalaya Publishing House
5	Shukla, Madhukar : Understanding Organizations – Organizational Theory & Practice in India, Prentice Hall
6	Sekharan, Uma: Organisational Behaviour , The McGraw –Hill Companies

Course Name:	**Research Methodology**			
Course Code:	OE-CS801G	**Category:**	Open Elective	
Semester:	Eighth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Nil	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To learn the basics of different research methodologies
2	To learn the collection process and analysis of data
3	To learn about the different ethical issues related to research work
4	To write a good research proposal

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Research Formulation and Design**: Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from	9L

	literature and research database, development of working hypothesis	
2	**Data Collection and Analysis:** Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing	9L
3	**Research Ethics, IPR and Scholarly Publishing:** Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability	9L
4	**Interpretation and Report Writing**: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Project Report, Layout of the Project/Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Project/Research Report, Precautions for Writing Research Reports, Conclusions	9L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate knowledge of research processes by formulating and designing methods
2	Describe and compare different statistical methods for conducting data analysis
3	Explain the justification for research ethics
4	Prepare the good research/project proposal or report

Learning Resources:	
1	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2	Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
3	Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
4	Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
5	Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

Course Name:	**Microelectronics and VLSI**			
Course Code:	OE-EC801B	**Category:**	Open Elective	
Semester:	Eighth	**Credit:**	3	
L-T-P:	3-0-0	**Pre-Requisites:**	Knowledge of CMOS	
Full Marks:	100			
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05	

Course Objectives:	
1	To learn about VLSI design methodologies.
2	To learn about VLSI fabrication process and layout design rules
3	To learn about CMOS analog circuits.
4	To learn about digital CMOS logic circuits.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	MOSFET: Electrical characteristics of MOSFET, Threshold voltage, Current expression, Body effect, Channel length modulation, MOSFET scaling, Short-channel effects.	6L
2	VLSI Methodologies: Introduction to VLSI design, Moore's Law, VLSI Design flow, Design hierarchy, VLSI Design style: Full custom, Gate array, standard-cell, and Macro cell based design, Field programmable devices.	4L
3	Micro-electronic Processes for VLSI Fabrication: Wafer preparation, Oxidation, Diffusion, Ion implantation, Deposition, Metallization, Etching and Lithography. NMOS fabrication: n-well and p well process, Twin tub process. Layout: Stick diagram, Layout and Layout design rules.	10L
4	Analog VLSI Circuits: Introduction to Analog IC Design, MOS switch, Active load / resistors, CMOS Current source & sink, CMOS Voltage reference circuits/voltage dividers, Current Mirror, Differential amplifier, Operational Amplifier, Switched capacitor filter	10L
5	CMOS for Digital VLSI Circuits: CMOS Inverter, CMOS logic Circuits: NAND, NOR and other complex CMOS logic circuits, CMOS Full Adder, CMOS Transmission Gate, Sequential CMOS logic circuits: SR Latch, D-latch, clocked JK Latch/ Master-Slave JK, Edge triggered flip-flop, CMOS Power: static and dynamic power	10L

	dissipation, latch up	
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	State VLSI design methodologies.
2	Describe different steps of VLSI fabrication process and layout design rules.
3	Explain the operation of different CMOS analog circuits.
4	Explain the operation of various digital CMOS logic circuits.

Learning Resources:	
1	CMOS Digital Integrated Circuits, S. Mo. Kang and Yusuf Leblebici, 3rd Ed, TMH.
2	Design of Analog CMOS Integrated Circuits, Behzad, Razavi, MGH.
3	CMOS Analog Integrated Circuit Design, Allen Holberg, Oxford University Press.
4	VLSI Design, Debaprasad Das, 2nd Edition, Oxford University Press.
5	Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey, Prentice-Hall Publication, 2nd Edition.
6	Basic VLSI Design, D. Pucknell & Eshraghian, PHI, 3rd Edition.
7	Fundamental of Semiconductor Fabrication, Garry S. May, Simon M SZE, WILEY.
8	CMOS Circuit Design, R. Jacob Baker, Harry W. Li, David E. Boyce, PHI.

Course Name:	**Project-IV**		
Course Code:	PW- AIML881	**Category:**	Sessional Course
Semester:	Eighth	**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.