Program Structure for ME (Information Technology - in AI & ROBOTICS)

Mumbai University
(With Effect from 2013-2014)

Semester I								
Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
IAC101	Soft Computing	4	--	--	4	--	--	4
IAC102	Ubiquitous Computing	4	--	--	4	--	--	4
IAC103	Robotics & Machine Intelligence	4	--	--	4	--	--	4
IAE101X	Elective - I	4	--	--	4	--	--	4
IAE102X	Elective - II	4	--	--	4	--	--	4
IAL101	Laboratory I –Course Lab	--	2	--	--	1	--	1
IAL102	Laboratory II –Elective Lab	--	2	--	--	1	--	1
Total		20	4	--	20	2	--	22

Subject Code	**Subject Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract. /oral**	**Total**
		Internal Assessment			**End Sem.**	**Exam Durat**			
		Test1	**Test2**	**AVG**					
IAC101	Soft Computing	20	20	20	80	3			100
IAC102	Ubiquitous Computing	20	20	20	80	3			100
IAC103	Robotics & Machine Intelligence	20	20	20	80	3			100
ISE101X	Elective - I	20	20	20	80	3			100
ISE102X	Elective - II	20	20	20	80	3			100
ISL101	Laboratory I –Course Lab	--	--	--	--		25	25	50
ISL102	Laboratory II –Elective Lab	--	--	--	--		25	25	50
Total		100	100	100	400	--	50	50	600

Semester - I			
Subject Code	**Elective I**	**Subject Code**	**Elective II**
IAE1011	Pattern Recongnition	IAE1021	Biometric Processing
IAE1012	Expert Systems	IAE1022	Speech Processing
IAE1013	Cognitive Robotics	IAE1023	Mechatronics

End Semester Examination: In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Program Structure for ME (Information Technology - in AI & ROBOTICS)

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Semester II								
Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
IAC201	Natural Language Processing	4	--	--	4	--	--	4
IAC202	Machine Learning	4	--	--	4	--	--	4
IAC203	Multi-Robot Systems	4	--	--	4	--	--	4
IAE201X	Elective - III	4	--	--	4	--	--	4
IAE202X	Elective - IV	4	--	--	4	--	--	4
IAL203	Laboratory III –Course Lab	--	2	--	--	1	--	1
IAL204	Laboratory IV –Elective Lab	--	2	--	--	1	--	1
Total		20	4	--	20	2	--	22

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem.	Exam Durat			
		Test1	Test2	AVG					
IAC201	Natural Language Processing	20	20	20	80	3			100
IAC202	Machine Learning	20	20	20	80	3			100
IAC203	Multi-Robot Systems	20	20	20	80	3			100
IAE201X	Elective - III	20	20	20	80	3			100
IAE202X	Elective - IV	20	20	20	80	3			100
IAL203	Laboratory III –Course Lab	--	--	--	--		25	25	50
IAL204	Laboratory IV –Elective Lab	--	--	--	--		25	25	50
Total		100	100	100	400	--	50	50	600

Semester - II			
Subject Code	**Elective III**	**Subject Code**	**Elective IV**
IAE2011	Knowledge Representation & Reasoning	IAE2021	Fuzzy Systems
IAE2012	Genetic Algorithms	IAE2022	Computer Vision
IAE2013	Robot Programming	IAE2023	Signal Processing

End Semester Examination: In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Program Structure for ME (Information Technology - in AI & ROBOTICS)

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Semester III								
Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
IAS301	Seminar	--	6	--	--	3	--	
IAD301	Dissertation I	--	24	--	--	12	--	
Total		--	30	--	--	15	--	

Subject Code	**Subject Name**	**Examination Scheme**						
		Theory					**Term Work**	**Total**
		Internal Assessment			**End Sem.**	**Exam Durat**		
		Test1	**Test2**	**AVG**				
IAS301	Seminar	--	--	--	--	50	50	100
IAD301	Dissertation I	--	--	--	--	100	--	100
Total		--	--	--	--	150	50	200

Semester IV								
Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
IAD401	Dissertation II	--	30	--	--	15	--	
Total		--	30	--	--	15	--	

Subject Code	Subject Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem.	Exam Durat		
		Test1	Test2	AVG				
IAD401	Dissertation II*	--	--	--	--	100	100	200
Total		--	--	--	--	100	100	200

* The Term Work and Oral of Dissertation II of Semester IV should be assessed jointly by the pair of Internal and External Examiners

Note- The Contact Hours for the calculation of load of teacher are as follows
Seminar - 01 Hour / week / student
Desertation I and II - 02 Hour / week / student

Subject Code	Subject Name	Credits
IAC101	Soft Computing	4

Module	Detailed content	Hours
1	Introduction to soft Computing: Introduction, Fuzzy Computing, Neural Computing, Genetic Algorithms, associative Memory, adaptive Resonance Theory, applications.	6
2	Fundamentals of neural Network: Model of artificial neuron, Architectures, Learning Methods, Taxonomy of NN Systems, single-Layer NN system, applications	10
3	Back propagation Network	4
4	Associative Memory: Description, Auto-associative Memory, bidirectional, hetero-associative memory	6
5	Adaptive Resonance Theory: Supervised, unsupervised, backprop algorithms,competitive Learning; ART Netowrks, Iterative Clustering, Unsupervised ART Clustering	6
6	Fuzzy Set Theory: Fuzzy set: Membership, operations, properties; Fuzzy relations	4
7	Fuzzy Systems: Fuzzy logic, Fuzzification, Fuzzy inference, fuzzy rule based system, defuzzification	4
8	Hybrid System: Genetic algorithm, GA Based Back Propagation, Networks, Fuzzy Associative Memories, simplified Fuzzy ARTMAP	8

References:

1)Principle of Soft computing:, sivanandam, wiley

2) Neural Netowrk, fuzzy logic, and genetic algorithm, Rajasekaran, Printice hall
3) Soft computing and Intelligent Systems- theory and application by Naresh sinha, Addison wesley

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAC102	Ubiquitous Computing	4

Module	Detailed content	Hours
1	Ubiquitous Computing: Basics and Vision. Living in a Digital World. Modelling the Key Ubiquitous Computing Properties. Ubiquitous System Environment Interaction. Architectural Design for UbiCom Systems: Smart DEI Model.	4
2	Applications and Requirements. Introduction. Example Early UbiCom Research Projects. Everyday Applications in the Virtual, Human and Physical World.	4
3	Smart Devices and Services. Introduction.Service Architecture Models. Service Provision Life-Cycle. Virtual Machines and Operating Systems.	4
4	Smart Mobiles, Cards and Device Networks. Introduction. Smart Mobile Devices, Users, esources and Code. Operating Systems for Mobile Computers and Communicator Devices. Smart Card Devices. Device Networks.	4
5	Human–Computer Interaction. Introduction. User Interfaces and Interaction for Four Widely Used Devices. Hidden UI Via Basic Smart Devices. Hidden UI Via Wearable and Implanted Devices. Human-Centred Design (HCD). User Models: Acquisition and Representation. iHCI Desi	6
6	Tagging, Sensing and Controlling. Introduction. Tagging the Physical World. Sensors and Sensor Networks. Micro Actuation and Sensing: MEMS. Embedded Systems and Real-Time Systems. Control Systems (for Physical World Tasks). Robots	6
7	Context-Aware Systems. Introduction. Modelling Context-Aware Systems. Mobility Awareness. Spatial Awareness. Temporal Awareness: Coordinating and Scheduling. ICT System Awareness.	6
8	Intelligent Systems (IS). Introduction. Basic Concepts. IS Architectures. Semantic KB IS. Classical Logic IS. Soft Computing IS Models. IS System Operations. Intelligent System Interaction. Introduction. Interaction Multiplicity. Is Interaction Design. Some Generic Intelligent Interaction Applications.	6
9	Autonomous Systems and Artificial Life. Introduction. Basic Autonomous Intra-Acting Systems. Reflective and Self-Aware Systems. Self-Management and Autonomic Computing. Complex Systems. Artificial Life	4

10	Ubiquitous Communication. Introduction. Audio Networks. Data Networks. Wireless Data Networks. Universal and Transparent Audio, Video and Alphanumeric Data. Ubiquitous Networks. Further Network Design Issues. Ubiquitous System: Challenges and Outlook. Introduction. Overview of Challenges. Smart Devices. Smart Interaction. Smart Physical Environment Device Interaction. Smart Human–Device Interaction. Human Intelligence Versus Machine Intelligence. Social Issues: Promise Versus Peril.	4

References:

1. Ubiquitous Computing: Smart Devices, Environments and Interactions, Stefan Poslad, Wiley Publication
2. Ubiquitous Computing Fundamentals, John Krumm, CRC Press.
3. Everyware The Drawing age of Ubiquitous Computing, Adam Greenfield.
4. Ubiquitous Computing: Design, Implementation, and Usability, Yin-Leng Theng; Henry B. L. Duh, IGI Global

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAC103	Robotics & Machine Intelligence	4

Module	Detailed content	Hours
1	Robotic Manipulation Automation and Robots, Classification, Application, Specification Notations	2
2	Direct and Inverse Kinematics: Co-ordinate frames, Rotations, Link Co-ordination Arm Equation, (Two axis , Three axis, Four-axis robot SCARA, Five-axis only Rhino XR-3 Robot).General properties of solutions Tool configuration Two axis, Three axis planar articulated, Four axis SCARA, Five axis robots only Rhino XR-3 Robot.	8
3	Workspace Analysis and Trajectory Planning: Introduction to Workspace Analysis and Trajectory Planning, Work Envelop and examples, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.	6
4	Machine Intelligence: Object Detection using Adaboost, Object Recognition using Moments, Template Matching using correlation principle & Principal Component Analysis (PCA), Object Tracking using Discrete Wavelet Transform, Segmentation, Region Labeling, Shrink and Swell operators, Perspective Transformation, Stereo Vision, Depth Measurement with Vision Systems, Real Time Video Processing.	8
5	Embedded Systems and Real-time Operating System: Introduction to Embedded systems, Embedded Micro Controller cores (ARM, RISC, CISC, SOC), Embedded Memories, Architecture of Embedded Systems, Real-Time Operating Systems, Required RTOS services/capabilities (in contrast with traditional OS). RT Linux, Programming languages for Embedded Systems	8
6	Robotics Convergence Technology: Telematric camera Robotic System, Non-Imaging Sensors, Artificial intelligence for robotics, Knowledge representation, planning, and task scheduling. Sound and touch sensing, People sensing, Autonomous mobile robot,humanoid robots and simulated humans,human-robot interaction.	6
7	Applications of Robotics: Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading Processing - spot and continuous arc welding & spray painting – Assembly Inspection, Selected Embedded System-based Applications: Database Applications (smart cards), Process-Control (Fuzzy logic), Robot application in Medical, Industrial Automation, Security	6

References:

1. Robert Shilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India
2. Fu, Gonzales and Lee, Robotics, McGraw Hill
3. J.J, Craig, Introduction to Robotics, Pearson Education
4. Curtis D. Johnson, Process Control Instrumentation Technology, PHI Publication, Eighth Edition
5. An Embedded Software Primer – David E. Simon – Pearson Education
6. Embedded Microcomputer Systems -Jonathan W. Valvano - Thomson

7. Embedded Realtime Systems Programming- Sriram V Iyer, Pankaj Gupta - Tata McGraw Hill
8. Staughard, Robotics and AI, Prentice Hall of India

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAL101	Laboratory I –Course Lab	1

Module	Detailed content	Lab. Sessions
1	Two Laboratory Practicals to be conducted for each of the core subjects.	24

Modality and Assessment:

1. Each Laboratory assignment will be done in a group of two students. The Faculty teaching each core subject will be required to propose and evaluate the respective Laboratory assignments. These will be essentially hands-on practical and not theory / research review types of assignments.

2. End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Assessment:

Subject Code	Subject Name	Credits
IAL102	Laboratory II –Elective Lab	1

Module	Detailed content	Lab. Sessions
1	One Mini Project based on any one of the selected elective subject.	24

Modality and Assessment:

1. Each mini project assignment will be done by individual student. The Faculty teaching elective subject will be required to propose and evaluate the respective mini projects. These will be essentially hands-on practical and not theory / research review types of projects

2. End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
IAE1011	Pattern Recongnition	4

Module	Detailed content	Hours
1	Introduction to analysis of Algorithms: Is Pattern Recognition Important?, Features, Feature Vectors and Classifiers , Supervised versus Unsupervised Pattern Recognition	2
2	Classifiers Based on Bayes Decision Theory: Bayes Decision Theory, Discriminant Functions and Decision Surfaces , Bayesian Classification for Normal Distributions, Estimation of Unknown Probability Density Functions, The Nearest Neighbour Rule	4
3	Linear Classifiers: Linear Discriminant Functions and Decision Hyperplanes, The Perceptron Algorithm, Least Squares Methods, Sum of Error Squares Estimation, Mean Square Estimation Revisited	4
4	Non Linear Classifiers: The XOR Problem, Three Layer Perceptrons , Algorithms Based on Correct Classification of the Training Set , The Backpropagation Algorithm, Generalized Linear Classifiers, Capacity of the 1-dimensional Space in Linear Dichotomies, Polynomial Classifiers, Radial Basis Function Networks, Universal Approximators, Decision Trees	6
5	Feature Selection: Feature Selection Based on Statistical Hypothesis Testing, Class Separability Measures, Feature Subset selection, Optimal Feature Generation , Neural Networks and Feature Generation / Selection	5
6	Feature Generation: Basis Vectors and Images, KL, DFT, DCT, Walsh, Haar, Regional Features, Features for Shape and Size Characterization, A Glimpse on Fractals	10
7	Template Matching: Similarity Measures Based on Optimal Path Searching Techniques, Similarity Measures Based on Correlation	3
8	Context Dependent Classification: The Bayes Classifier,Markov Chain Models, The Viterbi Algorithm, Channel Equalization, Hidden Markov Models	6

References:

1. Sergios Theodoridis , Konstantinos Koutroumbas,"Pattern Recognition", Academic Press, Third Edition,
2. Robert Schalkoff, "Pattern Recognition – Statistical , Structural and Neural Approaches" Wiley India Edition
3. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", Second Edition, Wiley india

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAE1012	Expert Systems	4

Module	Detailed content	Hours
1	Introduction to expert system, The anatomy of an expert system, Computational complexity of expert systems	4
2	Rule-Based Systems, Facts and Rules, Associative Nets and Frame-based Systems and design, Representing Uncertainty, Heuristic Classification	8
3	Knowledge engineering; the expert system development process, Expert systems in context: knowledge representation, logic, and reasoning beyond logic, Knowledge Acquistion	8
4	Induction Systems, Backward Chaining, Backward Chaining Design, Forward Chaining, Forward Chaining Design	6
5	Design pattern: diagnosis and backward chaining, Expert systems in context: an overview of AI, Intelligent agents	6
6	Advance expert system programming techniques , Building a small rule-based expert system , inexact reasoning, Study of inexact classification	6
7	ESS and Java; expert systems as components, Java inside JESS: facts connected to the real world, ESS inside Java: embedding JESS in web applications, JESS: the rule engine for Java platform, CLIPS: A Tool for Building Expert Systems, Review of MYCIN	6

References:

1. Durkin, J., Expert Systems: Design and Development, Prentice Hall, New York, NY, 1994.
2. Durkin, J., Expert Systems: Catalog of Applications, Intelligent Computer Systems, Inc., Akron, OH, 1993.
3. Expert Systems: Principles and Programming, Fourth Edition by Joseph C. Giarratano and Gary D. Riley (Oct 15, 2004)

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAE1013	Cognitive Robotics	4

Module	Detailed content	Hours
1	System Modeling: Biological and Cognitive Paradigms, Dynamical Systems, Turing Machines and Concepts of Machine Intelligence, The Declarative-Procedural-Reflexive Hierarchy Intelligent Agents	8
2	Principles of Control: Open- and Closed-Loop Control, Optimality and Constraints, Stability and Performance, Control Actuation	6
3	Introduction, Documentation, Behaviors, Events, Tekkotsu behaviors and events	6
4	Tekkotsu vision pipeline; color image segmentation, Ullman's visual routines; Sketches in Tekkotsu	6
5	Shape primitives, Shape representations, Shape predicates; Tekkotsu's local map builder	6
6	State machines, State machine formalism, Architectures for robot control	6
7	World maps and localization, Walking, Navigating with the Pilot, Object recognition, Gestalt perception	6

References:

H. Asada and J.-J. Slotine, *Robot Analysis and Control* , J. Wiley & Sons, 1986.
C. Asfahl, *Robots and Manufacturing Automation* , J. Wiley & Sons, 1992.
D. Auslander, J. Ridgely, and J. Ringgenberg, *Control Software for Mechanical Systems* , Prentice-Hall, 2002.
G. Bekey, *Autonomous Robots* , MIT Press, 2005.

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAE1021	Biometric Processing	4

Module	Detailed content	Hours
1	BIOMETRIC FUNDAMENTALS: Key Biometric terms and Processes – Definitions- verification and identification – matching, Accuracy in Biometric Systems – False match rate - False nonmatch rate - Failure to enroll rate – Derived metrics, biometrics and privacy.	6
2	FINGERPRINT IDENTIFICATION TECHNOLOGY: History, Components, Application of Fingerprints, Technology Evaluation of Fingerprint Verification Algorithms.	6
3	IRIS RECOGNITION: Introduction, Anatomical and Physiological underpinnings, Components, Sensing, Iris Scan Representation and Matching, Iris Scan Strengths and Weaknesses	6
4	FACE RECOGNITION: Introduction, components, Facial Scan Technologies, Face Detection, Face Recognition - Representation and Classification, Kernel- based Methods and 3D Models, Learning the Face Spare	6
5	VOICE SCAN: Introduction, Components, Features and Models, Addition Method for managing Variability, Measuring Performance, Alternative Approaches, Voice Scan Strengths and Weaknesses	6
6	Other physiological biometrics – Hand scan – Retina scan – AFIS (Automatic Finger Print Identification Systems) – Behavioral Biometrics – Signature scan- keystroke scan.	6
7	Biometrics Application – Biometric Solution Matrix – Bio privacy – Comparison of privacy factor in different biometrics technologies – Designing privacy sympathetic biometric systems. Biometric standards – (BioAPI , BAPI) – Biometric middleware	4
8	Biometrics for Network Security. Statistical measures of Biometrics. Biometric Transactions	4

References:

1. James Wayman & Anil Jain, Biometric Systems – Technology, Design and Performance Evaluation,Springer-verlag London Ltd, USA,2005

2. Sanir Nanavati, Michael Thieme, Biometrics Identity Verification in a Networked world,Wiley Computer Publishing Ltd, New Delhi,2003.

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAE1022	Speech Processing	4

Module	Detailed content	Hours
1	Introduction to Digital Speech Processing, Elements of Signal Processing, Acoustic Theory of Speech Production	4
2	Hearing and Phonetics, Phonetics: Vowels, Consonants and Prosody, Speech Synthesis: Words to Phonemes, Speech Synthesis: Phonemes to Sounds	4
3	Speech Perception--Auditory Models, Sound Perception Models, MOS Methods, Sound Propagation in the Vocal Tract	4
4	Characteristics of Filters, Autocorrelation Linear Prediction and Spectral Whitening, Covariance LPC and LPC Parameter Sets, Cepstral Coefficients and Line Spectrum Frequencies, Speech Coding using uniform and non-uniform quantisation, Speech Coding using Adaptive Differential PCM, Code-excited Linear Prediction	8
5	Time Domain Methods in Speech Processing, Short Time Fourier Analysis Methods--Filter Bank Summation and Overlap Add, Speech Representations Based on STFT Analysis-Synthesis Methods	8
6	Homomorphic Speech Processing, Linear Predictive Coding Methods, LPC Methods--Lattice Structures, Speech Detection, VUS Decision, Pitch Detection, Formant Estimation	8
7	Text-to-Speech Synthesis (TTS) Methods, Techniques for Speech Recognition and Natural Language Understanding, Hidden Markov Models and Viterbi Recognition, Hidden Markov Model Training, Continuous Speech Recognition, Language Modelling, Input Processing	8

References:

1. Spoken Language Processing, Huang, Acero & Hon, Prentice Hall, 2002.
2. Digital Speech Processing, Synthesis, and Recognition, Second edition, Furui, 2000.
3. Fundamentals of Speech Recognition, Rabiner and Juang, 1993.
4. Speech Communications: Human and Machine, Second edition, O'Shaughnessy, 2000.
5. Statistical Methods for Speech Recognition, Jelinek, 1998.

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAE1023	Mechatronics	4

Module	Detailed content	Hours
1	Introduction to Mechatronics, Traditional and Mechatronics design, Mechatronics Key elements, Basic Components of Mechatronics Systems, Integrated design issues in Mechatronics, Mechatronics design process, Mechatronics Systems in Factory, Home and Business Applications, Objectives, Advantages , disadvantages of Mechatronics	6
2	Overview of micro processors and micro-controllers ,8051 microcontrollers: Functional block diagram and architecture, Instruction set and assembly language programming.	12
3	Interfacing hardware with real world, analog interface and data acquisition, digital i/o interfacing, special function interfacing signal conditioning, special utility support hardware Interfacing of: HEX-keyboards, LCD display, ADC, DAC and stepper motor with 8051 Micro controller	10
4	Overview of Sensors and Transducers- Sensors for motion and position, Force Torque and Tactile Sensors, Range Sensors, Proximity Sensors, Ultrasonic Sensors. Interfacing of sensors with microcomputer system. Micro and Nano Sensors in Mechatronics	8
5	Electro-Pneumatic systems Electro- Hydraulic systems. Development of circuits for Industrial-automation. Logic Gates - AND, OR, NOT, NAND and NOR, applications of basic control circuits based on these gates, Karnaugh map for signal simplification Programmable logic controllers- Over viewand applications of programmable logic controllers in manufacturing,Relay logic, programming a PLC using ladder diagram programming,Ladder logic programme for control of single cylinder and two cylinder pneumatic systems and hydraulic systems	14
6	Case Studies of Mechatronics Systems- Timed Switch, Pick and Place Robot, Car Park Barriers, Automatic Camera, Car Engine Management, Bar Code System, CNC Machine, ABS,Artificial Intelligence in Mechatronics, Fuzzy Logic applications in Mechatronics	10

References:

1. The 8051 microcontroller and embedded systems using assembly and C by M.A.Mazidi, J. c:.Mazidi and R. D. McKinlay. PHI, second edition
2. The 8051 microcontroiler Architecture, Programming anJ Applications Kenn'th J T Ayala, Pemam International Publishing, (India).
3. Process control & Instrumentation technology : Cirtis D Johnson
4. Industrial control & instrumentation W Bolaton, (Orient Longman)
5. Mechatronics - Electronic Control Systems in Mechanical Engineering, Bolton Pearson education
6. Mechatronics. HMT
7. Fundamentals of Electro-Pneumatics :Festo Series

8. Fundamentals of Electro-Hydraulics: Festo Series

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAC201	Natural Language Processing	4

Module	Detailed content	Hours
1	Introduction NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. The role of machine learning. Brief history of the field.	6
2	N-gram Language Models The role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models.	8
3	Part Of Speech Tagging and Sequence Labeling Lexical syntax. Hidden Markov Models. Maximum Entropy Models. Conditional Random Fields .	8
4	Syntactic parsing Grammar formalisms and treebanks. Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs.	8
5	Semantic Analysis Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labelling and Semantic Parsing.	6
6	Information Extraction (IE) Named entity recognition and relation extraction. IE using sequence labelling.	4
7	Machine Translation (MT) Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars.	4

References:

1. Foundations of Statistical Natural Language Processing
C. Manning and H. Schutze
2. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition (second edition)
D. Jurafsky and J. Martin

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
IAC202	Machine Learning	4

Module	Detailed content	Hours
1	INTRODUCTION: Definition of learning systems. Goals and applications of machine learning. designing a learning system: training data, concept representation, function approximation. well posed learning problems, perspective & issues in machine learning	6
2	CONCEPT LEARNING: The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypothesis. FIND-S, candidate elimination algorithm	4
3	DECISION TREE LEARNING: Introduction, Decision tree representation, appropriate problems, for decision tree learning, basic decision tree algorithm, hyper space, search in decision tree learning, issues in decision tree learning .	6
4	BAYESIAN LEARNING: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies.	6
5	INSTANCE BASED LEANING: Introduction, K-nearest neighbour learning, case based learning, radial basis functions	4
6	CLUSTERING & UNSUPERVISED LEARNING: Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. k-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabelled data.	6
7	ARTIFICIAL NEURAL NETWORK: Introduction, neural network representation , problems for neural network learning, perceptrons , multilayer network & Back propagation Algorithm.	6
8	GENETIC ALGORITHMS: Introduction, genetic operators, genetic programming, models of evolution & learning, parallelizing genetic algorithm	6

References:

1. Tom M. Mitchell. "Machine Learning" McGraw-Hill, 1997.
2. P. Langley. "Elements of Machine Learning" Morgan Kaufmann Publishers, Inc. 1996.
3. Ethem Alpaydin "Introduction to machine learning" 2nd ed. The MIT Press, 2010

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

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Subject Code	Subject Name	Credits
IAC203	Multi-Robot Systems	4

Module	Detailed content	Hours
1	Introduction to probabilistic concepts related to sensors, sensor signal processing, multi-sensor control systems and optimal estimation.	8
2	Multiagent architectures. Communication, cooperation and coordination in mulitrobot systems. Diversity.	6
3	Taxonomies of multirobot systems and tasks. Adversarial domains including robot soccer. Example biological multiagent systems. Multirobot learning.	6
4	Kinematic and dynamic models, trajectory and motion planning	4
5	Adaptive robot control, integrated force and motion control, digital implementation of control laws, model identification and parameter estimation techniques.	6
6	Different control architectures (deliberative, reactive, behavior-based and hybrid control) Control topologies, and system configurations: cellular automata, modular robotic systems, mobile sensor networks, swarms, heterogeneous systems	8
7	Multi-robot control and connectivity, path planning and localization, sensor fusion and robot informatics, task-level control	6

References:

1. Multi-Robot Systems. From Swarms to Intelligent Automata, Volume III:
Proceedings from the 2005 International Workshop on Multi-Robot Systems
Lynne E. Parker, Frank E. Schneider, Alan C. Schultz
2. Autonomous Specialization in a Multi-Robot System using Evolving Neural Networks
Masanori Goka (Hyogo Prefectural Institute of Technology, Japan) and Kazuhiro Ohkura
(Hiroshima University, Japan)
3. Autonomous Robots: From Biological Inspiration To Implementation And Control
MIT Press, 2005 - Technology & Engineering

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Subject Code	Subject Name	Credits
IAL203	Laboratory III –Course Lab	1

Module	Detailed content	Lab. Sessions
1	Two Laboratory Practicals to be conducted for each of the core subjects.	24

Modality and Assessment:

1. Each Laboratory assignment will be done in a group of two students. The Faculty teaching each core subject will be required to propose and evaluate the respective Laboratory assignments. These will be essentially hands-on practical and not theory / research review types of assignments.

2. End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Assessment:

Subject Code	Subject Name	Credits
IAL204	Laboratory IV –Elective Lab	1

Module	Detailed content	Lab. Sessions
1	One Mini Project based on any one of the selected elective subject.	24

Modality and Assessment:

1. Each mini project assignment will be done by individual student. The Faculty teaching elective subject will be required to propose and evaluate the respective mini projects. These will be essentially hands-on practical and not theory / research review types of projects

2. End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
IAE2011	Knowledge Representation & Reasoning	4

Module	Detailed content	Hours
1	Introduction: The need for formal languages for representing (machine-understandable) knowledge. Reasoning services and logic-based reasoning. High level architecture of KR&R systems.	6
2	Propositional Logic: Syntax and semantics of propositional logic. Notions of satisfiability, validity, and entailment. Reasoning based on model enumeration. Normal forms.	6
3	Reasoning in Propositional Logic: Propositional resolution. The DPLL algorithm. Description Logics: Description logics as fragments of first order logic. Syntax and semantics.	6
4	Representing Knowledge in First Order Predicate Logic: Limitations of propositional logic for knowledge representation. Syntax and semantics of first order logic.	6
5	Reasoning in First Order Predicate Logic: Reasoning in first order logic. Normal forms, Herbrand interpretations and Herbrand's theorem. Undecidability of the satisfiability and validity problems.	6
6	Abductive Reasoning, Qualitative Reasoning, Constraint Satisfaction, Representation of Actions, Reasoning with Actions	4
7	Resolution in first order logic. expressing knowledge, resolution, horn clauses procedural representations, production systems, description logics, defaults, probabilities, explanation and diagnosis, action, planning	6
8	Ontology Languages and the Semantic Web: Introduction to Semantic Web languages such as RDF and OWL. Ontology Development, Ontology & Lexicon	4

References:

1. Knowledge Representation and Reasoning, Ron Brachman and Hector Levesque, Morgan Kaufmann

2. Knowledge Representation and Reasoning. Ronald Brachman and Hector Levesque. The Morgan Kaufmann Series in Artificial Intelligence, 2004.

3. First Order Logic and Automated Theorem Proving. Melvin Fitting. Texts in Computer Science. 1995.

4. Handbook of Knowledge Representation. Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds). Foundations of Artificial Intelligence, 2008.

5. The Description Logic Handbook: Theory, Implementation and Applications, 2nd Edition. Franz Baader, Diego Calvanese, Deborah L. MacGuinness, and Daniele Nardi. Cambridge University Press. 2007.

6. Foundations of Semantic Web Technologies. Chapman & Hall/ CRC Textbooks in Computing. Pascal Hitzler, Markus Kroetsch, and Sebastian Rudolph, 2009.

Assessment:

Internal:

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Subject Code	Subject Name	Credits
IAE2012	Genetic Algorithms	4

Module	Detailed content	Hours
1	An Overview and History of Evolutionary Computation, Biological Terminology, Search Spaces and Fitness Landscapes, Elements of Genetic Algorithms, GA Operators, Genetic Algorithms and Traditional Search Methods, Software engineering of GAs, variations on selection	8
2	Genetic Algorithms In Problem Solving: Data Analysis and Prediction Evolving Neural Networks	8
3	Genetic Algorithms in Scientific Models: Modelling Interactions between Learning and Evolution, Modelling Sexual Selection Modelling Ecosystems, Measuring Evolutionary Activity	6
4	Theoretical Foundations Of Genetic Algorithms: Schemas And The Two-Armed Bandit Problem, Royal Roads, Exact Mathematical Models Of Simple Genetic Algorithms, Statistical-Mechanics Approaches.	10
5	Real-coded GAs & evolution strategies, ES analysis & advanced operators, Genetic programming	6
6	Encoding A Problem For A Genetic Algorithm, Adapting GA, Competent GAs, Efficient GAs, Recent GA applications	6

References:

1. Genetic Algorithms in Search, Optimization, and Machine Learning by David E. Goldberg (Jan 11, 1989)

2. Genetic Algorithms: Concepts and Designs, Avec disquette K. Kim F. Man, K. S. Tang, S. Kwong

3. An Introduction to Genetic Algorithms (Complex Adaptive Systems) by Melanie Mitchell (Feb 6, 1998)

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End Semester Examination:

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Subject Code	Subject Name	Credits
IAE2013	Robot Programming	4

Module	Detailed content	Hours
1	Introduction: Robotics Software, Java and C++	4
2	ROS: Robot Operating System --- ROS basics (check homework); ROS Bags,	6
3	ROS: connecting to a robot and to simulators TurtleSim; Robotic Simulators; Simulation with Player/Stage,	6
4	Seminar Monday October 15th, 9:00 -- 13:30 Opensource Computer Vision and Robotics (slides)	6
5	Autonomous localization and navigation Robot set up with ROS, ROS Navigation	6
6	Actions and plans Basic actions in ROS , Petri Net Plans, PNP in ROS	6
7	Human Robot Interaction Human Robot Interaction, ROS support to HRI	6
8	Natural language HRI Talking robots	4

References:

1.Robot Programming : A Practical Guide to Behavior-Based Robotics, Joe Jones and Daniel Roth. 2003, ISBN: 0071427783 / 9780071427784 McGraw Hill

2. Robotic Systems - Applications, Control and Programming, Edited by Ashish Dutta, ISBN 978-953-307-941-7, Hard cover, 628 pages, Publisher: InTech, Chapters published February 03, 2012

3. Robotics Programming 101, Scott Preston, ISBN-10: 146113594X ISBN-13: 978-1461135944

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End Semester Examination:

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Subject Code	Subject Name	Credits
IAE2021	Fuzzy Systems	4

Module	Detailed content	Hours
1	Introduction: Definition of uncertainty, Definition of fuzzy system, Fuzzy system applications, Research areas on fuzzy systems.	4
2	The mathematics of fuzzy systems: Fuzzy sets and basic operations, Fuzzy relations and the extension principle, Linguistic variables and fuzzy if-then rules Fuzzy systems and their properties: Fuzzy inference engine, Fuzzifiers and defuzzifiers	8
3	Fuzzy systems as nonlinear mappings, Approximation Properties of Fuzzy Systems, Design of Fuzzy Systems From Input-Output Data	6
4	Fuzzy logic and approximate reasoning, Fuzzy numbers, Propositional logic, Mamdani-Assilian and Takagi-Sugeno Control	6
5	Fuzzy Rule Bases, Fuzzy Rule Base and Fuzzy Inference Engine	6
6	Mamdani-Assilian Controller, Takagi-Sugeno and Similarity-based Controller Fuzzy Clustering, Fuzzy Classification, Noise Clustering	6
	Non adaptive Fuzzy Control, Adaptive Fuzzy Control, Fuzzy Control based on Relational Equations, System of Relational Equations, Similarity Relations	4
7	Theory of Evolution, Evolutionary Fuzzy Systems, Neuro-Fuzzy Systems,	4

References:

1. R. Kruse, C. Borgelt, P. Held, C. Moewes, M. Steinbrecher (2012).
Computational Intelligence. Springer, New York (to appear).
2. R. Kruse, C. Borgelt, F. Klawonn, C. Moewes, G. Ruß, M. Steinbrecher (2011).
Computational Intelligence. Vieweg+Teubner, Wiesbaden.
3. C. Borgelt, F. Klawonn, R. Kruse, D. Nauck (2003). *Neuro-Fuzzy-Systeme* (3rd edition).
Vieweg, Braunschweig/Wiesbaden.
4. G.J. Klir and B. Yuan (1995). *Fuzzy Sets and Fuzzy Logic - Theory and Applications* .
Prentice Hall, Upper Saddle River, NJ.
5. R. Kruse, J. Gebhardt, and F. Klawonn (1994). *Fuzzy-Systeme* (2nd edition). Teubner, Stuttgart.
6. R. Kruse, J. Gebhardt, and F. Klawonn (1994). *Foundations of Fuzzy Systems* . Wiley, Chichester.
7. K. Michels, F. Klawonn, R. Kruse, and A. Nürnberger (2002). *Fuzzy-Regelung* .
Springer-Verlag, Heidelberg.

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Subject Code	Subject Name	Credits
IAE2022	Computer Vision	4

Module	Detailed content	Hours
1	Introduction to Computer Vision, Simple linear vision system, Mathematics for Computer Vision	4
2	Linear Algebra, Probability Review, Image statistics, Color, Texture, Motion	4
3	Linear Filters, Finding Lines: From Detection to Model Fitting	4
4	Edges and Segmentation, Clustering and Segmentation	4
5	Camera Models, Camera Calibration, Epipolar Geometry, Stereo & Multi-view Reconstruction	6
6	Detectors and Descriptors, SIFT & Single Object Recognition, Optical Flow & Tracking	8
7	Introduction to Object Recognition and Bag-of-Words Models, Object classification and detection: a part-based generative model (Constellation model), a part-based discriminative model (Latent SVM)	8
8	Objects in Scenes, Human Motion Recognition, Computer Vision: State-of-the-art and the Future	6

References:

1. Computer Vision: Algorithms and Applications, by Richard Szeliski, Springer, 2010.
2. Learning OpenCV, by Gary Bradski & Adrian Kaehler, O'Reilly Media, 2008.
3. Multiple View Geometry in Computer Vision, 2nd Edition, by R. Hartley, and
A. Zisserman, Cambridge University Press, 2004.
4. Computer Vision: A Modern Approach, by D.A. Forsyth and J. Ponce, Prentice Hall, 2002.
5. Pattern Classification (2nd Edition), by R.O. Duda, P.E. Hart, and D.G. Stork,
Wiley-Interscience, 2000.
6. Mathematics for Computer Vision, by Carlo Tomasi

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Subject Code	Subject Name	Credits
IAE2023	Signal Processing	4

Module	Detailed content	Hours
1	Review of following topics with relevant numerical examples: A typical real-time DSP system, DFT, its computation (DIT & DIF algorithms), & important properties, FIR filter design– Window & frequency sampling method, IIR filter design – Impulse invariant & Bilinear z-transform method, Realization structures for FIR & IIR filters	10
2	Multirate DSP: Introduction & concept of multirate processing, Design of practical sampling rate converters, Sample rate conversion using polyphase filter structure	8
3	Spectrum estimation & analysis: Principles of spectrum estimation, Traditional methods, Modern parametric estimation methods, Autoregressive spectrum estimation	8
4	General- and special-purpose digital signal processors: Computer architecture for signal processing, General purpose digital signal processors, Selecting digital signal processors, Special purpose DSP hardware	6
5	Analysis of finite wordlength effect in fixed-point DSP systems: DSP arithmetic, ADC quantization noise & signal quality, Finite wordlength effects in IIR & FIR digital filters	8
6	Overview of real-world applications of DSP: Audio applications of DSP, Telecommunication applications of DSP, Biomedical applications of DSP	4

References:

1. Digital Signal Processing, A Practical Approach by Emmanuel C. Ifeachor, Barrie W. Jervis, Pearson Education
2. Discrete Time signal Processing by Alan V. Oppenheim, Ronald Schafer, Pearson Education
3. Digital Signal Processing, Principles, algorithms and applications - J. Proakis, D. G. Manolakis, D. Sharma, Pearson Education
4. Fundamentals of Digital Signal Processing using MATLAB- Robert Schilling, Sandra Harris, Cengage Learning
5. Digital Signal Processing, S. K. Mitra, Tata McGraw Hill Publication 2001
6. Digital Signal Processing by Chen, OxfordUniversity Press
7. A Practical Approach to Digital Signal Processing, Padmanabhan K., New Age International

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