SDM College of Engineering and Technology, Dharwad
Department of Electronics and Communication Engineering

UG Syllabus of new courses introduced

18UECC400	Communication Systems - I	(4-0-0)4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on time and frequency domain description of various analog modulation techniques, their generation and detection with necessary mathematical analysis. Various types of noise and performance of radio receivers in the presence of noise are covered in the course. The course also deals with theoretical bounds on sampling rates, practical aspects of sampling, quantization and various encoding methods.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Analyze** various analog modulation techniques in time and frequency domain	1,2		
CO-2	**Describe** the generation and detection of various analog modulation techniques		1,3,13	12
CO-3	**Explain** various types of noise and **evaluate** the performance of the receiver in presence of noise		1,2,3	
CO-4	**Derive** sampling rates to convert signal from analog to digital and practical aspects of sampling	1,2	3	
CO-5	**Describe** types of quantization and various source encoding techniques for data transmission		1,2,3,13	12

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.4	2.5	2	-	-	-	-	-	-	-	-	1	2	-

Pre-requisites: Fourier analysis, Analog Electronic Circuits.

Contents:

Unit-I

Amplitude Modulation: Introduction to communication system, Need for modulation, AM, DSBSC, SSB, VSB: time domain description, frequency domain description, modulation index, bandwidth, power relations, modulation by several

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sine waves, generation, detection, quadrature carrier multiplexing, comparison of various amplitude modulation techniques, frequency translation, frequency division multiplexing, applications: AM radio. **12 Hrs**

Unit-II

Angle Modulation: Frequency modulation, Phase modulation, time domain description, spectrum analysis of FM waves, transmission bandwidth, narrow band FM, wideband FM, generation of FM waves: indirect FM, direct FM, demodulation: balanced frequency discriminator, zero crossing detector, phase locked loop, applications: FM radio, FM stereo multiplexing. **09 Hrs**

Unit-III

Noise in CW Modulation systems: Introduction, various types of noise, narrow band noise, noisy receiver model, noise in DSB-SC receivers, noise in SSB receivers, noise in AM receivers, noise in FM receivers, pre-emphasis and de-emphasis in FM **09 Hrs**

Unit-IV

Sampling Process: Introduction, sampling theorem, signal distortion in sampling, practical aspects of sampling: natural sampling, flat top sampling, sample and hold circuit, time division multiplexing, T1 carrier multiplexing, pulse modulation techniques: PAM, PWM, PPM **12 Hrs**

Unit-V

Waveform Coding Techniques: Quantization, quantization noise, signal to quantization noise ratio, robust quantization, Pulse Code Modulation, Differential Pulse Code Modulation, Delta Modulation, Adaptive Delta Modulation. **10 Hrs**

Reference Books:

1) Simon Haykin, “An introduction to analog and digital communications”, John Wiley India Pvt. Ltd., 2008.
2) Simon Haykin, “Communication systems”, 5/e, John Wiley India Pvt. Ltd., 2009.
3) Simon Haykin, “Digital Communications”, John Wiley India Pvt. Ltd., 2009.
4) B. P. Lathi, “Modern digital and analog communication systems”, Oxford University Press, 4/e, 2010.

18UECL407	Introductory Project	(0-0-2) 1

Contact Hours: 24

Course Learning Objectives (CLOs):

The course provides an exposure to the students to identify simple societal problems and propose a technical solution. It also helps them to find related material, use appropriate tool to obtain the solution and prepare a report based on the work carried out.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Conduct a **survey** and **identify** the community needs.	-	6, 7	2
CO-2	**Formulate** the problem statement.	-	2	1
CO-3	**Propose** a solution by applying the fundamental knowledge of basic sciences and basic engineering courses	-	1,2	3
CO-4	**Develop** the team spirit, communication and management skills.	-	9,10,12	11
CO-5	**Prepare** a report and present the findings.	-	9,12	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	1.5	1.7	1	-	-	2	2	-	2	2	1	2	-	-

Contents: **Introductory Project** is introduced with an objective of understanding and identifying the community expectation in terms of possible engineering solutions by applying the fundamental knowledge of basic sciences and basic engineering courses. The Project shall be engineering oriented in terms of problem definition, related literature survey and existing solutions. Students are supposed to meet the faculty members, discuss the problem definition and formulate the project. Project Team size Minimum of 03 and Maximum of 04 Students. The synopsis format shall be strictly adhered failing which may lead to rejection of the proposal and may cause delay in project. If the Introductory-Project idea is suggested by the faculty member, the synopsis must be duly signed by the respective faculty member. Maximum efforts will be made to allocate the same guide but may not be guaranteed. If the proposed project matches with one or more project titles, they are suggested to modify them in consultation with their respective guides and proceed with the submission.

18UECL506	Minor Project-1	(0-0-2) 1

Contact Hours: 30

Course Learning Objectives (CLOs):

Minor project –1 is introduced at V semester level to encourage students mainly to solve real time societal problems by integrating the knowledge gained in previous semesters. It may involve the investigation of a problem and the specification and implementation of a solution. Minor project help students to develop problem solving, analysis, synthesis and evaluation skills. It also helps in developing

collaborative work culture and team work. In focus with this, students understand the basics of electronics, communication and programming languages in depth and then work on Planning, analyzing, designing and executing a hardware/software project.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Identify** technical / social problemand **formulate** a problem statement	1,2	6	-
CO-2	**Propose** technical approach towards solution	2	6,7	11
CO-3	**Implement** the solution in hardware and / or software	3,5	13,14	11
CO-4	**Organize** the topics in a systematic manner and **Prepare** the report in a specific format	9,10	12	-
CO-5	**Present** the work in a systematic manner	10	12	-

POs/PSO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	3	3	3	-	3	2	2	-	3	3	1	2	2	2

Prerequisites:

Basics of Electronics, Communication and Programming languages.

Guidelines for Conduction Spirit of the Course:

To ensure that undergraduates successfully apply the knowledge they have gained in different courses and integrate material learnt at different stages of the curriculum up to the 5th semester so as to complete the project work within the stipulated time duration following guidelines are framed.

1. Project groups are formed with 3-4 students in each team.
2. Project coordinators instruct student project batches to submit synopsis in the prescribed format in the field of their choice.
3. Project coordinators allot guides based on their field of specialization. However students can have further discussions on the project topic and can modify their project title.

4. Students are instructed to report to their respective guides on weekly basis for discussion.
5. Students are instructed to maintain separate project diary/notebook to show the progress work while having discussion with guide and review committee members.
6. Two reviews are fixed in a semester to monitor the progress of the project.

Assessment: CIE- Guides evaluate project for 30 marks and 20 marks are allotted by reviewers by conducting 2 reviews. Total marks for project is 50 (CIE only). **SEE:** There is no semester end exam (SEE) component for minor project-1.

Note:

- Designated committee is constituted with 2-4 committee members to monitor the process of Mini Project-1
- An internal guide is allotted per group who guides and monitors the project
- progress.
- Problem statements can be derived from industry, society, etc., after interacting with them.
- Course outcomes (4 or more) are written and mapped toprogram outcomes and program specific outcomes. In addition to that other POs can also be included if those POs are deemed suitable.
- At the end of the course, students are required to document the project in the form of report.
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18UHUL507	**Soft skills/Aptitude**	**(0-0-2)1**

- **Contact Hours: 24**

Course Learning Objectives (CLOs):

This is included with the objectives of improving the communication skills, proficiency in English language and aptitude ability of the student to enhance the employability.

- **Course Outcomes (COs):**

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Explain** the significance of communication in the profession.	-	10	-
CO-2	**Use** the English language with proficiency	-	10	12
CO-3	**Solve** Aptitude related problems	-	9	12

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CO-4	**Demonstrate** the competency in the placement activities.	-	9	-

PO's	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
Mapping Level	-	-	-	-	-	-	-	-	2.0	2.0	-	1.0	-	-	-

Contents:

Training on communication skills, proficiency in English language and aptitude ability involving the internal and external resource.

Evaluation:

Both the internal and external resource persons shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component. There shall be one test conducted at the end for 25 marks in Aptitude testing and there shall be one presentation by the student for 25 marks or any other suitable testing components. The arrangement for CIE evaluation is to be done by the department and maintain the relevant documents.

18UECL604 Minor Project-2 (0-0-4) 2

Contact Hours: 30

Course Learning Objectives (CLOs):

Minor project-2 focuses on an exposure to the project work in the domain of their interest by selecting a problem definition from an emerging area. The problem could be defined to develop prototypes for industrial needs.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Identify** and **justify** the technical aspects of the chosen project with a comprehensive and systematic approach.	1	2,4	6,7
CO-2	**Reproduce** and **refine** technical aspects for engineering projects.	2	13	-
CO-3	**Work** as an individual or in a team in development of projects	9	8	-

CO-4	**Implement** the solution in hardware and / or software	3,5	13,14	11
CO-5	**Present** the work in a systematic manner	10	12	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	3	2.5	3	2	3	1	1	2	3	3	1	2	2	2

Prerequisites: Knowledge of VLSI, Signal Processing, Analog& Digital Communication and Any Programming Language

Guidelines for Conduction Spirit of the Course:

To ensure that undergraduates successfully apply the knowledge they have gained in different courses and integrate material learnt at different stages of the curriculum up to the 4th semester so as to complete the project work within the stipulated time duration following guidelines are framed.

1. Project groups are formed with 3-4 students in each team.
2. Project coordinators instruct student project batches to submit synopsis in the prescribed format in the field of their choice. In genuine case students can continue their minor project-I for this semester.
3. Project coordinators allot guides based on their field of specialization. However students can have further discussions on the project topic and can modify their project title.
4. Students are instructed to report to their respective guides on weekly basis for discussion.
5. Students are instructed to maintain separate project diary/notebook to show the progress work while having discussion with guide and review committee members.
6. Two reviews are fixed in a semester to monitor the progress of the project.

Assessment: CIE: Project guides evaluate for 30 marks and 20 marks are allotted by reviewers conducting two reviews. 50 marks allotment under CIE. **SEE:** Minor project-2has SEE component and marks allotted for SEE is 50, where students need to demonstrate the project and present it in the presence of examiners.

Note:

- Designated committee is constituted with 2-4 committee members to monitor the process of Mini Project-1
- An internal guide is allotted per group who guides and monitors the project

progress.

- Problem statements can be derived from industry, society, etc., after interacting with them.
- Course outcomes (4 or more) are written and mapped to program outcomes and program specific outcomes. In addition to that other POs can also be included if those POs are deemed suitable.
- At the end of the course, students are required to document the project in the form of report.

18UECC601 IOT and Embedded Systems Design (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on architectural features and instructions of -ARM Cortex M3, Develop Programs using the various instructions of ARM Cortex M3 and C language for different applications. Develop the prototype using hardware software co-design approach.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Describe** the architectural features and instructions of ARM Cortex M3.	-	2	1
CO-2	**Program** ARM Cortex M3 for different applications	-	1,2	-
CO-3	**Develop** an embedded system application using component engineering.	3	2,12	-
CO-4	**Develop** the hardware software co-design and firmware design approaches.	5	3,13	1,2
CO-5	**Demonstrate** the need of real time operating system and IoT.	5	2,12	14

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	1.33	1.8	2.5	-	3	-	-	-	-	-	-	2	2	1

Pre-requisites: Microcontrollers and Operating systems.

Contents:

Unit-I

ARM Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, Debugging support, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence **10 Hrs**

Unit-II

ARM Cortex M3 Instruction Sets and Programming: Assembly basics, Instruction list and description, Thumb and ARM instructions, Special instructions, Useful instructions, CMSIS, Assembly and C Language Programming **10 Hrs**

Unit-III

Embedded System Components: Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of embedded systems. Elements of an Embedded System, Differences between RISC and CISC, Harvard and Princeton architectures, Big and Little Endian formats, Memory (ROM and RAM types), Sensors, Actuators, Opt-coupler, Communication Interfaces. **10Hrs**

Unit-IV

Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain specific, Hardware Software Co-Design and Program Modeling, Embedded firmware design and development **10 Hrs**

Unit-V

Real Time Operating Systems: RTOS basics, Types of operating systems, Task, process and threads, Thread preemption, Preemptive Task scheduling techniques, Task Communication, Task synchronization issues – Racing and Deadlock, Concept of Binary and counting semaphores, How to choose an RTOS.

Introduction to IoT and applications: Introduction to IoT, Illustrating the Device-to-Device/ Machine-to-Machine Integration Concept, Explaining the Aspect of Device-to-Cloud (D2C) Integration, The Emergence of the IoT Platform as a Service (PaaS),Digging into the Cloud-to-Cloud (C2C) Integration Paradigm, Describing the Sensor-to-Cloud Integration Concept, Azure IoT Hub Device Management, The Prominent IoT Realization Technologies, Architecture for IoT Using Mobile Devices, Mobile Technologies for Supporting IoT Ecosystem, Layered Architecture for IoT, Protocol Architecture of IoT **12 Hrs**

Reference Books:

1) Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd Edition, Newnes, (Elsevier), 2010.
2) Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, 2nd edition.
3) Pethuru Raj and Anupama C. Raman “The Internet of Things Enabling Technologies, Platforms and Use Cases” CRC press 2017, Taylor & Francis Group.
4) James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008, ISBN: 978-0-471-72180-2.
5) Yifeng Zhu, “Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language andC”, 2nd E -Man Press LLC ©2015

6) Embedded real time systems by K.V. K. K Prasad, Dreamtech publications, 2003.

18UECE612 Image Processing & Computer Vision (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

This course introduces to the concepts of image processing and computer vision. Topics covered include radiometry, colors, various image enhancement techniques, detection of discontinuities, edge linking and boundary detection.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSO (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Describe** the basic radiometric properties and develop models of source geometry	--	1,2	12
CO-2	**Describe** image acquisition system, its representation and human color perception	--	1	12
CO-3	**Apply** suitable image enhancement techniques in spatial and frequency domain	2	1, 3	12
CO-4	**Compare** various restoration techniques	2	1, 13	--
CO-5	**Compare** various image segmentation techniques	--	1,13	--

PO's/PSO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.0	2.66	2	--	--	--	--	--	--	--	--	1	2	--

Prerequisites: Digital signal processing, Mathematics

Contents:

Unit-I

Radiometry — Measuring light: Light in space, Light at surfaces, Important special cases: Radiosity, Hemisperic reflectance, Lambertian and specular surfaces and models

Sources Shadows and Shading: Radiometric properties of light, Qualitative radiometry, Local shading models, Photometric stereo. **08 Hrs**

Unit-II

Colors: The physics of color, Human color perception, Representing color, Surface color from image color.

Digital Image Fundamentals: Image sensing and acquisition, Image sampling and quantization, Basic relationship between pixels, Linear and non-linear operations.

08 Hrs

Unit-III

Intensity Transformation: Basic intensity transformation functions, Image negatives, Contrast stretching, Histogram processing, Histogram equalization, Enhancement using arithmetic and Logic operations.

Spatial and Frequency Filtering: Spatial Filter Masks, Smoothing spatial filters, Sharpening spatial filters, Combining spatial enhancement methods, Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering. **08 Hrs**

Unit-IV

Fundamentals of Image Restoration: Introduction, noise models, Restoration in the presence of noise, Linear position invariant degradation, Degradation function.

Image Restoration Filters: Spatial filtering, Periodic noise reduction by frequency domain filtering, Inverse filtering, Minimum mean square error filtering, Constrained least squares filtering, Geometric mean filter, Geometric transformations.

08 Hrs

Unit-V

Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding.

Advanced Topics in Segmentation: Region-based segmentation, Segmentation using morphological watersheds, Use of motion in segmentation. **07 Hrs**

Reference Books:

1) C Gonzalez and Richard E Woods, Rafael, “Digital Image Processing”, 3/e, Pearson Education, 2005.
2) K.P.Soman, “Digital Signal & Image Processing”, 1/e edition, Elsevier India, 2012
3) David Forsyth and Jean Ponce, “Computer Vision, A modern Approach ”, 2/e, Pearson Education, 2012.
4) Richard Szeliski, “Computer Vision: algorithms and applications ”, 1/e, Springer-Verlag London Limited 2010

18UECE621	Robotics	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on the theory and design principles of Robotics. The course deals with utilization of Sensors, Actuators, Kinematics, Motion and Trajectory planning used in Robotics.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	**Identify** the different parameters of Robot and **Classify** the Robots on the considerations.	2	4	-
CO-2	**Develop** an understanding of specifications of robot and **choose** appropriate sensors, actuators and Processing platform.	2,3	4	12
CO-3	**Rephrase** the Kinematics of the robot, **understand** and **analyze** the kinematics using suitable model	4	2	5
CO-4	**Understand analyze and build** differential motion-oriented robots.	1,2,3,4,13, 14	-	5,7,10,11,12
CO-5	Perform **analysis** of dynamic forces motions, trajectory and achieve required goals by suitable **design**.	13,14	-	5,7,10,11,12

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	3	2.75	3	2.5	1	-	1	-	-	1	1	1	3	3

Pre-requisites: Microprocessors / Controllers, Embedded System Design

Contents:

Unit-I

Introduction: Brief History of Robotics, Working Definition of Robot, Growth of the Industry

Types of Robots: Classification by Degrees of Freedom, Classification by Robot Motion, Classification by Platform, Classification by Power Source, Classification by Intelligence, Classification by Application Area **08 Hrs**

Unit-II

Introduction to Robot Mechanics: Robot Arm Kinematics, End-Effectors, Dynamic Considerations, Obstacle Avoidance, Robot Electronic Subsystems, Robot External Sensing Systems, Motor System Design, Servo System Design, Hall-Effect Technology, Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Actuators, Pneumatic Devices, Electric Motors , Microprocessor Control of Electric Motors, Magnetostrictive Actuators, Shape-Memory Type Metals, Electroactive Polymer Actuators **08 Hrs**

Unit-III

Kinematics of Robots:, Position Analysis Robots as Mechanisms ,Conventions, Matrix Representation, Homogeneous Transformation, Matrices, Representation of Transformations, Inverse of Transformation Matrices, Forward and Inverse Kinematics of Robots Forward and Inverse Kinematic Equations: Position, Forward and Inverse Kinematic Equations: Orientation, Forward and Inverse Kinematic, Equations: Position and Orientation, Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots, The Inverse Kinematic Solution of Robots, Inverse Kinematic Programming of Robots, Degeneracy and Dexterity, The Fundamental Problem with the Denavit-Hartenberg Representation Design Projects **08 Hrs**

Unit-IV

Differential Motions and Velocities, Differential Relationships, Jacobian, Differential versus Large-Scale Motions, Differential Motions of a Frame versus a Robot, Differential Motions of a Frame, Differential Translations, Differential Rotations about the Reference Axes ,Interpretation of the Differential, Change, Differential Changes between Frames, Differential Motions of a Robot and its Hand Frame, Calculation of the Jacobian, How to Relate the Jacobian and the Differential Operator, Inverse Jacobian, Design Projects **07 Hrs**

U-V

Dynamic Analysis and Forces Introduction , Lagrangian Mechanics: A Short Overview , Effective Moments of Inertia , Dynamic Equations for Multiple-DOF Robots , Kinetic Energy , Potential Energy , The Lagrangian , Robot's Equations of Motion , Static Force Analysis of Robots ,Transformation of Forces and Moments between CoordinateFrames , Design Project Trajectory Planning Introduction, Path versus Trajectory ,Joint-Space versus Cartesian-Space, Descriptions , Basics of Trajectory Planning , Joint-Space Trajectory Planning , Cartesian-Space Trajectories , Continuous Trajectory Recording Design Project **08 Hrs**

Reference Books:

1) Harry H. Poole, "Fundamentals of Robotics Engineering", Springer Publication,1989.
2) Saeed Benjamin Niku, "Introduction to Robotics Analysis, Control, Applications", Second Edition, Wiley Publication, 2011
3) Ashitawa Goshal, "Robotics Fundamental Concepts and Analysis", Ninth Impression, Oxford University Press,2013.
4) Robert J. Schilling, "Fundamentals of Robotics Analysis and Control", Prentice Hall of India, 2003

18UECE623	Artificial Intelligence	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

This course focusses on overview of the main concepts in Artificial Intelligence (AI), algorithms applied in construction of intelligent systems, agents, problem solving, search, representation, reasoning, planning, communication, perception, robotics and neural networks.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Discuss** the basic concepts and characteristics of AI with illustrations of current state of the art research, solving real world problems with searching approaches.	14	2,3,4	1
CO-2	**Explain** the strengths and limitations of various state-space search algorithms along with knowledge representation, planning and constraint management.	11	1,2,3,4	13
CO-3	**Identify** the type of an AI problem with search inference, decision making under uncertainty, game theory, etc.	-	2,5	13
CO-4	**Apply** basic principles of AI in solutions that require different forms of learning and decision trees.	-	6,12,14	-
CO-5	**Demonstrate** different language models, steps in Natural language Processing (NLP) and expert systems.	-	14	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	1.5	2	3	4	2	2					3	2	1	2

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Pre-requisites: Discrete Mathematics, basic probability theory and Statistics Knowledge of any programming language and data structures.

Contents:

Unit-I

Introduction: Introduction and Intelligent systems, What Is AI, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, Applications of A.I. Intelligent Agents: Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents, How the components of agent programs work.

Solving Problems by Searching: Study and analysis of various searching algorithms. Implementation of Depth-first search Problem Solving Agents, Searching for Solutions, Uninformed and informed Search Strategies. **09 Hrs**

Unit-II

Local Search Algorithms and Optimization Problems: Local Search in Continuous Spaces, Searching with Nondeterministic Actions, Searching with Partial Observations, Introduction to adversarial Search and constraint satisfaction problems with examples.

Logical Agents: Knowledge agents, first-Order Logic, Inference to First-Order Logic, Classical planning, Planning and acting in the real world, knowledge representation. **08 Hrs**

Unit-III

Quantifying Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Bayes' Rule and Its Use, Representing Knowledge in an Uncertain Domain, Other Approaches to Uncertain Reasoning, Rule-based methods for uncertain reasoning, representing vagueness: Fuzzy sets and fuzzy logic, Study of fuzzy logic and Decision trees, Implementation aspects of Decision trees. **07 Hrs**

Unit-IV

Learning from Examples: Forms of Learning, Supervised Learning, Learning Decision Trees, The decision tree representation, Expressiveness of decision trees, inducing decision trees from examples. **08 Hrs**

Unit-V

Natural Language Processing: Language Models, Steps in NLP, Syntactic Analysis (Parsing), Semantic interpretation, Discourse and pragmatic Processing, Text Classification. Discourse and pragmatic 24 Processing, Implementation aspects of Syntactic Analysis (Parsing)

Expert Systems: What is Expert system, Components of Expert System, Case studies on Expert System. **07 Hrs**

Reference Books:

1) Stuart Russell, Peter Norvig**,** "Artificial Intelligence: A Modern Approach" by Pearson 3rd Edition, 2015.
2) Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Tata McGraw-Hill Education Pvt. Ltd, 3rd Edition, 2017.
3) Saroj Kausik, "Artificial Intelligence", Cengage Learning, 1st edition, 2011.
4) N P Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

18UMAO675	**Applied Mathematics**	**(3 - 0 - 0) 3**

Contact Hours: 39

Course Learning Objectives (CLOs):

The students are expected to learn about mathematical modelling, use of numerical techniques to deal with engineering systems. Further, they need to learn LPP and statistical tools for interpretation. They are also expected to carry out sampling distribution analysis and use of graph theory for engineering problems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Obtain Mathematical model of Engineering Systems using different domains.		1,2	
CO-2	Formulate LPP and obtain optimal solutions using different tools.		1,2	
CO-3	Apply statistical tools to Interpret the data using different tools.		1,2	
CO-4	Determine Type errors and test for goodness of fit using different methods.		1,2	
CO-5	Use graph theory to obtain solution for engineering problems.		1,2	

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POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	2	2	-	-	-	-	-	-		-	-	-

Pre-requisites: A basic course on the concepts of algebra, geometry, calculus, trigonometry and laws of physics, Statistical averages and probability theory.

Contents:

Unit-I

Introduction to Mathematical Modelling and Numerical Techniques: Introduction, Modelling technique, classification and characteristics. Mathematical modelling through algebra, geometry, calculus, trigonometry. Mathematical model of engineering system. 8 Hrs.

Unit-II

Linear and Non-Linear programming :

Introduction, Mathematical formulation of a L.P.P, basic solution. Geometric (or graphical) method, Simplex method.Assignment problem. Non Linear Programming – Constrained extremal problems-Lagrange's multiplier method-Kuhn- Tucker conditions and solutions. 8 Hrs.

Unit-III

Statistical Techniques : Co-efficient of Variation, Skewness, Karl Pearson's co-efficient of Skewness, Moments, Pearson's Beta and Gamma co-efficient, Kurtosis. Time series and Forecasting. 7 Hrs.

Unit-IV

Sampling distribution: Introduction, population and samples. Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square Distribution as a test of goodness of fit. 8 Hrs.

Unit-V

Graph Theory: Definition of a graph theory, incidence and degree, walks, paths, circuits, Connectedness, Eulerian and Hamiltonian graphs, Trees, basic properties of trees, Binary trees, Preorder and post order traversals, Spanning and Minimal spanning trees, Connectivity and Separability, fundamental circuits and cut sets Isomorphism of graphs, Matrix representation of graphs, adjacency and incidence matrix Graph theoretical algorithms: Dijkstra, Prims and Kruskal. 8 Hrs**.**

Reference Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th edition,2017.
2. E. Kreyszig Advanced Engineering Mathematics John Wiley & Sons,10 edition, 2016.
3. Srimanta Pal et al, Engineering Mathematics, Oxford University Press, 3rd edition, 2016.
4. Dougas B. West, Introduction to Graph theory, second edition, PHLearnig Private Limited, 2009.

18UECO722 Multicore Programming (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

This course focuses on basic concepts of Multi Core programming and various practical models of Multi Core programming. Aims to provide basic insight into multicore architecture along with Parallel Programming concepts. It also exposes OpenMP and MPI constructs, threading APIs and multicore software development and debugging techniques

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Identify** different parallel computing architectures and their applicability.	1,2		4,10
CO-2	**Develop** an insight into multicore hardware architecture and threading and synchronization and **utilize** it to build applications.	1, 2,14	3	4
CO-3	**Illustrate** programming using OpenMP and MPI.	2,3,4,5	13,14	
CO-4	Examine the threading APIs.	1,3,5		14
CO-5	Distinguish multiprocessor software development products and debugging techniques.	5,12	4	-

Pre-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	3	3	2.7	1.8	3	-	-	-	-	-	-	3	2	2

requisites: Probability theory, Communication Systems

Contents:

UNIT-I

INTRODUCTION TO MULTI-CORE ARCHITECTURE: Motivation for Concurrency in Software, Parallel Computing Platforms (SIMD & MIMD systems, an overview of Single-Core, Multi-Processor, Multi-Core Architectures), Parallel Computing in Microprocessors, Differentiating Multi-Core Architectures from Hyper-Threading Technology, Multi-threading on Single-Core versus Multi-Core Platforms, Understanding Performance, Amdahl's Law, Gustafson's Law **08 Hrs.**

Unit-II

MULTI-CORE PROCESSORS: An Overview of Software Threading Defining Threads, System View of Threads: Threading above the Operating System, Threads inside the OS, Threads inside the Hardware, Application Programming Models and Threading, Virtual Environment: Virtual Machines and Platforms Runtime Virtualization, System Virtualization**.**

PARALLEL PROGRAMMING FUNDAMENTAL CONCEPTS: Designing for threads, parallel programming patterns, Threading and parallel programming constructs: Synchronization, Critical sections, Deadlock, Synchronization Primitives, and Messages **08 Hrs.**

Unit-III

OPENMP PROGRAMMING: OpenMP Challenges in Threading a loop, Minimizing Threading overhead, Performance oriented Programming, Library Functions. Solutions to parallel programming problems: Data races, deadlocks and Livelocks Non-blocking algorithms, Memory and cache related issues.

MPI PROGRAMMING: Message-Passing Model, Message-Passing Interface, MPI functions, Compiling and running MPI Programs, collective communication, data decomposition, Point-to-point communication – MPI Library. **08 Hrs.**

Unit-IV

THREADING API'S: Threading APIs for Microsoft Windows, Threading APIs for Microsoft .NET Framework: Creating Threads, Managing Threads, Thread Pools, Thread Synchronization, POSIX Threads: Creating Threads, Managing Threads, Thread Synchronization, Signaling, Compilation and Linking **07 Hrs.**

Unit-V

MULTI-THREADED DEBUGGING TECHNIQUES: General Debug Techniques, Debugging Multi-threaded Applications in Windows: Threads Window, Trace points, Breakpoint Filters, Naming Threads, Multi-threaded Debugging Using GDB.

MULTI-CORE PROCESSORS SOFTWARE DEVELOPMENT PRODUCTS: An Overview of Software tools on Multi-Core Processors, Intel Software Development Products: overview, Thread Checker, Compilers: OpenMP, Software-based Speculative Pre computation, Compiler Optimization and Cache Optimization, Debugger , Intel Libraries, Intel Threading Building Blocks , VTune Performance Analyzer , Thread Profiler , MPI Programming :Intel Support for MPI **08 Hrs.**

Reference Books:

1) ShameemAkhter and Jason Roberts, "Multi-core Programming- Increasing Performance through Software Multi-Threading", 1st Edition, Intel Press, 2006.
2) Michael J Quinn, "Parallel programming in C with MPI and OpenMP", 2nd Edition, Tata McGraw Hill, 2007.

Peter S. Pacheco, “An Introduction to Parallel Programming”,Morgan Kaufmann Publishers is an imprint of Elsevier,2011

18UECO723	Mobile Computing	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

The course focuses on basics of mobile communications, mobile computing, GSM systems, networking, transport and application layer protocols, different mobile platforms and application development and security issues.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the basics of mobile telecommunication systems	-	-	1,4,6,7
CO-2	Illustrate the generations of telecommunication systems in wireless networks	-	1,2,4,5	12,13,14
CO-3	Determine the functionality of MAC, network layer and Identify a routing protocol for a given Adhoc network	-	2,4	12,13,14
CO-4	Explain the functionality of Transport and Application layers	-	1,2,4,10	-
CO-5	Develop a mobile application using android/blackberry/ios/Windows SDK	1,2,3,4,5,13, 14	-	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.0	2.25	3.0	2.0	2.5	1.0	1.0	-	-	2.0	-	1.0	1.33	1.33

Pre-requisites: Wireless communication, Digital communication Computer Communication Networks;

Contents:

Unit-I

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Introduction: Mobile Communications, Mobile Computing– Paradigm, Promises/Novel Applications and Impediments and Architecture; Mobile and Hand held Devices, Limitations of Mobile and Handheld Devices.

GSM–Services, System Architecture, Radio Interfaces, Protocols, Localization, Calling, Handover, Security, New Data Services, GPRS,CSHSD, DECT. **08 Hrs**

Unit-II

(Wireless) Medium Access Control (MAC): Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA, Wireless LAN / (IEEE802.11)

Mobile Network Layer: IP and Mobile IP Network Layers, Packet Delivery and Handover Management, Location Management, Registration, Tunnelling and Encapsulation, Route Optimization, DHCP. **08 Hrs**

Unit-III

Mobile Transport Layer: Conventional TCP/IP Protocols, Indirect TCP, Snooping TCP, Mobile TCP, Other Transport Layer Protocols for Mobile Networks.

Database Issues: Data base Hoarding & Caching Techniques, Client-Server Computing & Adaptation, Transactional Models, Query processing, Data Recovery Process & QoS Issues. **07 Hrs**

Unit-IV

Data Dissemination and Synchronization: Communications Asymmetry, Classification of Data Delivery Mechanisms, Data Dissemination, Broadcast Models, Selective Tuning and Indexing Methods ,Data Synchronization– Introduction, Software, and Protocols. **09 Hrs**

Unit-V

Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone–M Commerce–Structure–Pros & Cons– Mobile Payment System–Security Issues.

Protocols and Platforms for Mobile Computing: WAP,Bluetooth,XML,J2ME, Java Card, Palm OS, Windows CE, Symbian OS, Linux for Mobile Devices, Android. **07 Hrs**

Reference Books:

1) Jochen Schiller, “Mobile Communications” ,PHI,SecondEdition,2003.
2) RajKamal, “Mobile Computing”,OxfordUniversityPress,2007,
3) Prasant Kumar Pattnaik ,Rajib Mall,”Fundamentals of Mobile Computing”, PHI ,2012

PG Syllabus of new courses introduced

18PDEE151 Machine Learning (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on introduction to the fundamental concepts in machine learning and popular machine learning algorithms. It includes linear modeling, Bayesian approach, classification, clustering and Principal Component Analysis. In the course also discusses various issues related to the application of machine learning algorithms.

Course Outcomes(COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Describe** variety of mathematical modeling, inference, and prediction algorithms for machine learning	3	2	
CO-2	**Analyze** the situations of applying variety of mathematical models and algorithms for machine learning	2,3	1	
CO-3	**Compare and justify** mathematical models and algorithms for machine learning	1, 4		2
CO-4	**Apply** algorithms for machine learning and **solve** concerned problems	4, 6		
CO-5	**Justify** the selection of algorithms for machine learning	3	2	
CO-6	**Evaluate** the performance of algorithms for machine learning	3	1	

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2.3	4	3	3	-	3

Pre-requisites:

Basics of probability and statistics.

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Course Contents:

1. **Linear Modeling-A Least Squares Approach:** Linear Modeling, Making Predictions, Vector/Matrix Notation, Non-Linear Response from a Linear Model, Generalization and Over-Fitting, Regularized Least Squares. **06 Hrs.**
2. **Linear Modeling-A Maximum Likelihood Approach:** Errors as Noise, Random Variables and Probability, Popular Discrete Distributions, Continuous Random Variables - Density Functions, Popular Continuous Density Functions, Likelihood, The Bias-Variance Trade-off, Effect of Noise on Parameter Estimates, Variability in Predictions. **08 Hrs.**
3. **The Bayesian Approach to Machine Learning**: A Coin Game, The Exact Posterior, The Three Scenarios, Marginal Likelihoods, Hyper parameters, Graphical Models, A Bayesian Treatment of the Olympic100m Data, Marginal Likelihood for Polynomial Model Order Selection. **08 Hrs.**
4. **Bayesian Inference:** Non-Conjugate Models, Binary Responses, A Point Estimate - The Map Solution, The Laplace Approximation, Sampling Techniques. **07 Hrs.**
5. **Classification:** The General Problem, Probabilistic Classifiers, Non-Probabilistic Classifiers, Assessing Classification Performance, Discriminative and Generative Classifiers. **08 Hrs.**
6. **Clustering:** The General Problem, K-Means Clustering, Mixture Models. **08 Hrs.**
7. **Principal Components Analysis and Latent Variable Models:** The General Problem, Principal Components Analysis, Latent Variable Models, Variational Bayes, A Probabilistic Model for PCA, Missing Values, Non-Real-Valued Data. **07 Hrs.**

Activity beyond Syllabus: Program development for the machine learning Algorithms in MATLAB and Python.

Reference Books:

1. Simon Rogers, Mark Girolami, “A First Course in Machine Learning”, CRC Press, 2017.
2. Ethem Alpaydin, “Introduction to Machine Learning”, Prentice Hall of India, Third edition, 2014
3. Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashier, “Machine Learning, Algorithms and Applications”, CRC Press, 2017.
4. Tom Mitchell, “Machine Learning”, First Edition, McGraw- Hill, 1997.
5. Michael Paluszek, Stephanie Thomas, “MATLAB Machine Learning”, A press, 2017.

18PDEE353	VLSI Digital Signal Processing	(4-0-0)4

Contact Hours: 52

Course Learning Objectives(CLOs):

The subject focuses on DSP Architecture, parallel processing issues in analyzing DSP Computation systems. The next part covers further the Systolic Architecture Design and pipe lined and parallel recursive and Adaptive filters.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to Pos (1-6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Identify** the typical signal processing tasks	3		
CO-2	**Gain knowledge** possibility of reducing the computational complexity	3	6	
CO-3	**Acquire knowledge** various architectures	2		
CO-4	**Acquire knowledge** about optimization in view of power, area and speed	2, 4		
CO-5	**Acquire knowledge** about algorithms available for the purpose of optimization	1, 4, 6		
CO-6	**Compare** the techniques / architectures	6		

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	3	3	3	3	-	2.5

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Pre-requisites:

Knowledge of Digital Signal Processing, Analog and digital electronics, CMOS VLSI design.

Course Contents:

1	**Introduction to DSP Systems**: Introduction to DSP Systems, Iteration bound, Data Flow graphs (DFGs) representation, Loop Bound, Iteration rate, Critical loop, Critical path, Area-Speed-Power trade-offs, Algorithms for computing iteration bound, Pipelining of FIR Digital Filters, Parallel Processing, Pipelining and Parallel Processing for low power.	**10 Hrs.**
2	**Algorithmic Transformations**: Retiming Definitions and properties, Retiming Techniques, Clock period minimization, Unfolding, An algorithm for unfolding, Critical path, Applications of unfolding, Sample period reduction, Folding, Folding order, Folding Factor, register minimization techniques, register minimization in folded architecture, Forward Backward Register Allocation technique, folding of multi-rate systems, Folding Bi-quad filters, Retiming for folding.	**12 Hrs.**
3	**Systolic Architecture Design and Fast Convolution:** Introduction, system array design methodology, FIR systolic arrays, , Systolic Design for space representations containing delays Systolic architecture design methodology, Design examples of systolic architectures, selection of scheduling vector, matrix-matrix multiplication and 2-D systolic array design, Hardware Utilization efficiency, Cook-Toom Algorithm, Winograd Algorithm, Iterated Convolution, Cyclic Convolution, Design of fast convolution algorithm by inspection.	**12 Hrs.**
4	**Algorithm Strength Reduction in filter:** Introduction, Parallel FIR filters, Polyphase decomposition, Discrete Cosine Transform and Inverse Discrete Cosine Transform, parallel architectures for	**10 Hrs.**

Rank Order filters.

5 **Pipelined and Parallel Recursive and Adaptive Filters**: **08 Hrs.** Introduction, pipelining in 1st order IIR digital filters, pipelining in higher order IIR digital filters, parallel processing for IIR filters, combined pipelining and parallel processing for IIR filters, low power IIR Filter Design using pipelining and parallel processing, pipelined adaptive digital filters.

References Books:

1. Parhi, K.K., "VLSI Digital Signal Processing Systems: Design andImplementation", John Wiley 2007.
2. Oppenheim, A.V. and Schafer, R.W., "Discrete-Time Signal Processing", Prentice Hall, 2009, 2nd edition.
3. Mitra, S.K., Digital Signal Processing. A Computer Based Approach, McGraw Hill, 2007, 3rd edition.
4. Wanhammar, L., DSP Integrated Circuits, Academic Press, 1999, 2005, ISBN: 978-0131543188

20PDEE150	**Introduction to Artificial Intelligence & Machine Learning**	**(4-0-0) 4**

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on introduction to the fundamental concepts in artificial intelligence & machine learning. Topics covered include linear modeling, Bayesian approach, classification, clustering and popular machine learning algorithms in each topic. The course also discusses various issues related to the application of artificial intelligence using machine learning techniques.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1 to 6)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Recognize** the characteristics of artificial intelligence systems that make it useful to real-world problems	-	3,1	2

CO-2	**Analyze** the situations of applying variety of mathematical models and algorithms for machine learning	3	1	-
CO-3	**Compare** and **justify** various mathematical models and algorithms used in machine learning	4,1	3	2
CO-4	**Justify** the selection of various classification and regression supervised/unsupervised learning problems of machine learning	-	3,1	-
CO-5	**Select** and **implement** machine learning techniques that are suitable for the applications under consideration	4	3,1	-
CO-6	**Evaluate** the performance of various machine learning algorithms	-	3	1

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	2.0	1.0	2.2	3.0	---	----

Pre-requisites: Basics of probability and statistics, Linear algebra

Contents:

1) **Introduction to Artificial Intelligence:** History of artificial intelligence, Propositional logic; basics of propositional logic, Resolution, Artificial intelligence applicatons, First order logic; basics of first order logic, certain knowledge representation; Taxonomic knowledge, Frmames, Nonmonotonic logic. **08 Hrs**
2) **Linear Modeling-A Least Squares Approach:** Linear Modeling, Making Predictions, Vector/Matrix Notation, Non-Linear Response from a Linear Model, Generalization and Over-Fitting, Regularized Least Squares. **05 Hrs**
3) **Linear Modeling-A Maximum Likelihood Approach:** Errors as Noise, Random Variables and Probability, Popular Discrete Distributions, Continuous Random Variables - Density Functions, Popular Continuous Density Functions, Likelihood, The Bias-Variance Trade-off, Effect of Noise on Parameter Estimates, Variability in Predictions. **09 Hrs**
4) **The Bayesian Approach to Machine Learning**: A Coin Game, The Exact Posterior, The Three Scenarios, Marginal Likelihoods, Hyper parameters,

Graphical Models, A Bayesian Treatment of the Olympic100m Data, Marginal Likelihood for Polynomial Model Order Selection. **09 Hrs**

5) **Bayesian Inference:** Non-Conjugate Models, Binary Responses, A Point Estimate - The Map Solution, The Laplace Approximation, Sampling Techniques. **08 Hrs**
6) **Classification:** The General Problem, Probabilistic Classifiers, Non-Probabilistic Classifiers, Assessing Classification Performance, Discriminative and Generative Classifiers. **05 Hrs**
7) **Clustering:** The General Problem, K-Means Clustering, Mixture Models. **08 Hrs**

Activity beyond Syllabus: Program development for the machine learning Algorithms in MATLAB/ Python.

Reference Books:

1) Simon Rogers, Mark Girolami, “A First Course in Machine Learning”, second edition, CRC Press, 2017.
2) Richard E. Neapolitan & xia Jiang, “Artificial Intelligence with an introduction to machine learning”, second edition, CRC press, 2018.
3) Ethem Alpaydin, “Introduction to Machine Learning”, Prentice Hall of India, Third edition, 2014.
4) Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashier, “Machine Learning, Algorithms and Applications”, CRC Press, 2017.
5) Michael Paluszek, Stephanie Thomas, “MATLAB Machine Learning”, A press, 2017.

20PDEE253 Artificial Neural Networks & Deep Learning (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

This course offers an introduction to Artificial Neural Networks and Deep Learning. The course delve into selected topics of deep Learning, discussing recent models from both supervised and unsupervised learning. Special emphasis will be on convolutional architectures, invariance learning, back propagation and non-convex optimization. Also course covers models for various applications, how they are trained, validated and deployed in the wild.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to PO (1 to 6)**		
		Level 3 Substantial	**Level 2 Moderate**	**Level 1 Slight**
CO-1	**Understand** the role of neural networks in engineering, artificial intelligence and learn basic neural network architecture.	-	6	2

CO-2	**Implement** Perception learning algorithm and Adaptive linear combiner.	-	3	1
CO-3	**Develop** delta learning rule of the output layer and Multilayer feed forward neural network with continuous perceptions.	3	4	1
CO-4	**Calculate** weight gradients in a feed forward neural network using back propagation algorithm.	3	4	2
CO-5	**Identify** the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.	-	6	2,1

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1.0	1.0	2.7	2.0	---	2.0

Pre-requisites: Linear Algebra, Probability &Statistics

Contents:

1) **Introduction:** Neural Network, The human brain, Models of a neuron, Neural networks viewed as directed graphs, Feedback, Network architectures, Knowledge representation **02 Hrs**
2) **Single layer Perception:** Introduction, Pattern Recognition, Linear classifier, Simple perception, Perception learning algorithm, Modified Perception learning algorithm, Adaptive linear combiner, Continuous perception, Learning in continuous perception. Limitation of Perception. **06 Hrs**
3) **Multi-Layer Perceptron Networks**: Introduction, MLP with 2 hidden layers, Simple layer of a MLP, Delta learning rule of the output layer, Multilayer feed forward neural network with continuous perceptions, Generalized delta learning rule. **08 Hrs**
4) **Activation Functions, Gradient descent & Back propagation:** Sigmoid, ReLU, Hyperbolic Fns, Softmax, Gradient descent, Stochastic gradient descent, back propagation, Some problems with ANNs. **08 Hrs**
5) **Optimization& Regularization:** Overfitting and Capacity, Cross validation, Feature selection, Regularization & Hyperparameters. **06Hrs**
6) **Introduction to Convolutional & Recurrent Neural Network:** Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple filters, CNN applications, Introduction to RNNs, unfolded RNNs, Seq2seq RNNs, LSTM, RRN applications. **10 Hrs**
7) **Deep Unsupervised Learning:** Encoder Decoder architecture, Auto-encoders

(standard, sparse, denoising, contractive), Variational auto encoders, Adversarial generative networks, DBM. **06 Hrs**

8) **Applications of Deep Learning to NLP:** Introduction to NLP and vector space model semantics, Word vector representations: Continuous Skip-Gram model, Continuous of words model, Glove, Evaluations and applications in word similarity, analogy reasoning. **06 Hrs**

Activity beyond Syllabus: Seminar, Simulation based project.

Reference Books:

1) Simon Haykin, "Neural networks and Learning machines", 3/e, Pearson education, 2009.
2) Zurada and Jacek M, "Introduction to Artificial Neural Systems", West Publishing Company, 1992.
3) Goodfellow, I., Bengio, Y, and Courville A., "Deep learning", MIT press, 2016.
4) Bishop C.M., "Pattern Recognition & Machine learning", Springer, 2006.
5) Yegnanarayana, B., Artificial Neural Networks, PHI Learning Pvt Ltd 2009.

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20PDEE254	**IoT Applications**	**(4-0-0)4**

Contact Hours: 52

Course Learning Objectives (CLOs):

The course focuses on all the important design and implementation details of various functions possible with IoT such as use of specific sensors, computational devices and connectivity to the Internet.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1 to 6)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Understand** the vision of IoT from a global context.	-	6	5
CO-2	**Determine** the market perspective of IoT.	-	6	5

CO-3	**Explore** the devices, gateways and data management in IoT.	-	4,6	-
CO-4	**Build** the state of art architecture in IoT.	4	5,6	1
CO-5	**Apply** the concepts of IoT to solve industrial and commercial building automation and real world design constraints.	4,5	1	2
CO-6	**Understand** the vision of IoT from a global context.	-	6	5

POs	PO1	PO2	PO3	PO4	PO5	PO6
Mapping Level	1.5	1	-	2.6	1.6	2

Pre-requisites: Fundamentals of computer network, wireless sensor network, communication & internet technology, web technology, information security.

Contents:

1) **IoT & WebTechnology:** The Internet of Things Today, time for convergence, towards the IoT universe, Internet of things vision, IoT strategic research and innovation directions, IoT applications, Future Internet technologies, Infrastructure, Networks and Communication, processes, Data management, Security, Privacy & Trust, device level Energy issues, IoT related standardization, Recommendations on research topics. **9 Hrs**
2) **Machine to Machine(M2M) to IoT:** Basic perspective: Introduction, some definitions, M2M value chains, IoT value chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An architectural overview–building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. **10Hrs**
3) **IoT Architecture:** Introduction, State of the art, Architecture Reference Model-Introduction, Reference model and architecture, IoT reference Model, IoT reference architecture-Introduction, Functional view, Information view, Deployment and operational view, Other relevant architectural views. **10 Hrs**
4) **IoT Applications for Value Creations**: Introduction, IoT applications for industry: Future factory concepts, Brownfield IoT, Smart objects, Smart applications, Four aspects in your business to master IoT, Value creation from big data and serialization, IoT for retailing industry, IoT for oil and gas industry, Opinions on IoT application and value for industry, Home management, e-Health. **12 Hrs**

5) **Internet of Things Privacy, Security and Governance:** Introduction, Overview of governance, Privacy and security issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-data-Platforms for smart cities, First steps towards a secure platform, Smart approach. Data aggregation for the IoT in smart cities security. **11Hrs**

Reference Books:

1) Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, 1st Edition, VPT, 2015.
2) Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.
3) Cuno Pfister, “Getting Started with the Internet of Things,” Reilly Media, 2011.

Raj Kamal, "Internet of Things: architecture and design principles" McGraw Hill Education(India), 2017.

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