

ANNA UNIVERSITY, CHENNAI
NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. ELECTRONICS AND COMMUNICATION ENGINEERING (INDUSTRY INTEGRATED)
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM

Prerequisite for the programme: Offered if commitment for summer internship followed by projects is available for all students from industry and for collaboration with industry in delivering lectures for the subjects in all semesters in the curriculum.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To enable graduates to possess skills to develop new innovation in the field of Electronics and Communication Engineering (Industry Integrated) using analytical reasoning and state-of-the-art approaches derived from the Engineering Sciences and Engineering practice.
2. To enable graduates to create useful systems, components, or processes through agile, skillful, and innovative analysis and design, while respecting economic, environmental, cultural, and ethical standards or constraints and acquire technical and managerial leadership positions in their chosen fields.
3. To enable graduates to engage in lifelong learning, adapt to evolving Technology, work in multidisciplinary research for designing innovative products & solutions.
4. To become Entrepreneurs, understand current professional issues and apply latest technologies for the betterment of the nation and society.

PROGRAM OUTCOMES (POs)

1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4. To apply the core aspects of Electronics and Communication Engineering principles such as Signal Processing, Embedded Systems, Networking and Semiconductor Technology for designing end to end electronic products catering industry requirements.
5. To identify and utilize the strengths of current technologies used in industries in the field of Microelectronics, Signal Processing and Communication System domains in implementing ICT enabled services for societal needs
6. To identify industrial needs and provide suitable design solutions for implementing IoT, Cyber Physical Systems for given specifications

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I TO IV SEMESTERS CURRICULA AND SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4156	Linear Algebra, Probability and Queueing Theory	FC	3	1	0	4	4
2.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
3.	VE4151	Embedded Controllers	PCC	3	0	0	3	3
4.	II4101	Industrial Automation and Control	PCC	3	0	0	3	3
5.	II4102	Virtual Instrumentation	PCC	3	0	0	3	3
6.	EL4151	Modern Digital Communication Systems	PCC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	EL4161	Digital Communication systems Laboratory	PCC	0	0	3	3	1.5
9.	II4111	Application Software and Simulation Laboratory	PCC	0	0	3	3	1.5
TOTAL				19	1	6	26	21

*Audit course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	II4201	ASIC and FPGA Design	PCC	3	0	0	3	3
2.	II4202	Wireless Communication and Networking	PCC	3	0	0	3	3
3.	II4203	Advanced in Internet of Things	PCC	3	0	0	3	3
4.	MP4291	Cyber Physical Systems	PCC	3	0	2	5	4
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	II4211	Internet of Things Applications Laboratory	PCC	0	0	2	2	1
9.	II4212	Term Paper Writing and Seminar	EEC	0	0	2	2	1
TOTAL								21

*Audit course is optional

Note: Summer internship (in Industry) (30 days min)

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	II4301	Robotics and Automation	PCC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	2	5	4
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	II4311	Summer internship (in Industry) (30 days min)	EEC	0	0	0	0	2
6.	II4312	Project Work I	EEC	0	0	12	12	6
TOTAL				12	0	14	26	21

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	II4411	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL NO. OF CREDITS: 76

**PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE I**

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EL4391	Optical Networks	PEC	3	0	0	3	3
2.	NE4251	Network Security	PEC	3	0	0	3	3
3.	MP4093	Soft Computing Techniques	PEC	3	0	0	3	3
4.	II4092	System on Chip	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	II4091	Industry 4.0	PEC	3	0	0	3	3
2.	II4001	Broadband Access Technologies	PEC	3	0	0	3	3
3.	II4002	Smart Antennas	PEC	3	0	0	3	3
4.	EL4071	Electromagnetic Interference and Compatibility	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	II4003	Healthcare Technologies and Internet of Medical Things	PEC	3	0	0	3	3
2.	II4004	Cognitive Radio Communications	PEC	3	0	0	3	3
3.	IF4092	Computer Vision	PEC	3	0	0	3	3
4.	VL4073	MEMS and NEMS	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	II4005	Wireless Adhoc and Sensor Networks	PEC	3	0	2	5	4
2.	II4006	Real Time Systems	PEC	3	0	2	5	4
3.	II4007	Software Defined Networks	PEC	3	0	2	5	4
4.	CP4252	Machine Learning	PEC	3	0	2	5	4

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3

7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3
12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	ET4251	IoT for Smart Systems	3	0	0	3
17.	ET4072	Machine Learning and Deep Learning	3	0	0	3
18.	PX4012	Renewable Energy Technology	3	0	0	3
19.	PS4093	Smart Grid	3	0	0	3
20.	CP4391	Security Practices	3	0	0	3
21.	MP4251	Cloud Computing Technologies	3	0	0	3
22.	IF4072	Design Thinking	3	0	0	3
23.	MU4153	Principles of Multimedia	3	0	0	3
24.	CX4016	Environmental Sustainability	3	0	0	3
25.	TX4092	Textile Reinforced Composites	3	0	0	3
26.	NT4002	Nanocomposite Materials	3	0	0	3
27.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4156	Linear Algebra, Probability and Queueing Theory	3	1	0	4	I

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	VE4151	Embedded Controllers	3	0	0	3	I
2.	II4101	Industrial Automation and Control	3	0	0	3	I
3.	II4102	Virtual Instrumentation	3	0	0	3	I
4.	EL4151	Modern Digital Communication Systems	3	0	0	3	I
5.	EL4161	Digital Communication systems Laboratory	0	0	3	1 . 5	I
6.	II4111	Application Software and Simulation Laboratory	0	0	3	1 . 5	I
7.	II4201	ASIC and FPGA Design	3	0	0	3	II
8.	II4202	Wireless Communication and Networking	3	0	0	3	II

9.	II4203	Advanced in Internet of Things	3	0	0	3	II
10.	MP4291	Cyber Physical Systems	3	0	2	4	II
11.	II4211	Internet of Things Applications Laboratory	0	0	2	1	II
12.	II4301	Robotics and Automation	3	0	0	3	III

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	II4311	Summer internship	0	0	0	2	III
2.	EL4311	Project Work I	0	0	12	6	III
3.	EL4411	Project Work II	0	0	24	12	IV

SUMMARY

Sl. No.	NAME OF THE PROGRAMME: M.E. ELECTRONICS AND COMMUNICATION ENGINEERING (INDUSTRY INTEGRATED)					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	15	14	03	00	32
3.	PEC	00	06	07	00	13
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	01	08	12	21
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	TOTAL CREDIT	21	21	21	12	75

COURSE OBJECTIVES:

The objective of this course is to enable the student to

- grasp the basic concepts of Probability, Random variables, correlation and regression.
- characterize the phenomena which evolve with respect to time in a probabilistic manner.
- encourage students to develop a working knowledge of the ventral ideas of linear algebra.
- acquire skills in analyzing Queueing Models.
- develop a fundamental understanding of linear programming models and apply the simplex method for solving linear programming problems.

UNIT – I LINEAR ALGEBRA 12

Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization – Generalized eigenvectors – Jordan Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

UNIT – II PROBABILITY AND RANDOM VARIABLES 12

Probability Concepts – Axioms of probability – Conditional probability – Baye's theorem – Random variables – Probability functions – Two-dimensional random variables – Joint distributions – Marginal and conditional distributions – Correlation – Linear Regression.

UNIT – III RANDOM PROCESSES 12

Classification – Stationary random process – Markov process – Markov chain – Poisson process – Gaussian process – Auto correlation – Cross correlation.

UNIT – IV QUEUEING THEORY 12

Markovian queues – Single and multi-server models – Little's formula – Steady state analysis – Self-service queue.

UNIT – V LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M method – Variants of Simplex method – Transportation problems – Assignment models.

TOTAL: 60 PERIODS**COURSE OUTCOMES:**

After the completion of the course, the student will be able to

- apply various methods in Linear Algebra to solve the system of linear equations.
- use two-dimensional random variables, correlations and regression in solving application problem.
- apply the ideas of Random Processes.
- understand the basic characteristic features of a queueing system and acquire skills in analyzing queueing models.
- apply the Simplex method for solving linear programming problems.

REFERENCES:

1. Miller, S.L. and Childers D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2004.
2. Friedberg A.H, Insel A.J. and Spence L, "Linear Algebra", Prentice Hall of India, New Delhi, 2004.

3. Gross, D., Shortie, J.F., Thompson, J.M and Harris, C.M., "Fundamentals of Queueing Theory", 4th Edition, Wiley,2014.
4. T. Veerarajan, "Probability, Statistics and Random Process with Queueing Theory and Queueing Network, Tata McGraw Hill, 4th Edition,2017.
5. Taha H.A., "Operations Research: An Introduction", 9th Edition, Pearson Education Asia, New Delhi,2016.
6. Richard Bronson, "Matrix Operations" Schaum's outline series, McGraw Hill, 2nd Edition, New York,2011.
7. Oliver C. Ibe, " Fundamentals of Applied Probability and Random Processes", Academic Press, (An Imprint of Elsevier), Boston,2014.

RM4151

RESEARCH METHODOLOGY AND IPR

L T P C

2 0 0 2

COURSE OBJECTIVES:

- To arrange the conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose
- To gather information in a measured and systematic manner to ensure accuracy and facilitate data analysis
- To transform and model the collected data to discover useful information for decision-making
- To create public awareness about the benefits of Intellectual property among students
- To Provide legal certainty to inventors/ Patent applicants

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

- Ability to arrange the conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose
- Ability to gather information in a measured and systematic manner to ensure accuracy and facilitate data analysis
- Ability to transform and model the collected data to discover useful information for decision-making
- Ability to awareness about the benefits of Intellectual property
- Ability to take up legal certainty while applying for Patent

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

VE4151

EMBEDDED CONTROLLERS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To study the architecture and programming of PIC microcontrollers.
- To learn interfacing with PIC microcontrollers.
- To understand the ARM processor architecture.
- To program using ARM Instruction Set.
- To design and develop embedded applications.

UNIT I PIC MICROCONTROLLER – ARCHITECTURE

9

RISC Vs CISC Architectures – PIC Architecture and Assembly Language Programming - Program Memory Organization- Branch, Call and Time Delay Loop - PIC I/O Port Programming - Arithmetic and Logic Instructions and Programs - PIC Bank Switching, Table Processing, Macros And Modules PIC Configuration Registers-PIC Hardware Connection-ROM Loaders.

UNIT II PIC INTERFACING

9

PIC Timer / Counter Programming - Timers 0 And 1- Programming Timers 2 and 3 -Serial Port Programming -Interrupt Programming -Flash / EEPROM Programming - Standard and Enhanced CCP Modules -Compare Mode Programming - Capture Mode Programming- PWM Programming- ECCP Programming.

UNIT III ARM ARCHITECTURE

9

Introduction to ARM Processor families – Pipeline- ARM7TDMI Programmers Model- Processor Modes-Program Status Registers - Vector Table- Assembler Rules and Directives - Predefined Register Names – Macros – Assembler – Operators – Literals - Load and Store Instructions - Operand Addressing – Endianness - Arm Rotation Scheme - Loading Constants and Addresses into Registers.

UNIT IV ARM PROGRAMMING

9

ARM Instruction Set - Data Processing Instructions – Branch Instructions -- Load Store Instructions – Software Interrupt Instruction – Program Status Register Instructions – Conditional Execution - Thumb Instruction Set-Thumb Programmers Model-Thumb Branch Instructions- Thumb Data Processing Instructions-Thumb Single Register Data Transfer- Thumb Multiple Register Data Transfer Instructions - Thumb Implementation.

UNIT V EMBEDDED APPLICATIONS

9

ADC, DAC and Sensor Interfacing –LCD and Keyboard Interfacing -Calculator with Keypad – Relays and Optoisolators - Stepper Motor Interfacing - DC Motor Interfacing - PWM Motor Control with CCPDC - Motor Control With ECCP.

SUGGESTED ACTIVITIES:

- 1: Interfacing PIC microcontrollers with peripherals.
- 2: Assignments on programming ARM processors.
- 3: Design embedded systems for real – time applications.

COURSE OUTCOMES:

- CO1: Understand the architecture of a PIC microcontroller.
CO2: Program using PIC microcontrollers.
CO3: Program using ARM processors.
CO4: Design interfacing circuits with PIC microcontrollers.
CO5: Design embedded applications to solve real world problems.

TOTAL:45 PERIODS

REFERENCES:

1. Muhammad Ali Mazidi, "PIC Microcontrollers and Embedded Systems using Assembly and C for PIC18 ", Pearson Education, 2016.
2. William Hohl, "ARM Assembly Language", CRC Press, Second Edition, 2015.
3. John B. Peatman, "Design with PIC Microcontrollers", Pearson Education, Singapore – 1998
4. Andrew Sloss, Dominic Symes, and Chris Wright, "ARM System Developer's Guide Designing and Optimizing System", The Morgan Kaufmann Series, 2004.
5. Steve Furber,"ARM System-on-Chip Architecture", Addison- Wesley Professional; II Edition 2000.

PROGRESS THROUGH KNOWLEDGE

II4101

INDUSTRIAL AUTOMATION AND CONTROL

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

The students will be able to

- Understand PLC Instructions
- Develop Ladder Logic for working models
- Use SCADA programming
- Interface various sensors with Arduino for industrial Automation

UNIT I PROGRAMMABLE LOGIC CONTROLLERS

9

Programmable Logic Controllers (PLCs) – architecture-Types- features -Programming a PLC using ladder/connected Component workbench-Input & Output Modules- Bit Instructions- Timer & Counter Instructions- Comparison & Data Handling Instructions- Program Control Instructions-

Sequencing Instructions- PLC Programming Exercises for Industrial Applications- DOL starter- Star Delta starter- Automatic water level controller- Conveyor-Lift-Bottle filling and process control applications-Analog I/Os -High speed counter-PTO PWM and RTC

UNIT II SCADA SYSTEM

9

Evolution of SCADA, Various SCADA architectures, advantages and disadvantages of each system, SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Communication Network, SCADA Server Data acquisition systems, SCADA applications in Automation, SCADA –Memory tag, Device tag, Alarm logging, Data logging, OPC server- HMI Systems –DCS- DCS integration with PLC and Computers - Features of DCS

UNIT III ARDUINO AND SENSORS FOR INDUSTRIAL AUTOMATION AND CONTROL

9

Arduino board and IDE – Digital and Analog I/Os – Interfacing with Sensors –IR-PIR-Ultrasonic sensor – colour sensor -barometric pressure-Pulse- smoke-Temperature - Sound-Flame –Touch-Accelerometer-Humidity and temperature - Seven segment display – LCD – Stepper Motor and DC Motor control, Graphical display, robot arm, Joystick, Wi fi interface, Blue tooth interface, Home automation, GPS tracker

UNIT IV DATA ACQUISITION SYSTEM

9

Data acquisition of digital and analog signals (input and output) – Stand alone, LabVIEW compatible, Mat lab compatible, Real time data acquisition and storing using different data acquisition cards. Retrieving the stored data for analysis – High level language programming for using data acquisition system

UNIT V PROCESS CONTROL AND PNEUMATICS

9

Process control- P, PI, PD.PID–Tuning methods- Statistical Process Control, Model Predictive Control, Fuzzy Logic Based Control, Neural-Network Based Control
Actuators in motor vehicles, power switches, electrical rotary and linear actuators - pneumatic system - Properties of air – Perfect Gas Laws –Components of pneumatic system- ISO symbols for their elements -Control and regulation Elements—Direction, flow and pressure control valves-- Methods of actuation, types, Design of Pneumatic and Electro pneumatic circuit–Simulation of Pneumatic and Electro pneumatic circuits - Applications using Robotics

TOTAL: 45PERIODS

COURSE OUTCOMES:

The students will be able to

- Program PLC for Industrial Applications
- Interface PLC with working models
- Control Applications using SCADA programming
- Develop industrial Automation using Arduino with various sensors

REFERENCES:

1. Gary Dunning, Introduction to Programmable Logic Controllers,3rd India edition, Cengage Learning, 2007
2. John Webb, Programmable Logic Controllers: Principles and Applications,5th edition Prentice Hall of India, 2012.
3. Krishna Kant Computer Based Process Control, Prentice Hall of India, 2004.

4. Michael P. Lukas, Distributed Control Systems: Their Evaluation and Design, Van Nostrand Reinhold Co., 1986
5. B. G. Liptak Instrument Engineers Handbook – Process Software and Digital Network, 3rd edition, CRC Press, 2002.
6. Jose A. Romagnoli, Ahmet Palazoglu, Introduction to Process control, CRC Taylor and Francis group, 2005.
7. Richard Cox, Programmable Controllers, Delmer Thomson learning, 2001.
8. Richard Zurawski, Industrial Communication Technology Handbook 2nd edition, CRC Press, 2015.
9. W. Bolton, “Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering”, Pearson Education, 2003
10. “Automation, Production Systems and Computer Integrated Manufacturing”- M.P. Grover, Pearson Education.
11. “Computer Based Industrial Control” – Krishna Kant, EEE-PHI 2.

II4102

VIRTUAL INSTRUMENTATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

The students will be able to

- understand the basics of Virtual Instrumentation
- differentiate analog and digital I/Os
- use LabVIEW for experiments
- analyze tools and applications in VI

UNIT I REVIEW OF DIGITAL INSTRUMENTATION

8

Representation of Analog signals in the Digital domain – Review of quantization in amplitude and time axis, sample and hold, sampling theorem, ADC and DAC types.

UNIT II FUNDAMENTALS OF VIRTUAL INSTRUMENTATION

10

Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card, Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog outputs on the universal DAQ card.

UNIT III CLUSTER OF INSTRUMENTS IN VI SYSTEM

10

Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus, PXI Bus

UNIT IV GRAPHICAL PROGRAMMING ENVIRONMENT IN VI

10

Concepts of graphical programming language LabVIEW – Concept of VIs and sub VI – Graphs & charts – Dataflow programming - Loops – Case and sequence structures - Types of data – Arrays & clusters – Formula nodes – math scrip integration - Local and global variables – String and file I/O – Building executables and installers – Web publishing tools

UNIT V ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI**7**

Build virtual instruments like oscilloscope, FFT analyzer – Windowing and filtering tools – Introduction of Electrical power measurement suite - Simple temperature ON/OFF controller – P-I-D controller design - Simulation of a simple second order system – Building autonomous embedded system using FPGA target

TOTAL:45 PERIODS**COURSE OUTCOMES:****The students will be able to**

- use VI basics for Industrial Applications
- develop Virtual Instrumentation using LabVIEW
- use DAQ for Real Time Applications

REFERENCES:

1. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI publications, 2010
2. S.Gupta and J.P Gupta, 'PC Interfacing for Data Acquisition and Process Control',
3. Instrument society of America, 1994.
4. Peter W. Gofton, 'Understanding Serial Communications', Sybex International.
5. Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2003.
6. Richard Jennings & Fabiola De La Cueva, LabVIEW Graphical Programming - Fifth Edition, McGraw-Hill
7. John Essick, Hands-On-Introduction to LabVIEW for Scientists and Engineers – Fourth Edition, OXFORD Publications
8. BehzadEhsani, Data Acquisition using LabVIEW, Packt Publishing, 2016

EL4151**MODERN DIGITAL COMMUNICATION SYSTEMS****L T P C
3 0 0 3****COURSE OBJECTIVES:**

- To understand the coherent and non coherent receivers and their performance under AWGN channel conditions
- To understand the effect of signalling through bandlimited channels and Equalization techniques used to overcome ISI
- To understand different channel models, channel capacity and different block coding techniques
- To understand the principle of convolutional coding and different decoding techniques
- To understand the basics of OFDM as a multicarrier communication and CDMA as a multiuser communication technique.

UNIT I COHERENT AND NON-COHERENT COMMUNICATION**9**

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – QAM modulation and demodulation Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK-BER Performance Analysis. Carrier Synchronization Bit synchronization.

UNIT II EQUALIZATION TECHNIQUES**9**

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms– Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT III BLOCK CODED DIGITAL COMMUNICATION 9

Architecture and performance – Binary block codes; – Shannon’s channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hamming; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

UNIT IV CONVOLUTIONAL CODED DIGITAL COMMUNICATION 9

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT V MULTICARRIER AND MULTIUSER COMMUNICATIONS 9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Differentiate coherent and non coherent receivers and analyse their performance under AWGN channel conditions

CO2: Illustrate the effect of signalling through bandlimited channels and Equalization techniques used to overcome ISI

CO3: Determine the channel capacity and design various block coding techniques to combat channel errors

CO4: Construct convolutional coders and analyze the performance of different decoding techniques.

CO5: Describe the basics of OFDM as a multicarrier communication and CDMA as a multiuser communication technique.

TOTAL:45 PERIODS

REFERENCES:

1. John G. Proakis and Masoud Salehi “Digital Communication”, Fifth Edition, Mc Graw Hill Publication, 2014.
2. Simon Haykin, “Digital communication Systems”, John Wiley and sons, 2014.
3. Bernard Sklar and Pabitra Kumar Ray, “Digital Communications Fundamentals & Applications”, second edition, Pearson Education, 2009.
4. Lathi B P and Zhi Ding, “Modern Digital and Analog communication Systems”, Oxford University Press, 2011.
5. Richard Van Nee & Ramjee Prasad, “OFDM for Multimedia Communications” Artech House Publication, 2001.
6. Theodore S.Rappaport, ‘Wireless Communications’, 2nd edition, Pearson Education,2002.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	-	3	3	1	1

2	2	-	3	3	1	1
3	3	-	3	3	1	2
4	3	-	3	3	1	2
5	3	-	3	2	1	2
Avg	(13/5)=2.6	-	(15/5)=3	(14/5)=2.8	(5/5)=1	(8/5)=1.6

EL4161

**DIGITAL COMMUNICATION SYSTEMS
LABORATORY**

**L T P C
0 0 3 1.5**

COURSE OBJECTIVES:

- To study & measure the performance of digital communication systems.
- To provide a comprehensive knowledge of Wireless Communication.
- To learn about the design of digital filter and its adaptive filtering algorithms.

LIST OF EXPERIMENTS (MATLAB/SCILAB/CABVIEW)

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

1. Generation & detection of binary digital modulation techniques using SDR
2. Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS.
3. MIMO system transceiver design using MATLAB/SCILAB/LABVIEW
4. Performance evaluation of simulated CDMA system
5. Channel Coder/decoder design (block codes / convolutional codes/ turbo codes)
6. OFDM transceiver design using MATLAB /SCILAB/LABVIEW
7. Channel equalizer design using MATLAB (LMS, RLS algorithms)
8. Design and Analysis of Spectrum Estimators (Bartlett, Welch) using MATLAB
9. BER performance Analysis of M-ary digital Modulation Techniques (coherent & non coherent) in AWGN Environment using MATLAB/SCILAB/LABVIEW
10. Design and performance analysis of Lossless Coding Techniques - Huffman Coding and Lempel Ziv Algorithm using MATLAB/SCILAB/LABVIEW
11. Noise / Echo cancellation using MATLAB (LMS / RLS algorithms).
12. Study of synchronization (frame, bit, symbol.)
13. Wireless channel characterization.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon the completion of course, students are able to

- Implement the adaptive filtering algorithms
- Generate and detect digital communication signals of various modulation techniques using MATLAB.
- Evaluate cellular mobile communication technology and propagation model.
- Apply mathematical formulation to analyze spectrum estimation of a signal and bit rate determination of a transmission link
- Analyze the performance of optimization algorithms for equalizing the channel or noise/echo cancellation
- Able to design synchronization algorithm for Digital Communication systems

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	3	2	3	2	1
2	2	3	2	3	2	1
3	3	3	2	3	3	2
4	2	3	2	2	3	1
5	2	3	2	2	3	1
Avg	2	3	1	1	3	1
	(13/6)=2.16	(18/6)=3	(11/6)=1.83	(14/6)=2.3	(14/6)=2.3	(7/6)=1.1

II4111

APPLICATION SOFTWARE AND SIMULATION LABORATORY

**L T P C
0 0 3 1.5**

COURSE OBJECTIVE:

- To develop skills in writing programs and simulation of experiments.

Programming and Simulation for laboratory experiments and Industrial Applications to be performed (10 to 14 experiments)

1. Generation of standard discrete time deterministic and random signals using simulation tools
2. Generation and detection of digital modulation techniques using simulation tools
3. Bit Error Rate Analysis of different modulation scheme in AWGN and Rayleigh fading environments using simulation tools
4. Outage Analysis of communication system in AWGN and Rayleigh fading environments using simulation tools
5. Communication system analysis using Universal Software Radio Platform
6. Design of electronic circuits for the given application and analyze its performance using simulation tools
7. Design and Testing of electronic circuits for the given application using simulation tools
8. Design and simulation of Potential Distribution/Field of the MOSFET using finite difference method.
9. Design and simulation of P-Channel and N-Channel MOSFET
10. Implementing Data communication with WIFI module
 - i. Analog sensor monitoring
 - ii. Digital input monitoring
11. Implementing IOT with sensors monitoring
 - i. Analog sensor monitoring
 - ii. Digital input monitoring
12. Implementing IOT with actuator control
 - i. ON-OFF control
 - ii. Analog control

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to

CO1:To design, simulate, test and analyze electronic circuits/systems for given specifications/applications

CO2:To design and simulate experiments and industrial applications based on communication systems using simulation tools

CO3:To simulate experiments using available hardware and tools and implement them

II4201

ASIC AND FPGA DESIGN

L T P C

3 0 0 3

COURSE OBJECTIVES:

The students will be able to

- study the design flow of different types of ASIC.
- familiarize the different types of programming technologies and logic devices.
- learn the architecture of different types of FPGA.
- gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC

UNIT I OVERVIEW OF ASIC AND PLD

9

Types of ASICs - Design flow – CAD tools used in ASIC Design – Programming Technologies: Antifuse – static RAM – EPROM and EEPROM technology, Programmable Logic Devices: ROMs and EPROMs – PLA –PAL. Gate Arrays – CPLDs and FPGAs

UNIT II ASIC PHYSICAL DESIGN

9

System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning - placement – Routing: global routing - detailed routing - special routing - circuit extraction - DRC

UNIT III LOGIC SYNTHESIS, SIMULATION AND TESTING

9

Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language - PLA tools -EDIF- CFI design representation. Verilog and logic synthesis -VHDL and logic synthesis - types of simulation - boundary scan test - fault simulation - automatic test pattern generation.

UNIT IV FIELD PROGRAMMABLE GATE ARRAYS

9

FPGA Design: FPGA Physical Design Tools -Technology mapping - Placement & routing - Register transfer (RT)/Logic Synthesis - Controller/Data path synthesis - Logic minimization.

UNIT V SOC DESIGN

9

System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies: Canonical Signed Digit Arithmetic, Knowledge Crunching Machine, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.

COURSE OUTCOMES:

The students will be able to

CO1:analyze the synthesis, Simulation and testing of systems.

CO2:apply different high performance algorithms in ASICs.

CO3:discuss the design issues of SOC.

TOTAL: 45 PERIODS

REFERENCES:

1. David A.Hodges, Analysis and Design of Digital Integrated Circuits (3/e), MGH 2004
2. H.Gerez, Algorithms for VLSI Design Automation, John Wiley, 1999
3. Jan.M.Rabaey et al, Digital Integrated Circuit Design Perspective (2/e), PHI 2003
4. J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley& Sons, New York.
5. M.J.S. Smith : Application Specific Integrated Circuits, Pearson, 2003
6. P.K.Chan& S. Mourad, Digital Design using Field Programmable Gate Array, Prentice Hall.
7. Sudeep Pasricha and NikilDutt, On-Chip Communication Architectures System on Chip Interconnect, Elsevier, 2008
8. S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Pub.

II4202

WIRELESS COMMUNICATION AND NETWORKING

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the characteristics of wireless channels and the fundamental limits on the capacity of wireless channels
- Understand various types of local area networks, WiMax and wide area networks.
- Understand various wireless networking standards such as 3G and 4G.
- To interwork between WLAN and WWAN.
- To have a good understanding of emerging wireless networks such as Adhoc, Sensor networks and cooperative wireless networks.

UNIT I THE WIRELESS CHANNEL

9

Overview of wireless systems – Physical modeling for wireless channels – Time and Frequency coherence – Statistical channel models – Capacity of wireless Channel- Capacity of Flat Fading Channel — Channel Distribution Information known – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver – Capacity with Receiver diversity – Capacity comparisons – Capacity of Frequency Selective Fading channels.

UNIT II 3G EVOLUTIONS

9

IMT-2000 - W-CDMA, CDMA 2000 – radio & network components, network structure, packet-data transport process flow, Channel Allocation, core network, interference-mitigation techniques, UMTS-services, air interface, network architecture of 3GPP, UTRAN – architecture, High Speed Packet Data-HSDPA,HSUPA.

UNIT III 4G AND BEYOND

9

Introduction to LTE-A – Requirements and Challenges, network architectures – EPC, E- UTRAN architecture - mobility management, resource management, services, channel - logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure.

UNIT IV 5G COMPONENTS 9

Introduction to WLAN – IEEE 802.11 and HIPERLAN, Bluetooth, WiMAX. Characteristics of MANETs, Table-driven and Source-initiated On Demand routing protocols, Hybrid protocols, Wireless Sensor networks- Classification, MAC and Routing protocols.

UNIT V INTERWORKING CONCEPTS AND COOPERATIVE WIRELESS NETWORKS 9

Interworking objectives and requirements, Schemes to connect WLANs and 3G Networks, Session Mobility, Interworking Architectures for WLAN and GPRS. Introduction to User cooperation and cognitive systems- Relay channels- A general three node relay channel- Wireless relay channel- User cooperation in wireless networks- Two user cooperative network

TOTAL :45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, student will be able to

CO1: Understand the concepts of wireless LAN, WAN and various wireless standards.

CO2: Work with different wireless networks.

CO3: Familiarize with advanced wireless networks such as Adhoc, Sensor networks and cooperative wireless networks.

REFERENCES:

1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
2. Cognitive Radio Communication and Networks- Alexander M. Wyglinski published by Academic Press December 2009.
3. Clint Smith, P.E, Dannel Collins, "3G Wireless Networks" 2nd edition, Tata McGraw-Hill, 2008.
4. Jochen H. Schiller, "Mobile Communications", 2/e, Pearson, 2014.
5. Kaveh Pahlavan, "Principles of wireless networks", Prentice-Hall of India, 2008.
6. Sassan Ahmadi, "LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies", Elsevier, 2014.
7. Sumit Kaspera and Nishit Narang, "3G Networks – Architecture, Protocols and Procedures", Tata McGraw Hill, 2007.
8. Vijay K. Garg, "Wireless Network Evolution- 2G & 3G" Pearson, 2013.

II4203

ADVANCED IN INTERNET OF THINGS

L T P C

3 0 0 3

OBJECTIVES:

- To understand the fundamentals of Internet of Things
- To learn about the basics of IoT protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario.

UNIT I INTRODUCTION TO IoT 9

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT II	IoT ARCHITECTURE	9
M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture		
UNIT III	IoT PROTOCOLS	9
Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP – Security		
UNIT IV	BUILDING IoT WITH RASPBERRY PI & ARDUINO	9
Building IOT with RASPBERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.		
UNIT V	ADVANCED INTERNET OF THINGS	9
Smart Convergent technologies for IoT- SDN and NFV for IoT- The impact of IoT in 5G Mobile Communication- Fog Computing and Internet of Things- Big data Analytics in IoT- Energy harvesting and Power Management for IoT-Wearable Computing and Mixed reality and Internet of Everything- Privacy and Security in IoT- The world of future – Internet of Everything		

TOTAL : 45 PERIODS

OUTCOMES

Upon completion of this course, the students should be able to:

- Analyze various protocols for IoT
- Develop web services to access/control IoT devices.
- Design a portable IoT using Raspberry Pi
- Deploy an IoT application and connect to the cloud.
- Analyze applications of IoT in real time scenario

REFERENCES:

1. Arshdeep Bahga, Vijay Madiseti, “Internet of Things – A hands-on approach”, Universities Press, 2015
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
3. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.
4. Jan Ho“ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things –Key applications and Protocols”, Wiley, 2012
6. Mike Miller, The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World, Que Publishing, 2015
7. Dr. John Bates , “Thingalytics - Smart Big Data Analytics for the Internet of Things”, John Bates, 2015.
8. Practical Internet of Things Security (Kindle Edition) by Brian Russell, Drew Van Duren, 2016

9. Fog Computing and Its Role in the Internet of Things, Flavio Bonomi, Rodolfo Milito, Jiang Zhu, Sateesh Addepalli, MCC'12, August 17, 2012, Helsinki, Finland. Copyright 2012 ACM 978-1-4503-1519-7/12/08... \$15.00.
10. Fundamentals of Wearable Computers and Augmented Reality, Second Edition by Woodrow Barfield 2015
11. Mohammad Ayoub Khan, "Internet of Things: A Hardware Development Perspective", CRC Press, 2022

MP4291

CYBER PHYSICAL SYSTEMS

L T P C

3 0 2 4

COURSE OBJECTIVES:

- To learn about the principles of cyber-physical systems
- To familiarize with the basic requirements of CPS.
- To know about CPS models
- To facilitate the students to understand the CPS foundations
- To make the students explore the applications and platforms.
- To provide introduction to practical aspects of cyber physical systems.
- To equip students with essential tools to implement CPS.

UNIT I INTRODUCTION TO CYBER-PHYSICAL SYSTEMS 6

Cyber-Physical Systems(CPS)-Emergence of CPS, Key Features of Cyber-Physical Systems,, CPS Drivers-Synchronous Model : Reactive Components, Properties of Components, Composing Components, Designs- Asynchronous Model of CPS: Processes, Design Primitives, Coordination Protocols

UNIT II CPS - REQUIREMENTS 12

Safety Specifications: Specifications, Verifying Invariants, Enumerative Search, Symbolic Search- Liveness Requirements: Temporal Logic, Model Checking, Proving Liveness

UNIT III CPS MODELS 9

Dynamical Systems: Continuous, Linear Systems-Time Models, Linear Systems, Designing Controllers, Analysis Techniques- Timed Model: Processes, Protocols, Automata- Hybrid Dynamical Models

UNIT IV CPS FOUNDATIONS 9

Symbolic Synthesis for CPS- Security in CPS-Synchronization of CPS-Real-Time Scheduling for CPS

UNIT V APPLICATIONS AND PLATFORMS 9

Medical CPS- CPS Built on Wireless Sensor Networks- CyberSim User Interface- iClebo Kobuki - iRobot Create- myRIO- Cybersim- Matlab toolboxes - Simulink.

LIST OF EXPERIMENTS (30)

1. Installation of Xilinx SDK, LABVIEW, MatLab and Cybersim
2. Installation of, myRIO iRobot Create Wiring, Kobuki Wiring
3. CPS DDesign with the iRobot Create
4. CPS Design with the Kobuki.
5. Write a program in MATLAB to implement open loop system stability.

6. Write a program in MATLAB to implement timed automation.

COURSE OUTCOMES:

CO1: Explain the core principles behind CPS

CO2: Discuss the requirements of CPS.

CO3: Explain the various models of CPS.

CO4: Describe the foundations of CPS.

CO5: Use the various platforms to implement the CPS.

TOTAL: 45+30=75 PERIODS

REFERENCES

1. Raj Rajkumar, Dionisio De Niz , and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional, 2016
2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
3. Lee, Edward Ashford, and Sanjit Arunkumar Seshia. Introduction to embedded systems: A cyber physical systems approach. 2nd Edition, 2017
4. André Platzer, Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics., Springer, 2010. 426 pages,ISBN 978-3-642-14508-7.
5. Jean J. Labrosse, Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C, The publisher, Paul Temme, 2011.
6. Jensen, Jeff, Lee, Edward, A Seshia, Sanjit, An Introductory Lab in Embedded and Cyber-Physical Systems, <http://leeseshia.org/lab>, 2014.
7. documentation | KOBUKI (yujinrobot.com)

II4211

INTERNET OF THINGS APPLICATIONS LABORATORY

**L T P C
0 0 4 2**

OBJECTIVES: The students will be able to

- Understand concepts of IoT and Cyber Physical Systems

LIST OF EXPERIMENTS:

Internet of Things Applications using the following experiments:

- Raspberry Pi – GPIO and Cloud
- Design and Develop Cloud based master and slave systems using Internet
- Explore different communication methods with IoT devices.
- To interface LED/Buzzer with platform/ Aurdino /Raspberry Pi. and write an embedded C program to turn on / off LED/Buzzer with specified delay
- To interface DC/stepper motor using relay with open platform/ Aurdino /Raspberry Pi and write an embedded C program to turn on motor if push button is pressed.
- Develop simple application – testing infrared sensor – IoT Applications – using open platform/Raspberry Pi.

- Develop simple application to interface with DHT11 sensor and write a program to display temperature humidity readings in LCD.
- Implement IoT with sensors monitoring : Analog sensor monitoring, Digital input monitoring
- Implement IoT with actuator control : ON-OFF control, Analog control
- Develop Internet of Medical Things(IoMT) Application using open platform/ Aurdino. /Raspberry Pi and sensors such as temperature, ECG, Pulse etc.
- Deploy IoMT applications using platforms.
- Electromechanical modelling of QUBE Servo Inertia Disk system
- Analysis of Physical system with RIO hardware integration (Step response, time domain, stability)
- Mathematical modelling of Second-order system with PID Controller design control
- Mathematical modelling of Pendulum system and design a balance control and swing- up control

OUTCOMES: The students will be able to

- Develop IoT and Cyber Physical System based Real Time Applications

II4212

TERM PAPER WRITING AND SEMINAR

**L T P C
0 0 2 1**

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.
Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2 nd week	3 % Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	<ol style="list-style-type: none"> 1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area. 	3 rd week	3% (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	<ul style="list-style-type: none"> • You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: <ul style="list-style-type: none"> • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered 	4 th week	6% (the list of standard papers and reason for selection)
Reading and notes for first 5 papers	Reading Paper Process <ul style="list-style-type: none"> • For each paper form a Table answering the following questions: 	5 th week	8% (the table given should indicate your

	<ul style="list-style-type: none"> • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? <p>Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)</p>		understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next 5 papers	Repeat Reading Paper Process	6 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7 th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8 th week	8% (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9 th week	6% (Clarity, purpose and conclusion) 6% Presentation & Viva Voce

Introduction Background	Write an introduction and background sections	10 th week	5% (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11 th week	10% (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12 th week	5% (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13 th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14 th & 15 th week	10% (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

II4301

ROBOTICS AND AUTOMATION

L T P C

3 0 0 3

OBJECTIVES:

The students will be able to

- understand the basics of robotics for industrial needs
- understand how to select robotics according to different applications
- analyse material handling techniques

UNIT I INTRODUCTION:

7

Types of industrial robots - Load handling capacity - general considerations in Robotic material handling - material transfer - machine loading and unloading - CNC machine tool loading, Robot centered cell- robots for Industrial automation.

UNIT II ROBOTS FOR INSPECTION:

9

Robotic vision systems - image representation - object recognition and categorization - depth measurement - image data compression - visual inspection - software considerations. Application of Robots in Spray painting, assembly operation, cleaning - robot for underwater applications.

UNIT III END EFFECTORS:

10

Gripper force analysis and gripper design for typical applications - design of multiple degrees of freedom - active and passive grippers - Forward and inverse kinematics, DH matrices and Trajectory control.

UNIT IV SELECTION OF ROBOT**10**

Factors influencing the choice of a robot - robot performance testing - economics of robotisation
- Impact of robot on industry and society.

UNIT V MATERIAL HANDLING:**9**

Concepts of material handling - principles and considerations in material handling systems design
- conventional material handling systems - industrial trucks, monorails, rail guided vehicles,
conveyor systems, cranes and hoists - advanced material handling systems - automated guided
vehicle systems - automated storage and retrieval systems(ASRS) - bar code
technology - radio frequency identification technology.

TOTAL: 45 PERIODS**OUTCOMES: The students will be able to**

- assemble basic robot for industrial automation
- select robots for industrial applications
- use robots for material handling

REFERENCES:

1. Richard D Klafter, Thomas Achmielewski and MickaelNegin, —Robotic Engineering – An integrated Approachll Prentice HallIndia, New Delhi, 2001.
2. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, 2015.
3. James A Rehg, —Introduction to Robotics in CIM Systemsll, Prentice Hall of India, 2002.
4. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994.

EL4391**OPTICAL NETWORKS****L T P C
3 0 0 3****COURSE OBJECTIVES:**

- Understand the concepts of optical components and networks.
- To gain an understanding of various issues in designing a high speed, and huge bandwidth optical network.
- To acquire knowledge of architecture and standards of optical networks.
- Thorough knowledge about the routing and access mechanism in optical networks.
- Thorough understanding of the scientific and engineering principles underlying the photonics technology.

UNIT I OPTICAL SYSTEM COMPONENTS**9**

Light propagation in optical fibers-Loss & Bandwidth, System limitations, Non-Linear effect, Solitons, Optical Network Components- Couplers, Isolators & Circulators, Multiplexers & Filters Optical Amplifiers, Switches, Wavelength Converters.

UNIT II OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks; WDM networks , SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks- Topologies for Broadcast Networks, Media-Access Control Protocols, Wavelength Routing Architecture. WOBAN and OTDM networks. Introduction to ASON.

UNIT III WAVELENGTH ROUTING NETWORKS 9

The Optical layer, Node Designs, Optical layer cost tradeoff, Routing and Wavelength Assignment algorithms, Virtual Topology design, Architectural variations

UNIT IV PACKET SWITCHING AND ACCESS NETWORKS 9

Photonic Packet Switching – OTDM , Multiplexing and Demultiplexing, Synchronization, Broadcast OTDM networks, Switch based networks; Access Networks- Network Architecture overview , Future Access Networks, Optical Access Network Architectures.

UNIT V NETWORK DESIGN AND MANAGEMENT 9

Transmission system Engineering-system model, Power penalty-transmitter, receiver, Optical amplifiers, crosstalk, dispersion, wavelength stabilization; overall design consideration; Control and Management-Network management functions, Configuration management, Performance management, Fault management. Optical safety, Service interface.

COURSE OUTCOMES:

On completion of the course the student will be

CO1:able to-design state-of-the-art optical networks.

CO2: able to implement optical network protocols.

CO3: able to design high speed networks using optical fibers

CO4: able to simulate access network

CO5: able to design the optical network infrastructure and network management methods.

TOTAL: 45 PERIODS

REFERENCES

1. Rajiv Ramaswami and Kumar N.Sivarajan, "Optical Networks: A Practical Perspective ", Harcourt Asia Pvt Ltd., Second Edition 2004.
2. C.Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks: Concept, Design and Algorithms", PHI, 1st Edition, 2002.
3. P.E.Green, jr., "Fiber Optical Networks", Prentice Hall, New Jersey, 1993.
4. Optical Networks: Third Generation Transport Systems, Prentice Hall, 2002.
5. Martin Maier, "Optical Switching Networks", Cambridge India, 2014.

NE4251

NETWORK SECURITY

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the fundamentals of cryptography and its application to network security.
- To understand the mathematics behind cryptography.
- To learn about the security issues in internet protocol.
- To understand the security issues in other layers
- To study about intrusion detection and prevention system and wireless hacking.

UNIT I INTRODUCTION TO NETWORK SECURITY 9

Security Services and Mechanisms – Vulnerabilities in wireless communications –security basics – Attack and its types Security essentials on layers - Electronic signatures – PKI and electronic certificate

UNIT II SYMMETRIC AND ASYMMETRIC CIPHERS 9

Classical Techniques – Substitution Ciphers - Transposition Ciphers. Modern symmetric ciphers : Stream cipher - RC4, Block cipher - DES – AES – Uses of Modes of operation. Modern Asymmetric block ciphers - RSA, ElGamal., MAC – Cryptographic Hash Functions- Key management system- Key Distribution & Key Agreements.

UNIT III SECURITY ISSUES IN INTERNET PROTOCOL 9

Reconnaissance-Wireshark- TCPDump - Netdiscover - Shodan ,NESSUS,Hping3 NSE Scripts: Introduction - How to write and read NSE script - TCP session Hijacking - UDP session Hijacking -HTTP Session – Hijacking - Spoofing basics - IP, DNS and ARP Spoofing

UNIT IV SECURITY IN OTHER LAYERS 9

EMail Security and its services – PGP - S/MIME – DNS Security - VPN Concept and its configuration - AAA Concept, RADIUS, TACACS+ technologies, SSL architecture and protocol.

UNIT V INTRUSION DETECTION AND PREVENTION SYSTEM(IDPS) AND WIRELESS HACKING 9

IDPS introduction - Uses of IDPS Technologies - Key functions of IDPS Technologies , Signature Based Detection , Anomaly Based Detection - Wireless networks - WPA Handshaking - Wireless hacking tools.

COURSE OUTCOMES:

CO1: To design cryptographic algorithms and carry out their implementation.

CO2: To carry out cryptanalysis on cipher.

CO3: To be able to design and implement security based internet protocols.

CO4: To carry out system security for other layers.

CO5: To understand the importance of intrusion detection and prevention system and wireless hacking.

TOTAL PERIODS: 45

REFERENCES

1. Behrouz A. Ferouzan, Debdeep Mukhopadhyay —Cryptography & Network Security, 3rd edition, Tata McGraw Hill, 2015.
2. William Stallings "Network Security Essentials Applications and Standards", Pearson Education., 5th Edition, 2014.
3. Ryan Russell, " Hack Proofing your network ", Wiley,2nd Edition,2002.
4. David M. Durton, "Elementary Number Theory", Tata McGraw Hill, Sixth Edition, 2009.
5. Jonathan Katz, Yehuda Lindell, "Introduction to Modern Cryptography: Principles and Protocols (Chapman & Hall/CRC Cryptography and Network Security Series)", 1st Edition , CRC Press Taylor and Francis Group, 2008.
6. Douglas R. Stinson," Cryptography: Theory and Practice, Third Edition (Discrete Mathematics and Its Applications), Chapman & Hall/CRC, 2005.

COURSE OBJECTIVES:

- To give the knowledge of soft computing theories fundamentals
- To provide the mathematical background for carrying out the optimization associated with neural network learning
- To familiarize the ideas of fuzzy sets, fuzzy logic, use of heuristics and Fuzzy Logic Control Systems
- To introduce the mathematical background for genetic algorithms
- To expose the hybrid soft computing systems and its applications

UNIT I SOFT COMPUTING FUNDAMENTALS 9

Introduction: Soft Computing Constituents – From Conventional AI to Computational Intelligence – Applications - Introduction, characteristics- learning methods - taxonomy - Evolution of neural networks - Artificial Neural Network (ANN): Fundamental Concept – Basic Terminologies – Neural Network Architecture – Learning Process – Fuzzy logic: Introduction – crisp - sets- fuzzy sets - crisp relations and fuzzy-relations: Cartesian product

UNIT II NEURAL NETWORKS 9

Fundamental Models of ANN: McCulloch- Pitts Model –Hebb Network – Linear Separability Pitts Model –Hebb Network - Supervised Learning Networks: Perceptron Network – Adaline and Madaline Networks – Back Propagation Network – Radial Basis Function Network - Unsupervised Learning Networks: Kohonen Self Organizing Network – ART network - Hopfield Network - Special Network– Support Vector Machine- Kernel methods for Pattern classification- Kernel methods for function optimization.

UNIT III FUZZY COMPUTING AND MODELING 9

Fuzzy Equivalence and Tolerance Relation – Value assignments- Fuzzy Composition- Membership Functions–Fuzzification- Defuzzification: lambda cuts - Fuzzy Arithmetic – Extension Principle – Fuzzy Measures –Fuzzy Classification – Fuzzy Rules and Fuzzy Reasoning: Fuzzy Propositions – Formation of Rules – Decomposition of Rules – Aggregation of Rules – Approximate Reasoning – Fuzzy Inference and Expert Systems – Fuzzy Decision Making – Fuzzy Logic Control Systems.

UNIT IV GENETIC ALGORITHM AND APPLICATIONS 9

Genetic Algorithm: Fundamental Concept – Basic Terminologies – Traditional Vs Genetic Algorithm - Elements of GA - Encoding - Fitness Function – Genetic Operators: Reproduction – CrossOver - Inversion and Deletion - Mutation – Simple and General GA - The Schema Theorem- difference between GA and GP- Applications of GA. Multi-objective Optimization- Real-life case studies - optimization of traveling salesman problem using genetic algorithms

UNIT V HYBRID SOFT COMPUTING AND APPLICATIONS 9

Case Studies: Neuro-fuzzy Hybrid system- genetic neuro hybrid systems - genetic fuzzy hybrid and fuzzy genetic hybrid systems - simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images with SAR - Knowledge Leverage Based TSK Fuzzy System Modeling - Fuzzy C-Means algorithms for very large Data. Hybrid GA for Feature Selection- Multiobjective Genetic Fuzzy Clustering for pixel classification- Clustering Wireless Sensor Network Using Fuzzy Logic and Genetic Algorithm

COURSE OUTCOMES:

After completion of the course, the student will be able to:

CO1: Apply various soft computing concepts for practical applications

CO2: Choose and design suitable neural network for real time problems

CO3: Use fuzzy logic rules and reasoning to handle uncertainty and develop decision making and expert system

CO4: Describe the importance of genetic algorithms for solving combinatorial optimization problems

CO5: Analysis the various hybrid soft computing techniques and apply in real time problems

TOTAL: 45 PERIODS

REFERENCES:

1. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley, Second Edition, 2011.
2. S. Rajasekaran, G.A.V Vijayalakshmi Pai, "Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications" Prentice Hall, Second Edition, 2017.
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications, 4th Edition, Wiley 2016.
4. David E. Goldberg, Genetic Algorithm in Search Optimization and Machine Learning Pearson Education India, 2013.
5. Simon Haykin, Neural Networks Comprehensive Foundation Third Edition, Pearson Education, .2016.
6. James A. Freeman, David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education India, 2011.
7. J. -S. R. Jang, C.-T. Sun, E. Mizutani, "Neuro Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Pearson, 2015.

II4092

SYSTEM ON CHIP

L T P C

3 0 0 3

OBJECTIVE:

- To introduce architecture and design concepts underlying system on chips.
- Students can gain knowledge of designing SoCs.
- To impart knowledge about the hardware-software design of a modest complexity chip all the way from specifications, modeling, synthesis and physical design.

UNIT I SYSTEM ARCHITECTURE: OVERVIEW

9

Components of the system – Processor architectures – Memory and addressing – system level interconnection – SoC design requirements and specifications – design integration – design complexity – cycle time, die area and cost, ideal and practical scaling, area-time-power tradeoff in processor design, Configurability.

UNIT II PROCESSOR SELECTION FOR SOC

9

Overview – soft processors, processor core selection. Basic concepts – instruction set, branches, interrupts and exceptions. Basic elements in instruction handling – Minimizing pipeline delays – reducing the cost of branches – Robust processors – Vector processors, VLIW processors, Superscalar processors.

UNIT III MEMORY DESIGN**9**

SoC external memory, SoC internal memory, Scratch pads and cache memory – cache organization and write policies – strategies for line replacement at miss time – split L- and Dcaches – multilevel caches – SoC memory systems – board based memory systems – simpleprocessor/memory interaction.

UNIT IV INTERCONNECT ARCHITECTURES AND SOC CUSTOMIZATION**9**

Bus architectures – SoC standard buses – AMBA, CoreConnect – Processor customization approaches – Reconfigurable technologies – mapping designs onto reconfigurable devices - FPGA based design – Architecture of FPGA, FPGA interconnect technology, FPGA memory, Floor plan and routing.

UNIT V FPGA BASED EMBEDDED PROCESSOR**9**

Hardware software task partitioning – FPGA fabric Immersed Processors – Soft Processors and Hard Processors – Tool flow for Hardware/Software Co-design – Interfacing Processor with memory and peripherals – Types of On-chip interfaces – Wishbone interface, Avalon Switch Matrix, OPB Bus Interface, Creating a Customized Microcontroller - FPGA-based Signal Interfacing and Conditioning.

TOTAL:45 PERIODS**OUTCOMES:**

Upon successful completion of the program the students shall

CO1: Explain all important components of a System-on-Chip and an embedded system, i.e.

CO2: digital hardware and embedded software;

CO3: Outline the major design flows for digital hardware and embedded software;

CO4: Discuss the major architectures and trade-offs concerning performance, cost and power

CO5: consumption of single chip and embedded systems;

REFERENCES:

- Wayne Wolf, "Modern VLSI Design – System – on – Chip Design", Prentice Hall, 3rd Edition, 2008.
- Wayne Wolf, "Modern VLSI Design – IP based Design", Prentice Hall, 4th Edition, 2008

II4091**INDUSTRY 4.0**

L	T	P	C
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OBJECTIVES:

The students will be able to

- understand Industry 4.0
- apply IoT and IIoT for Industry 4.0
- understand CPS for Industry 4.0

UNIT I**9**

Introduction to Industry 4.0 The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - Comparison of

Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

UNIT II **9**

Road to Industry 4.0 - Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics

UNIT III **9**

System, Technologies for enabling Industry 4.0–Cyber Physical Systems - Robotic Automation and Collaborative Robots - Support System for Industry 4.0 - Mobile Computing - Cyber Security

UNIT IV **9**

Role of data, information, knowledge and collaboration in future organizations - Resource- based view of a firm - Data as a new resource for organizations - Harnessing and sharing knowledge in organizations - Cloud Computing Basics -Cloud Computing and Industry 4.0

UNIT V **9**

Industry 4.0 IIoT case studies - Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world – Society 5.0

OUTCOMES:

The students will be able to

CO1:use Industry 4.0 for Industrial Applications

CO2:use IoT and IIoT for Industry 4.0

CO3:apply smart devices Industrial Applications

TEXT BOOKS

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things
2. Arsheep Bahga, Internet of Things: A Hands-On Approach

II4001

BROADBAND ACCESS TECHNOLOGIES

L	T	P	C
3	0	0	3

OBJECTIVES:

The students will be able to

- explain fundamental concepts related to broadband access technologies.
- understand the current and emerging wired and wireless access technologies.
- acquire knowledge about cable modems and fiber access technologies.
- have an exposure to different systems standards for next generation broadband access networks.

UNIT I **REVIEW OF ACCESS TECHNOLOGIES** **5**

Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless, Standards for access network.

UNIT II	DIGITAL SUBSCRIBER LINES	10
Asymmetric Digital subscriber lines (ADSL) – Rate Adaptive subscriber line (RADSL)-ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)-Single line DSL (SDSL) - very high bit rate DSL (VDSL) - Standards for XDSL & Comparison.		
UNIT III	CABLE MODEM	10
Cable Modem, DOCSIS – Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation – Downstream operation – Access control – framing Security sub layer – Data link layer – LLC & Higher layers – ATM centric VS IP – centric cable modem.		
UNIT IV	FIBER ACCESS TECHNOLOGIES	10
Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison, Broadband PON , Gigabit-Capable PON.		
UNIT V	BROAD BAND WIRELESS	10
Fixed Wireless, Direct Broadcast Satellite (DBS), Multi channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G – IMT 2000 - Introduction to LTE-A.		
		TOTAL : 45 PERIODS
OUTCOMES: The students will be able to		
to design systems meeting out the requirements of the recent standards.		
<ul style="list-style-type: none"> • meet out the industry requirements for man power in next generation networks. • contribute towards the enhancement of the existing wireless technologies. 		
REFERENCES:		
<ol style="list-style-type: none"> 1. Dennis J. Rauschmayer, "ADSL/VDSL Principles: A Practical and Precise Study of Asymmetric Digital Subscriber Lines and Very High Speed Digital Subscriber Lines", Macmillan Technology Series, 1998. 2. Gilbert Held, "Next Generation Modems: A Professional Guide to DSL and Cable Modems", John Wiley & Sons, 2000. 3. Leonid G. Kazovsky, Ning Cheng, Wei-Tao Shaw, David Gutierrez, Shing-Wa Wong, "Broadband Optical Access Networks", John Wiley and Sons, New Jersey, 2011. 4. Martin P. Clarke, "Wireless Access Network: Fixed Wireless Access and WLL Network Design and Operation", John Wiley & Sons 2000. 5. Niel Ransom and Albert A. Azzam, "Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS", McGraw Hill, 1999. 6. Sassan Ahmadi, "LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies", Elsevier, 2014. 7. Walter J Woralski, "ADSL and DSL Technologies", McGraw Hill Computer Communication Series, Second Edition Oct 2001. 8. William Webb, "Introduction to Wireless Local Loop Broadband and Narrow Band System", Mobile Communication Series, Artech House Publishers, Second Edition 2000. 		

OBJECTIVES:

- To understand smart antenna environments
- To learn channel models
- To learn algorithms for Multi target decision

UNIT I**9**

Spatial processing for wireless systems. Adaptive antennas. Beam forming networks. Digital radio receiver techniques and software radios.

UNIT II**9**

Coherent and non-coherent CDMA spatial processors. Dynamic re-sectoring. Range and capacity extension – multi-cell systems.

UNIT III**9**

Spatio – temporal channel models. Environment and signal parameters. Geometrically based single bounce elliptical model.

UNIT IV**9**

Optimal spatial filtering – adaptive algorithms for CDMA. Multi target decision – directed algorithm.

UNIT V**9**

DOA estimation – conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using eigen decomposition. Direction finding and true ranging PL systems. Elliptic and hyperbolic PL systems. TDOA estimation techniques.

TOTAL :45 PERIODS**OUTCOMES:**

- To compare algorithms for target decision
- To explain DOA estimation techniques

REFERENCES:

1. M.J. Bronzel, Smart Antennas, John Wiley, 2004. Recent literature in Smart Antennas.
2. R.Janaswamy, Radio Wave Propagation and Smart Antennas for Wireless Communication, Kluwer, 2001.
3. T.S.Rappaport&J.C.Liberti, Smart Antennas for Wireless Communication, Prentice Hall (PTR) , 1999.

COURSE OBJECTIVES:

- To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility
- To develop a theoretical understanding of electromagnetic shielding effectiveness
- To understand ways of mitigating EMI by using shielding, grounding and filtering
- To understand the need for standards and to appreciate measurement methods
- To understand how EMI impacts wireless and broadband technologies

UNIT I INTRODUCTION & SOURCES OF EM INTERFERENCE 9

Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment.

UNIT II EM SHIELDING 9

Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures

UNIT III INTERFERENCE CONTROL TECHNIQUES 9

Equipment screening - Cable screening - grounding - Power-line filters - Isolation - Balancing - Signal-line filters - Nonlinear protective devices.

UNIT IV EMC STANDARDS, MEASUREMENTS AND TESTING 9

Need for standards - The international framework - Human exposure limits to EM fields -EMC measurement techniques - Measurement tools - Test environments.

UNIT V EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES 9

Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications.

SUGGESTED ACTIVITIES:

1. Investigate various case studies related to EMIC. Example: Chernobyl Disaster in 1986.
2. Develop some understanding about the design of EM shields in electronic system design and packaging.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

- CO1:**Demonstrate knowledge of the various sources of electromagnetic interference
- CO2:**Display an understanding of the effect of how electromagnetic fields couple through apertures, and solve simple problems based on that understanding
- CO3:**Explain the EMI mitigation techniques of shielding and grounding
- CO4:**Explain the need for standards and EMC measurement methods
- CO5:**Discuss the impact of EMC on wireless and broadband technologies

TOTAL:45 PERIODS

REFERENCES

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.
2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition, 2008.
3. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition, 2010.
4. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, New York, 2009.
5. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley & Sons Inc., Wiley Interscience Series, 1997.

II4003 HEALTH CARE TECHNOLOGIES AND INTERNET OF MEDICAL THINGS LT PC
3 0 03

OBJECTIVES:

The students will be able to

- know the principles and applications of biomedical devices
- comprehend the basics of healthcare technologies
- understand the applications of computer in medicine
- comprehend the telemedicine technology
- understand the applications of IoT for medical field and IoMT

UNIT I BIOMEDICAL TRANSDUCERS AND AMPLIFIERS 9

Introduction to Anatomy & Physiology of Human Body- Categories and Characteristics of Transducer - Signal conditioning units - Multichannel data acquisition system - various types recorders - necessity for low noise pre amplifiers - Difference amplifier - Chopper amplifier - Different types of electrode and its equivalent circuits.

UNIT II BIOPOTENTIAL RECORDING & MEASUREMENTS 9

ECG, EEG, EMG, PCG, EOG, ERG lead system and recording methods - typical waveform - frequency spectrum - abnormal waveform.

NON ELECTRICAL PARAMETER MEASUREMENTS : Respiration rate - Pulse rate - Temperature - Blood Pressure - O₂, CO₂ measurements - Respiratory volume measurement - BMR measurement - Plethysmography technique - Impedance technique - Bipolar and Tetra polar circuits - Detection of various physiological parameters using impedance technique - Blood Flow meter - Biochemical measurements.

UNIT III COMPUTER APPLICATIONS IN MEDICINE 9

Computer Applications in Medicine - ICT - Networking - Data Security and Standards: Encryption, Cryptography - Mechanisms of encryption - phases of Encryption. Realtime Telemedicine integrating doctors / Hospitals, Clinical laboratory data - Radiological data and other clinically significant biomedical data - Administration of centralized medical data - Medical Informatics - Medical Information System - security and confidentiality of medical records and access control - Cyber laws related to telemedicine.

UNIT IV TELEMEDICINE APPLICATIONS

9

Telemedicine - Tele radiology: Definition - Basic parts of teleradiology system: Image Acquisition system Display system - Tele pathology - multimedia databases - Medical information storage and management for telemedicine- patient information medical history - medical images diagnosis and treatment. Hospital information system - Telemedicine access to health care services – Introduction to robotics surgery - Telesurgery. Telecardiology – Teleoncology - Telemedicine in neurosciences – Mobile Telemedicine.

UNIT V CONNECTED HEALTH

9

E-Health – E-health services security and interoperability - Internet of Things (IoT) in Medical Field – Internet of Medical Things (IoMT) - Applications of IoMT – M- Health - Connected Health –Innovations in Healthcare Techs.

OUTCOMES:

By the completion of this course the student will to

Identify various functional blocks present in biosignal acquisition system

- Design the data acquisition system.
- Analyze different biopotential characteristics and recording methods of biosignals.
- Develop measurement systems by selecting different types of sensors, signal conditioning circuits for acquiring and recording various physiological parameters.
- Use the Applications of Computers in Medicine
- Differentiate the Protocols behind encryption techniques for secure transmission of data.
- Use the techniques, skills, and tools necessary for Telemedicine
- Apply new knowledge as needed in Connected Health including IoMT in healthcare

REFERENCES:

1. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer's, Biomedical Instrumentation and Measurements, Biomedical Instrumentation and Measurements, Prentice Hall, 2001
2. Joseph J Carr and John m Brown – Introduction to Biomedical equipment Technology Pearson Education 4th edition New Delhi 2001.
3. Webster J.G Medical Instrumentation application and design, John Wiley and sons New York 3rd edition 1999
4. Khandpur R.S, Hand Book of Biomedical Instrumentation – Tata Mc Graw Hill publication, New Delhi 2nd edition 2003
5. Bernard Fong, A.C.M. Fong, C.K. Li, Telemedicine Technologies: Information Technologies in Medicine and Telehealth, Wiley, 2011.
6. Magnuson, J.A., Fu, Jr., Paul C. (Eds.), Public Health Informatics and Information systems, ISBN 978-1-4471-4237-9, Springer, 2014
7. Norris, A.C. Essentials of Telemedicine and Telecare. Wiley, 2002.
8. Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006.
9. Teresa L. Thompson, Roxanne Parrott, Jon F. Nussbaum, TheRoutledge Handbook of Health Communication, Routledge, 2011.
10. Ahmed, Mobyen Uddin, Begum, Shahina, Fasquel, Jean-Baptiste (Eds.), Internet of Things (IoT) Technologies for HealthCare, Proceedings of 4th International Conference, HealthyIoT 2017, Angers, France, October 24-25, 2017.

II4004

COGNITIVE RADIO COMMUNICATIONS

L T P C

3 0 0 3

OBJECTIVES:

- To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
- To enable the student to understand the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.
- To expose the student to the evolving next generation wireless networks and their associated challenges.

UNIT I INTRODUCTION TO SDR

9

Definitions and potential benefits - software radio architecture evolution – foundations, technology tradeoffs and architecture implications - Antenna for Cognitive Radio.

UNIT II SDR ARCHITECTURE

9

Essential functions of the software radio - architecture goals - quantifying degrees of programmability - top level component topology - computational properties of functional components - interface topologies among plug and play modules, architecture partitions.

UNIT III INTRODUCTION TO COGNITIVE RADIOS

9

Marking radio self-aware, the cognition cycle - organization of cognition tasks - structuring knowledge for cognition tasks - Enabling location and environment awareness in cognitive radios – concepts, architecture, design considerations.

UNIT IV COGNITIVE RADIO ARCHITECTURE

9

Primary Cognitive Radio functions, Behaviors, Components, A-Priori Knowledge taxonomy, observe – phase data structures, Radio procedure knowledge encapsulation - components of orient, plan, decide phases, act phase knowledge representation, design rules.

UNIT V NEXT GENERATION WIRELESS NETWORKS

9

The XG Network architecture - spectrum sensing - spectrum management - spectrum mobility, spectrum sharing - upper layer issues - cross – layer design.

TOTAL: 45 PERIODS

OUTCOMES:

- The student would be able to appreciate the motivation and the necessity for cognitive radiocommunication strategies.
- The student would be able to evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.
- The student would be able to demonstrate the impact of the evolved solutions in future wireless network design.

REFERENCES:

1. Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, “Cognitive Radio Communications And Networks - Principles And Practice”, Elsevier Inc. , 2010.

2. Kwang-Cheng Chen and Ramjee Prasad, "Cognitive Radio Networks", John Wiley & Sons, Ltd, 2009.
3. Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, "Cognitive Radio Networks - From Theory to Practice", Springer Series: Analog Circuits and Signal Processing, 2009.
4. J. Mitola, "Cognitive Radio: An Integrated Agent Architecture for software defined radio", Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
5. Simon Haykin, "Cognitive Radio: Brain –empowered wireless communications", IEEE Journal on selected areas in communications, Feb 2005.
6. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, "NeXt generation /dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Computer Networks, May 2006.

IF4092

COMPUTER VISION

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- Articulate & apply standard computer vision concepts
- Implement standard image processing tasks
- Applying Clustering concept for Image Classification
- Identify practical constraints in computer vision application
- Architecture of an existing computer vision pipeline based on deep learning models

UNIT I COMPUTER VISION

8

About Computer Vision. Components of an Image Processing System. Image Resolution. Image Formats. Colour Spaces. Fundamental of Image Processing. Visual Inspection System. Biomedical Imaging Methods. Image Thresholding. Based Image Retrieval. Human Visual Inception. Image Formation. Geometric Properties. 3D Imaging. Stereo Images.

UNIT II PIXEL-BASED MANIPULATIONS & TRANSFORMATION

8

Visual properties. Pixel colour manipulation. Colour Change with Pixel Position. Colour Change with Pixel Distance. Colour Change with Trigonometric Functions. Randomness. Drawing with existing images. Blending multiple images. Image transformation. Image orientation. Image resizing. Affine transform. Known Affine Transformations. Unknown Affine Transformations. Perspective transform. Linear vs. polar coordinates. Three-dimensional space. General pixel mapping.

UNIT III STRUCTURE IDENTIFICATION

11

Image preparation. Conversion to grayscale. Conversion to a black-and-white image. Morphological operations (erode, dilate). Blur operations (smoothing) Edge detection. First Derivative Edge Detectors. Second Derivative Edge Detectors. Multispectral Edge Detection. Line detection. Circle detection. Contours processing. Finding the contours. Bounding box. Minimum area rectangle. Convex hull. Polygon approximation. Testing a point in contour. Checking intersection. Shape detection. Moravec Corner Detection. Harris Corner Detection. FAST Corner Detection. SIFT.

UNIT IV CLUSTERING IMAGES & IMAGE RETRIEVAL

9

About Transfer Learning. Extract features. SciPy Clustering Package. K-Means Clustering.

Clustering Images. Principal Components. Clustering Pixels. Hierarchical Clustering. Spectral Clustering. Fast Fourier Transforms. -Based Image Retrieval. Indexing Images. Searching the Database for Images. Querying with an Image. Benchmarking and Plotting the Results. Ranking Results Using Geometry.

UNIT V IMAGE CLASSIFICATION USING DEEP LEARNING

9

Working with Image Datasets. k-NN: A Simple Classifier. k-NN Hyperparameters. Gradient Descent. Loss Functions. Stochastic Gradient Descent (SGD). Regularisation. The Perceptron Algorithm. Backpropagation and Multi-layer Networks. Weight Initialization. Constant Initialization. Uniform and Normal Distributions. CNN Building Blocks. Image Classification.

SUGGESTED ACTIVITIES:

- 1: Identify and List various noises in the Image.
- 2: Identify Image Manipulation
- 3: Add colour descriptors and improve the search results.
- 4: Hierarchical k-means is a clustering method that applies k-means recursively to the clusters to create a tree of incrementally refined clusters
- 5: Image Classification using CNN

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Understand the basic knowledge, theories and methods of computer vision.

CO2: to understand the essentials of image processing concepts through mathematical interpretation.

CO3: Demonstrate a knowledge of a broad range of fundamental image processing and image analysis techniques

CO4: Apply Clustering algorithms for clustering.

CO5: Analyse cognitive tasks including image classification, recognition and detection through deep learning.

REFERENCES

1. Pro Processing for Images and Computer Vision with OpenCV, Bryan WC Chung, Apress, 2017
2. Programming Computer Vision with Python, Jan Erik Solem, O'Reilly Media, 2012
3. A PRACTICAL INTRODUCTION TO COMPUTER VISION WITH OPENCV, Kenneth Dawson-Howe, Wiley, 2014
4. Practical Computer Vision Applications Using Deep Learning with CNNs: With Detailed Examples in Python Using TensorFlow and Kivy, Ahmed Fawzy Gad, Apress. 2018
5. Computer Vision Principles, Algorithms, Applications, Learning E.R. Davies, Academic Press, 5th edition, 2017

COURSE OBJECTIVES:

- to introduce the concepts of Micro Electro Mechanical devices.
- to know the fabrication process of microsystems.
- to know the design concepts of micro sensors and micro actuators.
- to familiarize concepts of Quantum Mechanics and Nano systems.

UNIT I OVERVIEW 9

New trends in Engineering and Science: Micro and Nanoscale systems, introduction to design of MEMS and NEMS, MEMS and NEMS – applications, devices and structures. Materials for MEMS: Silicon, Silicon compounds, polymers, metals

UNIT II MEMS FABRICATION TECHNOLOGIES 9

Microsystem Fabrication Processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin Film Depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching Techniques: Dry and Wet Etching, Electrochemical Etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-Like) Technology; Packaging: Microsystems Packaging, Essential Packaging Technologies, Selection of Packaging Materials

UNIT III MICRO SENSORS 9

MEMS Sensors: Design of Acoustic Wave Sensors, Resonant Sensor, Vibratory Gyroscope, Capacitive and Piezo Resistive Pressure Sensors- Engineering Mechanics Behind These Microsensors. Case Study: Piezo-Resistive Pressure Sensor.

UNIT IV MICRO ACTUATORS 9

Design of Actuators: Actuation Using Thermal Forces, Actuation Using Shape Memory Alloys, Actuation Using Piezoelectric Crystals, Actuation using Electrostatic Forces (Parallel Plate, Torsion Bar, Comb Drive Actuators), Micromechanical Motors and Pumps. Case Study: Comb Drive Actuators.

UNIT V NANOSYSTEMS AND QUANTUM MECHANICS 9

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave Function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their Quantization, Molecular Wires and Molecular Circuits

TOTAL:45 PERIODS**COURSE OUTCOMES:**

At the end of this course, the student will be able to:

- CO1:** Discuss micro sensors
- CO2:** Explain micro actuators
- CO3:** Outline nanosystems and Quantum mechanics
- CO4:** Design micro actuators for different applications
- CO5:** Analyze atomic structures

REFERENCES

1. Chang Liu, "Foundations of MEMS", Pearson Education India Limited, 2006.
2. Marc Madou, "Fundamentals of Microfabrication", CRC Press 1997.
3. Stephen D. Senturia, "Micro System Design", Kluwer Academic Publishers, 2001

4. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002.
5. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata Mcraw Hill, 2002.

II4005

WIRELESS ADHOC AND SENSOR NETWORKS

L T P C

3 0 0 3

OBJECTIVES: The students will be able to

- understand the basics of Ad-hoc & Sensor Networks.
- learn various fundamental and emerging protocols of all layers.
- study about the issues pertaining to major obstacles in establishment and efficient manage of Ad-hoc and sensor networks.
- understand the nature and applications of Ad-hoc and sensor networks.
- understand various security practices and protocols of Ad-hoc and Sensor Networks.

UNIT I MAC & TCP IN AD HOC NETWORKS

9

Fundamentals of WLANs – IEEE 802.11 Architecture - Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols - TCP over Ad-Hoc networks-TCP protocol overview - TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.

UNIT II ROUTING IN AD HOC NETWORKS

9

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services - DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- Issues and Challenges in providing QoS.

UNIT III MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS

9

Introduction – Architecture - Single node architecture – Sensor network design considerations – Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer : Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues - Routing Protocols – Mobile Nodes and Mobile Robots - Data Centric & Contention Based Networking – Transport Protocols & QOS – Congestion Control issues – Application Layer support.

UNIT IV SENSOR MANAGEMENT

9

Sensor Management - Topology Control Protocols and Sensing Mode Selection Protocols - Time synchronization - Localization and positioning – Operating systems and Sensor Network programming – Sensor Network Simulators.

UNIT V SECURITY IN AD HOC AND SENSOR NETWORKS

9

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks - Secure Adhoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

LIST OF EXPERIMENTS

Wireless Adhoc and Sensor Networks

Any 10 experiments:

1. Network Simulator installation of wireless sensor network.
2. Write TCL script for transmission between mobile nodes.
3. Write TCL script for sensor nodes with different parameters.
4. Generate TCL script for UDP and CBR traffic in WSN nodes.
5. Implementation of routing protocol in NS2 for AODV protocol.
6. Implementation of routing protocol in NS2 for DSR protocol.
7. Implementation of routing protocol in NS2 for TORA protocol
8. Study other wireless sensor network simulators (Mannasim, Contiki.).
9. Communication: Write code to send & receive data over wireless radio
10. Localisation: Centroid method using signal strength for weights
11. Power Management : Explore functionality on SPOTs to take current and voltage measurements.
12. Security: Experiment with Eschenauer-Gligor key management scheme
13. Contour tracking: Implement a lightweight distributed algorithm where nodes compute the contours using purely local information
14. Alternative Platforms & Tools :
 - Introduce TinyOS and NesC;
 - Build and deploy Blink, CntToRfmAndLeds, RfmToLeds.
 - Learn to use the TOSSIM simulator.

OUTCOMES:

Upon Completion of the course, the students should be able to:

- Identify different issues in wireless ad hoc and sensor networks.
- To analyze protocols developed for ad hoc and sensor networks.
- To identify and address the security threats in ad hoc and sensor networks.
- Establish a Sensor network environment for different type of applications.

REFERENCES:

1. Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.
2. Carlos De Moraes Cordeiro, Dharma Prakash Agrawal "Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition), World Scientific Publishing, 2011.
3. C.K.Toh, "Ad Hoc Mobile Wireless Networks", Pearson Education, 2002.
4. C.Siva Ram Murthy and B.S.Manoj, "Ad Hoc Wireless Networks – Architectures and

Protocols”, Pearson Education, 2004.

5. Erdal Çayırıcı , Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.

6. Holger Karl, Andreas willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons, Inc .2005.

7. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, “Ad Hoc Mobile Wireless Networks”, Auerbach Publications, 2008.

8. Waltenequs Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010

II4006

REAL TIME SYSTEMS

L T P C

3 0 0 3

OBJECTIVES:

- To learn real time operating system concepts, the associated issues & Techniques.
- To understand design and synchronization problems in Real Time System.
- To explore the concepts of real time databases.
- To understand the evaluation techniques present in Real Time System.

UNIT I REAL TIME SYSTEM AND SCHEDULING 9

Introduction– Structure of a Real Time System –Task classes – Performance Measures for Real Time Systems – Estimating Program Run Times – Issues in Real Time Computing – Task Assignment and Scheduling – Classical uniprocessor scheduling algorithms –Fault Tolerant Scheduling.

UNIT II SOFTWARE REQUIREMENTS ENGINEERING 9

Requirements engineering process – types of requirements – requirements specification for real time systems – Formal methods in software specification – structured Analysis and Design – object oriented analysis and design and unified modelling language – organizing the requirements document – organizing and writing documents – requirements validation and revision.

UNIT III INTERTASK COMMUNICATION AND MEMORY MANAGEMENT 9

Buffering data – Time relative Buffering- Ring Buffers – Mailboxes – Queues – Critical regions – Semaphores – other Synchronization mechanisms – deadlock – priority inversion – process stack management – run time ring buffer – maximum stack size – multiple stack arrangement – memory management in task control block - swapping – overlays – Block page management – replacement algorithms – memory locking – working sets – real time garbage collection – contiguous file systems.

UNIT IV REAL TIME DATABASES 9

Real time Databases – Basic Definition, Real time Vs General Purpose Databases, Main Memory Databases, Transaction priorities, Transaction Aborts, Concurrency control issues, Disk

Scheduling Algorithms, Two– phase Approach to improve Predictability – Maintaining Serialization Consistency – Databases for Hard Real Time Systems.

UNIT V VALUATION TECHNIQUES AND CLOCK SYNCHRONIZATION 9

Reliability Evaluation Techniques – Obtaining parameter values, Reliability models for Hardware Redundancy–Software error models. Clock Synchronization–Clock, A Nonfault– Tolerant Synchronization Algorithm – Impact of faults – Fault Tolerant Synchronization in Hardware – Fault Tolerant Synchronization in software.

OUTCOMES:

Upon completion of this course, the students should be able to:

- Apply principles of real time system design techniques to develop real time applications.
- Make use of database in real time applications.
- Make use of architectures and behaviour of real time operating systems.
- Apply evaluation techniques in application.

List of Experiments

Real Time Systems

Any ten experiments

1. Development of problem statement.
2. Preparation of Software Requirement Specification Document, Design Documents and Testing Phase related documents.
3. Develop DFD model (level-0, level-1 DFD and Data dictionary) of the project.
4. Develop Structured design for the DFD model developed.
5. Develop UML Use case model for a problem.
- 6 .Develop sequence diagram.
7. Develop Class diagrams
8. Preparation of Software Configuration Management and Risk Management related documents.
9. Study and usage of any Design phase CASE tool
10. Performing the Design by using any Design phase CASE tools.
11. Develop test cases for unit testing and integration testing
12. Develop test cases for various white box and black box testing techniques.
13. Use MATLAB/Simulink to Control Qball
 - Safely turn on/off the qball and change the batteries,
 - Establish a wireless connection between qball and workstation
 - Work with Quarc and MATLAB/Simulink and compile and run models on both workstation and qball sides.
 - Receive and monitor the sensor data on the workstation,
 - Read back the joystick data on workstation
 - Send command to control rotors speed .
- 14 .Develop socket programming class to do the following class objectives
 - Establish a TCP/IP connection
 - Bind to a TCP port
 - Listen to connection requests
 - Accept connection requests
 - Receive data
 - Send data

15. Develop Communication Program with Target and Display Sensors
 Develop a cqstreamclient class to receive and display data of sensors of the Qball

16. Joystick Interface

- Develop a driver for joystick and build a cjoystick class
- Read back the joystick X,Y,Z and RZ data and display the data

17. Maneuver Qball by Joystick

Objectives

- Use ctimer class and cjoystick class to read back the joystick X,Y,Z and RZ data
- Develop a cqstreamsrv class to send the joystick data to qball
- Use ctimer class and cqstreamclient class to read the qball sensors and display it
- Use qball_motor_control Simulink model to send the sensors data to SPC and receive commands from SPC to control the motors speeds.

REFERENCES:

1. C.M. Krishna, Kang G. Shin, "Real-Time Systems", McGraw-Hill International Editions, 1997
2. Philip.A.Laplante, "Real Time System Design and Analysis", Prentice Hall of India, 3rd Edition, 2004
3. Rajib Mall, "Real-time systems: theory and practice", Pearson Education, 2009
4. R.J.A Buhur, D.L Bailey, "An Introduction to Real-Time Systems", Prentice Hall International, 1999
5. Stuart Bennett, "Real Time Computer Control-An Introduction", Prentice Hall of India, 1998
6. Allen Burns, Andy Wellings, "Real Time Systems and Programming Languages", Pearson Education, 2003.

II4007

SOFTWARE DEFINED NETWORKS

**LT P C
3 0 0 3**

Objectives

- To learn about what software defined networks are
- To understand the separation of the data plane and the control plane
- To learn about the use of SDN in data centers
- To learn about different applications of SDN

UNIT I INTRODUCTION

9

History of Software Defined Networking (SDN) – Modern Data Center – Traditional Switch Architecture – Why SDN – Evolution of SDN – How SDN Works – Centralized and Distributed Control and Date Planes

UNIT II OPEN FLOW & SDN CONTROLLERS

9

Open Flow Specification – Drawbacks of Open SDN, SDN via APIs, SDN via Hypervisor Based Overlays – SDN via Opening up the Device – SDN Controllers – General Concepts

UNIT III DATA CENTERS

9

Multitenant and Virtualized Multitenant Data Center – SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – NVGRE

UNIT IV SDN PROGRAMMING

9

Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs – Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.

UNIT V SDN

9

Juniper SDN Framework – IETF SDN Framework – Open Daylight Controller – Floodlight Controller – Bandwidth Calendaring – Data Center Orchestration

TOTAL :45 PERIODS

LIST OF LAB EXPERIMENTS:

Software Defined Network (SDN) experiments

(using Mininet and POX Controller)

Any ten experiments

Lab 1: basic mininet operations

Lab 2: manually control the switch

Lab 3: move the rules to the POX controller

Lab 4: set different forwarding rules for each switch in the controller

Lab 5: set traffic to different output queues (QoS issue)

Lab 6: FlowVisor

Lab 7: Multiple Tables Test

Lab 8: IP Load Balancer

Lab 9: Traffic measurement 1, Traffic measurement 2 (IP -> IP with mask --> TCP/UDP/ICMP)

Lab 10: Duplicate Packets

Lab 11: Bridge remote mininets using VXLAN

Lab 12: Using I2_multi to find a shortest path

(implement Floyd-Warshall algorithm: find the shortest paths between all pairs of vertices.)

Lab 13: Using I2_bellmanford to find a shortest path

(Bellman-Ford algorithm: computes the shortest paths from a single source to all of the other vertices)

Lab 14: Traffic Volume Control

Lab 15: A host with two interfaces

Ring Topology
Three Hosts
switch_host1 switch_host2 switch_host3
application layer routing

Lab 16: IPv6 example

Lab 17: IPv4 GRE Tunnel

OUTCOMES:

Upon completion of the course, the students will be able to

- Critically analyze and appreciate the evolution of software defined networks
- Point out the various components of SDN and their uses
- Explain the use of SDN in the current networking scenario
- Design and develop various applications of SDN

TEXT BOOKS:

1. Thomas D. Nadeau, Ken Gray, —SDN: Software Defined NetworksII, O'Reilly Media, 2013.
2. Paul Goransson and Chuck Black, —Software Defined Networks: A Comprehensive ApproachII, First Edition, Morgan Kaufmann, 2014.

REFERENCES:

1. SiamakAzodolmolky, —Software Defined Networking with Open FlowII, PacketPublishing, 2013.
2. Vivek Tiwari, —SDN and Open Flow for BeginnersII, Amazon Digital Services, Inc.,2013.
3. Fei Hu, Editor, —Network Innovation through Open Flow and SDN: Principles andDesignII, CRC Press, 2014.

CP4252

MACHINE LEARNING

L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

UNIT I INTRODUCTION AND MATHEMATICAL FOUNDATIONS 9

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory

UNIT II SUPERVISED LEARNING 9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbors - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING 9

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

UNIT IV PROBABILISTIC METHODS FOR LEARNING- 9

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

UNIT V NEURAL NETWORKS AND DEEP LEARNING 9

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases

45 PERIODS

SUGGESTED ACTIVITIES:

1. Give an example from our daily life for each type of machine learning problem
2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN

PRACTICAL EXERCISES:

30 PERIODS

1. Implement a Linear Regression with a Real Dataset (<https://www.kaggle.com/harrywang/housing>). Experiment with different features in building a model. Tune the model's hyperparameters.
2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.
3. Classification with Nearest Neighbors. In this question, you will use the scikit-learn's KNN classifier to classify real vs. fake news headlines. The aim of this question is for you to read

the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset

4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5. Implement the k-means algorithm using <https://archive.ics.uci.edu/ml/datasets/Codon+usage> dataset
6. Implement the Naïve Bayes Classifier using <https://archive.ics.uci.edu/ml/datasets/Gait+Classification> dataset
7. Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.
 - a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.
 - b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.
 - c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
 - d. You must properly provide references to any work that is not your own in the write-up.
 - e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

List of Projects (datasets available)

1. Sentiment Analysis of Product Reviews
2. Stock Prediction
3. Sales Forecasting
4. Music Recommendation
5. Handwriting Digit Classification
6. Fake News Detection
7. Sports Prediction
8. Object Detection
9. Disease Prediction

COURSE OUTCOMES:

Upon the completion of course, students will be able to

CO1: Understand and outline problems for each type of machine learning

CO2: Design a Decision tree and Random forest for an application

CO3: Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.

CO4: Use a tool to implement typical Clustering algorithms for different types of applications.

CO5: Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification.

TOTAL:75 PERIODS

REFERENCES

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.

- Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
- Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
- Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
- Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
- Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015
- Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
- Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online)
- Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)

AUDIT COURSES

AX4091	ENGLISH FOR RESEARCH PAPER WRITING	L T P C
		2 0 0 0

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I	INTRODUCTION TO RESEARCH PAPER WRITING	6
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Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II	PRESENTATION SKILLS	6
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Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III	TITLE WRITING SKILLS	6
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Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV	RESULT WRITING SKILLS	6
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Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V	VERIFICATION SKILLS	6
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Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES:

- CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092

DISASTER MANAGEMENT

L T P C
2 0 0 0

COURSE OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION

6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS

6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA

6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT

6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT

6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company, 2007.
3. Sahni, Pardeep Et. Al. , " Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2001.

AX4093

CONSTITUTION OF INDIA

L T P C
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, □Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094

நற்றமிழ் இலக்கியம்

L T P C

2 0 0 0

UNIT I

சங்க இலக்கியம்

6

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
- எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
- இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
- போரை நிறுத்திய ஔவையார்

UNIT II	அறநெறித் தமிழ்	6
	1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்	
	2. பிற அறநூல்கள் - இலக்கிய மருந்து - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)	
UNIT III	இரட்டைக் காப்பியங்கள்	6
	1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை	
	2. சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை	
UNIT IV	அருள்நெறித் தமிழ்	6
	1. சிறுபாணாற்றுப்படை - பாரி முல்லைக்குத் தேர் கொடுத்தது, மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஓளவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்	பேகன்
	2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு	
	3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள்	
	4. தர்மச்சாலையை நிறுவிய வள்ளலார்	
	5. புறநானூறு - சிறுவனே வள்ளலானான்	
	6. அகநானூறு (4) - வண்டு நற்றிணை (11) - நண்டு கலித்தொகை (11) - யானை, புறா ஐந்திணை 50 (27) - மான் ஆகியவை பற்றிய செய்திகள்	
UNIT V	நவீன தமிழ் இலக்கியம்	6
	1. உரைநடைத் தமிழ், - தமிழின் முதல் புதினம், - தமிழின் முதல் சிறுகதை, - கட்டுரை இலக்கியம், - பயண இலக்கியம், - நாடகம்,	
	2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,	
	3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,	
	4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ்	

இலக்கியமும்,

5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL : 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
- www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
-https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
- தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

OPEN ELECTIVES

OCE431

INTEGRATED WATER RESOURCES MANAGEMENT

LT P C

3 0 0 3

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM

9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS

9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS

9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: ‘blue’ versus ‘green’ water debate – Water foot print - Virtual water trade for achieving global water and food security – Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3	Apply law and governance in the context of IWRM.
CO4	Discuss the linkages between water-health; develop a HIA framework.
CO5	Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, “Effective Water Governance”. Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

OCE432

WATER, SANITATION AND HEALTH

L T P C

3 0 0 3

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality-

Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)- Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

OUTCOMES:

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R., Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. *New Directions for Teaching and Learning*, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary*. Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. *On Economic Inequality*. Enlarged edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press, 1997.
5. *Intersectoral Water Allocation Planning and Management*, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations’ 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity – Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

- Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
- A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
- Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Roulledge Taylor and Francis, 2017.
- The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla*, IIED and UNFPA, Earthscan, UK, 2008
- Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
- Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book”, Earthscan Publications Ltd, London, 2002.

OCE434

ENVIRONMENTAL IMPACT ASSESSMENT

**L T P C
3 0 0 3**

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION

9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT IDENTIFICATION AND PREDICTION

10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT

8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS**OUTCOMES:**

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

- EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
- Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
- Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
- Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
- Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
- World Bank –Source book on EIA ,1999
- Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431**BLOCKCHAIN TECHNOLOGIES****L T P C
3 0 0 3****COURSE OBJECTIVES:**

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I	INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN	9
Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.		
UNIT II	BITCOIN AND CRYPTOCURRENCY	9
Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.		
UNIT III	INTRODUCTION TO ETHEREUM	9
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.		
UNIT-IV	INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING	10
Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.		
UNIT V	BLOCKCHAIN APPLICATIONS	8
Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

- CO1:** Understand and explore the working of Blockchain technology
- CO2:** Analyze the working of Smart Contracts
- CO3:** Understand and analyze the working of Hyperledger
- CO4:** Apply the learning of solidity to build de-centralized apps on Ethereum
- CO5:** Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432

DEEP LEARNING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.

- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS

6

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS

9

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK

10

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN

10

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics-based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING

10

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data

CO2: Implement Image Segmentation and Instance Segmentation in Images

CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)

CO4: Traffic Information analysis using Twitter Data

CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT- I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT- II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise

sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

L	T	P	C
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COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO 9

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING 9

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV 9

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS 9
 Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES 9
 Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors
 (Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.



OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9
 Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9
 CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION**9**

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION**9**

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-- Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters - Materials -Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES**9**

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS**REFERENCES:**

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

OME434**ELECTRIC VEHICLE TECHNOLOGY****L T P C****3 0 0 3****UNIT I NEED FOR ELECTRIC VEHICLES****9**

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECTURE 9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor - drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2005

OME435	NEW PRODUCT DEVELOPMENT	L	T	P	C
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COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identifying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.

4. Generating, selecting, and testing the concepts for new product design and development.
5. Applying the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNIT V INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development” McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S., “Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN1-55623-603-4.
3. Pugh.S, “Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, 1991, ISBN0-202-41639-5.

4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431

SUSTAINABLE MANAGEMENT

**LT P C
3 0 3**

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
- CO2: An understanding of corporate sustainability and responsible Business Practices
- CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
- CO4: Knowledge of innovative practices in sustainable business and community management
- CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432

MICRO AND SMALL BUSINESS MANAGEMENT

L T P C

3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance-sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT**9**

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

CO1. Familiarise the students with the concept of small business

CO2. In depth knowledge on small business opportunities and challenges

CO3. Ability to devise plans for small business by building the right skills and marketing strategies

CO4. Identify the funding source for small start ups

CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433**INTELLECTUAL PROPERTY RIGHTS****L T P C
3 0 0 3****COURSE OBJECTIVE**

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION**9**

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS**9**

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES**9**

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY**9**

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS**9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

CO1: Understanding of intellectual property and appreciation of the need to protect it

CO2: Awareness about the process of patenting

CO3: Understanding of the statutes related to IPR

CO4: Ability to apply strategies to protect intellectual property

CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

OBA434**ETHICAL MANAGEMENT****L T P C****3 0 0 3****COURSE OBJECTIVE**

➤ To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY**9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS**9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT**9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT**9**

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical

emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS

9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1: Role modelling and influencing the ethical and cultural context.
- CO2: Respond to ethical crises and proactively address potential crises situations.
- CO3: Understand and implement stakeholder management decisions.
- CO4: Develop the ability, knowledge, and skills for ethical management.
- CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251

IoT FOR SMART SYSTEMS

L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS

9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE

9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT

9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS

9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT : Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES

9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadiseti : A Hands-on Approach "Internet of Things", Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
3. Samuel Greengard, " The Internet of Things", The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013.
9. Vijay Madiseti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
13. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNs, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012

RENEWABLE ENERGY TECHNOLOGY

L T P C

3 0 0 3

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION

9

Classification of energy sources – Co₂ Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS

9

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN

9

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS

9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES

9

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the student will be able to:

- CO1: Demonstrate the need for renewable energy sources.
- CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
- CO3: Design a stand-alone and Grid connected PV system.
- CO4: Analyze the different configurations of the wind energy conversion systems.
- CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kashtra, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093

SMART GRID

L T P C
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID

9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES

9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area

monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

- CO1: Relate with the smart resources, smart meters and other smart devices.
- CO2: Explain the function of Smart Grid.
- CO3: Experiment the issues of Power Quality in Smart Grid.
- CO4: Analyze the performance of Smart Grid.
- CO5: Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391

SECURITY PRACTICES

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I	SYSTEM SECURITY	9
Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.		
UNIT II	NETWORK SECURITY	9
Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.		
UNIT III	SECURITY MANAGEMENT	9
Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit		
UNIT IV	CYBER SECURITY AND CLOUD SECURITY	9
Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA		
UNIT V	PRIVACY AND STORAGE SECURITY	9
Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.		

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1:** Understand the core fundamentals of system security
- CO2:** Apply the security concepts to wired and wireless networks
- CO3:** Implement and Manage the security essentials in IT Sector
- CO4:** Explain the concepts of Cyber Security and Cyber forensics
- CO5:** Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools",2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing

CO2: Identify the architecture, infrastructure and delivery models of cloud computing

CO3: Develop the Cloud Application in AWS platform

CO4: Apply the concepts of Windows Azure to design Cloud Application

CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly, 2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , McGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner's Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072

DESIGN THINKING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE

8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II CONTEXTUAL INQUIRY

10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes.

Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

- 1: Hands on Design Thinking process for a product
- 2: Defining the Look and Feel of any new Project
- 3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
- 4: Identify a customer problem to solve.
- 5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- CO1:** Build UI for user Applications
- CO2:** Use the UI Interaction behaviors and principles
- CO3:** Evaluate UX design of any product or application
- CO4:** Demonstrate UX Skills in product development
- CO5:** Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers,

Writers, Designers, and Developers, Edward Stull. Apress, 2018

4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016

5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153

PRINCIPLES OF MULTIMEDIA

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION

9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA

9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS

9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS**COURSE OUTCOMES:**

CO1:Handle the multimedia elements effectively.

CO2:Articulate the concepts and techniques used in multimedia applications.

CO3:Develop effective strategies to deliver Quality of Experience in multimedia applications.

CO4:Design and implement algorithms and techniques applied to multimedia objects.

CO5:Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

CX4016	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C
		3	0	0	3
UNIT I	INTRODUCTION				9
Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems					
UNIT II	CONCEPT OF SUSTAINABILITY				9
Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture					
UNIT III	SIGNIFICANCE OF BIODIVERSITY				9
Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation					
UNIT IV	POLLUTION IMPACTS				9
Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.					
UNIT V	ENVIRONMENTAL ECONOMICS				9
Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics					
TOTAL : 45 PERIODS					

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092	TEXTILE REINFORCED COMPOSITES	L	T	P	C
		3	0	0	3

UNIT I	REINFORCEMENTS				9
Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites					
UNIT II	MATRICES				9
Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices					
UNIT III	COMPOSITE MANUFACTURING				9
Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of					

composites and composite design requirements

UNIT IV TESTING

9

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS

9

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang, "Advanced Polymer composites", ASM International, USA, 1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials", Second Edition, CRC Press, New Jersey, 1996.
3. George Lubin and Stanley T. Peters, "Handbook of Composites", Springer Publications, 1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 & 2, Prentice Hall PTR, New Jersey, 1997.
5. Richard M. Christensen, "Mechanics of composite materials", Dover Publications, 2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering", CRC Press, 2001

NT4002

NANOCOMPOSITE MATERIALS

**L T P C
3 0 0 3**

UNIT I BASICS OF NANOCOMPOSITES

9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES

9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES

9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS

9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY**9**

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS**REFERENCES:**

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization-Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepřek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016**IPR, BIOSAFETY AND ENTREPRENEURSHIP****LT P C
3 0 0 3****UNIT I IPR****9**

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D, IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES**9**

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of “prior art” – Patent databases – Searching International Databases – Country-wise patent searches (USPTO, espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY**9**

Introduction – Historical Background – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS**9**

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT**9**

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS**REFERENCES**

1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, 2007.

PROGRESS THROUGH KNOWLEDGE