M.Tech. (ECE) with Specialization in (Intelligent Communication Systems)

Regulations, Curriculum and Syllabus

(with effect from academic year 2023-2024)

Submitted by

DEPARTMENT OF ELECTRONICS ENGINEERING

SCHOOL OF ENGINEERING AND TECHNOLOGY

PONDICHERRY UNIVERSITY

PONDICHERRY -14

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i) Regulations for M.Tech. (ECE) with Specialization in (Intelligent Communication Systems)

The Department of Electronics Engineering under the School of Engineering and Technology, Pondicherry University offers this M.Tech. in Electronics and Communication Engineering (ECE) with specialization in Intelligent Communication Systems programme which is specifically designed to meet the needs of Digital India's objective in the areas of Electronics and Communication for both the design, development and implementation.

Further, the proposed M.Tech. (ECE) with specialization in Intelligent Communication Systems Programme has been devised such that it will culminate into the curriculum which has been designed to promote holistic and multidisciplinary education with flexibility in structure and length of degree programmes.

Name of the Programme	**M.Tech. (ECE) with Specialization in (Intelligent Communication Systems)**
Nature of Programme	Regular
Programme Duration	Two years (Four Semesters). However, one can complete the programme within maximum of eight semesters.
Eligibility Criteria	B.E. / B.Tech. with at least 55% marks (or) equivalent in Electronics & Communication Engineering/ Electronics & Telecommunication Engineering / Electronics Engineering/ Electrical & Electronics Engineering/Electronics & Instrumentation Engineering/ Instrumentation & Control Engineering/Information Technology/Computer Science & Engineering/Robotics Engineering/Robotics & Automation/ Biomedical Engineering/Mechatronics (or) equivalent. A valid GATE qualified candidates will be given preference.
Admission Criteria	Admission through CUET/Valid GATE Score
Intake	30 Seats (As Per AICTE Approval)
Teaching and Learning Methods	Lectures, tutorials and seminars are the main methods of course delivery, which would be supplemented by individual practical work, project work, simulation assignment, seminars and industrial visits.
Minimum number of credits to be acquired for successful completion of the programme	Semester – I : **24 Credits** Semester – II : **24 Credits** Semester – III : **18 Credits** Semester – IV : **18 Credits**
Total Credits	**84 Credits**

1. UNIVERSITY VISION

- To serve as an enabler of societal transformation through state-of-the art higher education and research that match global benchmarks by providing access, resources and opportunities.
- To become an institution of global eminence.
- To adapt to ever-changing needs of the society and industries.

2. UNIVERSITY MISSION

- To deploy globally competent resources in terms of people, infrastructure and partners through development of trained human resources, who will serve as agents of value-based societal transformation in various spheres of life enriched with technology-assisted education, research, training and cultural integration.

- The University has entered into MoUs with a good number of reputed international institutions in India and abroad for collaboration and faculty development

3. DEPARTMENT VISION

- To motivate the students towards conceptual realization

4. DEPARTMENT MISSION

- To mould the students to be the backbone of modern technologies in the field of Electronics & Communication Engineering.

5. BRIEF ABOUT THE DEPARTMENT

- The Department of Electronics Engineering is the first Engineering Department, which has been established under the School of Engineering and Technology in the Academic Year 2010 –11 during XI Plan. The prime aim of the Department is to impart quality research in the field of Electronics and Communication Engineering to meet the increasing demand of highly qualified technical personnel. The department offers two programmes namely, Master of Technology and Doctor of Philosophy in Electronics & Communication Engineering. The department provides opportunities for the students to pursue multi-disciplinary, inter-disciplinary and trans-disciplinary courses. Our curriculum provides a strong base to the students in Electronics and Communication Engineering and provides exposure to the latest technologies. The course and laboratory contents are being revised from time to time so as to keep abreast with the latest developments and emerging technologies. The department has competent faculty members and non-teaching staffs. The faculty members are actively involved in teaching and world-class research to cater the societal and industrial needs. The major areas of faculty expertise include Antennas,

Digital Image Processing, Digital Signal Processing, Microwave/Millimeter-wave/Terahertz Engineering, MEMS/NEMS, Optical Communication, Pattern Recognition, Speech Processing, Steganography and Cryptography, Embedded Systems and VLSI Design, 5G & beyond Wireless Communication, Wireless Networks, Internet of Things, Optical Communication, RF Design and Technology, Device Modeling. The research activity of the department includes both fundamental research and sponsored projects.

6. PROGRAMMES OFFERED BY ELECTRONICS ENGINEERING DEPARTMENT:

- The department offers following programmes

Sl. No.	Program	Description
1.	M.Tech.	**ECE with Specialization in (Intelligent Communication Systems)**
2.	Ph.D.	**Electronics and Communication Engineering**

Programme Educational Objectives (PEOs)

The Program Educational Objectives specify the professional accomplishments that the students will attain within 2 years of their Post-graduation. The following are the PEOs for the Programme Master of Technology (M.Tech.) – ECE with Specialization in Intelligent Communication Systems.

PEO1:
To enable the Graduates to emerge as a globally competent team player or leader in the allied fields of Electronics and Communication Engineering.

PEO2:
To make the Graduates to have core technical competency that will enable them to engage in life-long learning and research.

PEO3:
To Enable the Graduates to provide innovative solutions and services to solve industrial and societal problems adhering to ethical practices and social concerns.

Programme Outcomes (POs)

M.Tech. (ECE) with Specialization in Intelligent Communication Systems professionals graduating from our department will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems related to Electronics and Communication Engineering.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using fundamental principles of ECE.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling to complex engineering activities, with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings to complete the task/project in a successful manner.

9. Communication: Ability to communicate effectively with the engineering community and society in both oral and written contexts in the form of research papers, project reports, design documentation and presentations on complex engineering activities.

10. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs):

At the end of the program, the students will be able to:

PSO1:

Apply their knowledge to provide feasible solutions for complex problems related to Intelligent Communication system design.

PSO2:

Analyze, design, simulate, develop, integrate and validate the prototype model of Intelligent Communication systems useful for society.

PROGRAMME STRUCTURE

It is a 4 semester program with total 84 credits. It is having one specialization, as regard to the specialization, semester-I will have common curriculum and semester-II curriculum will be varied as per the specialization. Semester 3 & 4 includes dissertation and industrial internship. The M.Tech. Electronics and Communication Engineering with specialization in Intelligent Communication Systems.

Semester-I courses will be from main stream.
Semester -II courses will be as per the specialization.
Semester – III & IV Skill based Courses as per NEP-2020

GUIDELINES FOR SKILL BASED COURSES AS PER NEP-2020:

1) Skill Based Training & Seminar

The student should do a skill based training in the field of ECE domain during the summer vacation period of First Year and complete it before the beginning of the third semester. Training will be monitored by a faculty member of the department and will be evaluated in every odd semester starting from the 2nd year. The evaluation will be done based on the criteria set by the Training Evaluation Committee (TEC) under the supervision of the HoD to award the allotted credits. The student must take prior approval from the TEC/HoD before starting the internship process. The minimum training duration should be at least minimum of 4 weeks and maximum of 6 weeks. A student can pursue a training either in the industrial sector or academic sector (with reputed industry/institutions).

TEC will evaluate for 100 marks (75% of marks for the training skills and report and 25 % of marks for the seminar presentation).

2) Mandatory Course – I (NPTEL)

The student should obtain permission from HoD/Coordinator before registering for the course. Student should undergo NPTEL course related to ECE branch for a period of minimum 12 weeks.

* (A valid score card to be submitted in the Department for the award of the degree).

3) Mandatory Course – II (Hands on Training)

Employability of students is less than 80% for the professional students as they lack practical/industry relevant training when they pass out from the Institution.

These training programmes have been offered for the candidates who are studying M.Tech. (ECE) Programme. They can avail these courses during the course of study to have hands-on experience on the latest technologies that are industry relevant to enhance their employability

Student should undergo Hands on Training on the Latest Technology course related to ECE branch for a period of minimum 5 days (30 Hours) such as Workshops, Short Term Courses related to Hands on Training and should obtain permission from HoD/Coordinator before registering for the course.

* (A valid Certificate to be submitted in the Department for the award of the degree).

4) Open Elective Course

The student can select the OEC as per his/her choice either in University campus or outside campus (India/Abroad) through offline/online mode.
* (A valid score card to be submitted in the Department for the award of the degree).

Assessment Methods : CBCS is the method of assessment with the following weightage of marks for the various courses of the programme.

For Theory Courses:

40% of marks for internal and 60% for end semester examinations.

The end semester question paper will have Part A (6 × 2 = 12 Marks) consisting of six two mark questions and Part B (4 × 12 = 48 Marks) consisting of six twelve mark descriptive questions of which one of them is compulsory and totally a candidate has to answer four out of six. For the end semester examination (University Semester Examination), the questions will be chosen only from the first four units of every theory subject of the programme to account end semester marks of 60 and internally (cumulatively) to assess a candidate's depth of knowledge in the concerned subject for 40 marks, a minimum of two internal tests (30 marks) shall be conducted. Further, the content of the fifth unit in each subject shall be considered to conduct seminars, tutorials, simulations, assignments, development of hardware models etc. for 10 marks as it is formulated at system level for all subjects of the programme.

For Practical Courses:

75% of marks for internal and 25 % for end semester examinations.

For Project Dissertation – I & II :

75% of marks for internal and 25% for end semester examinations.

The Project Dissertation work shall be evaluated for a maximum of 100 marks. There shall be two assessments during the third and fourth semesters by a review committee. The Head of the Department shall constitute the review committee consisting of supervisor, project coordinator and another faculty member from the Department for the internal assessment (40 marks). The contribution by the respective supervisor of a student for 35 marks shall be accounted for the internal marks of 75. The end semester Project Viva Voce (for 25 marks) shall be conducted by the external member nominated by the competent Authority of the University. The distribution of the marks is shown in the Table given below.

Allocation of Marks for Project Dissertation – I&II (100 Marks)				
Internal (75 Marks)			**External (25 Marks)**	**Total (100 Marks)**
Review Committee (40 Marks)		Supervisor (35 Marks)		
First Review	Second Review			
20 Marks	20 Marks	35 Marks	25 Marks	100 Marks

ii) Semester wise Structure and Curriculum for M.Tech. (ECE) with Specialization in (Intelligent Communication Systems)

I Semester

Sl. No.	Course Code	Name of the Course (Program Core Course)	H/S	L-T-P	Credits
1.	ECEICS 510	Embedded Systems & Communication Laboratory	H	0-0-4	2
2.	ECEICS 511	Advanced Digital Communication	H	3-1-0	4
3.	ECEICS 512	Advanced Digital Signal Processing	H	3-1-0	4
4.	ECEICS 513	High Speed Semiconductor Devices	H	3-1-0	4
5.	ECEICS 514	VLSI Design and Embedded System	H	3-1-0	4
6.		Program Elective Course – I	S	3-0-0	3
7.		Program Elective Course – II	S	3-0-0	3
				Total Credits for Semester I	**24**

(H – Hard Core Course; S – Soft Core Course)

II Semester: Main Stream ECE with Specialization in Intelligent Communication Systems

Sl. No.	Course Code	Name of the Course (Program Core Course)	H/S	L-T-P	Credits
8.	ECEICS 520	Intelligent Communication Systems Laboratory	H	0-0-4	2
9.	ECEICS 521	5G Technologies	H	3-1-0	4
10.	ECEICS 522	Computational Methods for Intelligent Communication Systems	H	3-1-0	4
11.	ECEICS 523	Intelligent Communication Systems	H	3-1-0	4
12.	ECEICS 524	Multimedia Technologies	H	3-1-0	4
13.		Program Elective Course – III	S	3-0-0	3
14.		Program Elective Course – IV	S	3-0-0	3
				Total Credits for Semester II	**24**

(H – Hard Core Course; S – Soft Core Course)

III Semester

Sl. No.	Course Code	Name of the Course (Program Core Course)	H/S	L-T-P	Credits
15.	ECEICS 610	Project Dissertation – I	H	0-0-24	12
16.	ECEICS 611	Skill Based Training & Seminar	S	0-0-6	3
17.	ECEICS 612	Open Elective Course	S	3-0-0	3
18.	ECEICS 613	Mandatory Course – I (Hands-on Training)	-	-	-
19.	ECEICS 614	Mandatory Course – II (NPTEL)	-	-	-
Total Credits for Semester III					**18**

(H – Hard Core Course; S – Soft Core Course)

IV Semester

Sl. No.	Course Code	Name of the Course (Program Core Course)	H/S	L-T-P	Credits
20.	ECEICS 620	Project Dissertation – II	H	0-0-36	18
Total Credits for Semester IV					**18**

(H – Hard Core Course; S – Soft Core Course)

Minimum number of credits required to complete

M.Tech. (ECE) with Specialization in (Intelligent Communication Systems) : 84 Credits

Semester I – List of Programme Elective Courses for ECE Main Strem

Sl. No.	Course Code	Name of the Course	L-T-P	Credits
1	ECEICS 531	Advanced Wireless Communication	3-0-0	3
2	ECEICS 532	Analog and Digital IC Design	3-0-0	3
3	ECEICS 533	Antenna Engineering	3-0-0	3
4	ECEICS 534	Artificial Intelligence	3-0-0	3
5	ECEICS 535	Biosensors	3-0-0	3
6	ECEICS 536	Digital Image Processing and Pattern Recognition	3-0-0	3
7	ECEICS 537	Electromagnetic Interference and Compatibility	3-0-0	3
8	ECEICS 538	Embedded Systems for Networking	3-0-0	3
9	ECEICS 539	High Performance Communication Networks	3-0-0	3
10	ECEICS 540	Information Security	3-0-0	3
11	ECEICS 541	Low Power Digital VLSI Design	3-0-0	3
12	ECEICS 542	MEMS and NEMS	3-0-0	3
13	ECEICS 543	Microwave Theory and Technology	3-0-0	3
14	ECEICS 544	Optical Communication and Networks	3-0-0	3
15	ECEICS 545	Optoelectronics Devices	3-0-0	3
16	ECEICS 546	Real Time Embedded System Design	3-0-0	3

Semester II - List of PROGRAMME ELECTIVE COURSES FOR SPECIALIZATION IN INTELLIGENT COMMUNICATION SYSTEMS

Sl. No.	Course Code	Name of the Course	L-T-P	Credits
1	ECEICS 711	Internet of Everythings	3-0-0	3
2	ECEICS 712	Machine Learning and Deep Learning	3-0-0	3
3	ECEICS 713	Millimeter Wave Technology	3-0-0	3
4	ECEICS 714	Mobile Adhoc Networks	3-0-0	3
5	ECEICS 715	Multimedia Compression	3-0-0	3
6	ECEICS 716	Network Security	3-0-0	3
7	ECEICS 717	Optical Wireless Communications	3-0-0	3
8	ECEICS 718	Photonics Integrated Circuits	3-0-0	3
9	ECEICS 719	Radar Engineering	3-0-0	3
10	ECEICS 720	Radio Frequency Integrated Circuit Design	3-0-0	3
11	ECEICS 721	RF MEMS Design and Technology	3-0-0	3
12	ECEICS 722	Robotics	3-0-0	3
13	ECEICS 723	Terahertz Technology	3-0-0	3
14	ECEICS 724	Under Water Communication Systems	3-0-0	3
15	ECEICS 725	Vehicular Networks	3-0-0	3
16	ECEICS 726	Wireless Networks	3-0-0	3

(* Elective courses will be offered as per the choice of the students and the expertise of the faculty members in the department)

iii) Syllabus for M.Tech. (Electronics and Communication Engineering):

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 510	Embedded Systems & Communication Laboratory	0	0	4	2	60

Objective : Hands on experience on hardware experiments in order to acquire sufficient knowledge and understand practical nuances of various Embedded Systems and Communication techniques.

LIST OF EXPERIMENTS (Given the list is minimal, however, the course teacher can decide the level of experiments)

Hardware Based Experiments

- **Microcontroller Experiments**

  Develop and Test Assembly Language Programs using 8051 and 89552 Microcontrollers

- **Microwave and Antenna Experiments**

- Study of radiation pattern measurement of various antennas
- Study of Microwave Test Bench Experiments

- **Communication Experiments**

  Study of Digital Modulation Techniques

Simulation Based Experiments

- Simulation of Transforms
- Simulation of Multiplexing Techniques
- Simulation of Advanced Modulation Schemes
- Simulation of Combinational and Sequential Circuits

ECEICS 510

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 511	ADVANCED DIGITAL COMMUNICATION	3	1	0	4	60

Prerequisite: Basics of analog and digital communication systems.

Objective : To make the students to understand the various advanced concepts of digital communication techniques.

Outcome : Students will be able to imply the concepts of advanced digital communication techniques to various applications.

Module I: Digital Modulation Techniques **12 Hours**

Elements of Digital Communication system - Factors influencing digital modulation techniques; Linear Modulation Techniques: BPSK - QPSK - DPSK; Constant envelope modulation techniques: MSK- GMSK; Linear and constant envelope modulation techniques: M- ary PSK and M- ary QAM.

Module II: Additive White Gaussian Noise Channel **12 Hours**

Optimum receiver for signals corrupted by AWGN - performance of the optimum receiver for memory less modulation; optimum receiver for CPM signals - optimum receiver for signals with random phase in AWGN channel.

Module III: Equalization Techniques and Synchronization **12 Hours**

Optimum receiver for channels with ISI and AWGN – Nyquist criterion for zero ISI - linear equalization and its variations - Decision Feedback Equalization - Predictive Decision Feedback Equalization -Turbo equalization- Signal Parameter Estimation: Carrier phase estimation - symbol timing estimation.

Module IV: Multiple Carrier Modulation **12 Hours**

Physical modelling for wireless channels – Fading and diversity – OFDM – CDMA – MIMO- Beam-steering – MIMO-OFDM – Spatial Multiplexing.

Module V: Instructional Activity **12 Hours**

Simulation: Different digital modulation - AWGN channel - equalization techniques and synchronization using any related platforms

Reference Books:

1. George R. C & Clare D M, “Modern Communications and Spread Spectrum,” McGraw Hill Book Company, 1986.
2. John G P, Masoud S, “Digital Communications,” 5th Edition, McGraw Hill Book Company, 2014.
3. Kamilo Feher, “Wireless Digital Communications Modulation & Spread Spectrum Applications,” PHI, 1995.
4. Bernard S, “Digital Communication fundamentals and applications,” 2nd Edition, Pearson education, 2009.
5. Theodire S R, “Wireless Communications,” 2nd Edition Pearson Education, 2010.

Hyperlinks:

1. http://nptel.iitm.ac.in/courses/117101051.html
2. http://nptel.ac.in

ECEICS 511

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 512	ADVANCED DIGITAL SIGNAL PROCESSING	3	1	0	4	60

Prerequisite : Knowledge in Signal and Systems, and Digital Signal Processing

Objective : To make the students to understand the concepts in signal processing mechanisms and power spectrum estimation methods

Outcome : Students will be able to analyze and implement advanced signal processing techniques for various applications.

Module I: Fundamentals of Signal Processing **12 Hours**

Introduction: Basic elements of Digital Signal Processing System- advantages of digital over analog signal processing; Classification of signals: Deterministic vs random signals - multi channel and multi-dimensional signals; Down Sampling-decimation-up sampling- interpolation.

Module II: Power spectrum estimation **12 Hours**

Estimation of spectra using the DFT from finite duration signals - non– parametric methods for power spectrum estimation: Welch- Bartlett methods; Parametric methods for power spectrum estimation: Yule-Walker method- Burg method for the ARM parameters.

Module III: Adaptive Signal processing **12 Hours**

FIR adaptive filters- steepest descent adaptive filter - LMS algorithm - convergence of LMS algorithms; Applications: Noise cancellation - channel equalization.

Module IV: Wavelet Transform **12 Hours**

Introduction: Continuous Wavelet Transform - basic properties of wavelet transforms - Discrete Wavelet Transform: Haar scaling functions and function spaces - nested spaces - Haar wavelet function - orthogonality of $\phi(t)$ and $\psi(t)$ - normalization of Haar bases at different scales.

Module V: Instructional Activity **12 Hours**

EEG/ECG signal analysis for the real time environment; Echo cancellation using adaptive filters; Voice recognition and speech-to-text conversion using related tools.

Reference Books:

1. Proakis J G and Manolkis D G, “Digital Signal Processing: Principles, Algorithms and Applications”, 4th Edition, Prentice Hall of India, 2007.
2. Monson H H, “Statistical Digital Signal Processing and Modeling”, Wiley, 2002.
3. Cristi R, “Modern Digital Signal Processing”, Thomson Brooks/ Cole, 2004.
4. Lokenath D and Firdous A S, “Wavelet Transforms and Their Applications”, 2nd Edition, Birkhauser, Springer, 2014.
5. Raghuveer R M, and Ajit S B, “Wavelet Transforms: Introduction to Theory and Applications”, Pearson Education, New Delhi, 1998.

Hyperlink:

1. www.ece.umd.edu/class/enee630.F2012.html
2. http://ar.book.org/s/?q=DSP+PROAKIS&yearFrom=&yearTo=&language=&extension=&t=0

ECEICS 512

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 513	HIGH SPEED SEMICONDUCTOR DEVICES	3	1	0	4	60

Prerequisite : Fundamental knowledge in Semiconductor Devices and Circuits

Objective : The course aims to give exposure on the band diagram, structure, characteristics of hetero-junction devices and their fabrication techniques.

Outcome : Students will be able to understand the behavior of semiconductor materials and be aware of the structure of advanced devices and their fabrication techniques.

Module I: Semiconductor Materials Characteristics **12 Hours**

Review of Crystal Structure: Crystal structure of important semiconductors (Si, GaAs, InP) - energy band diagram - carrier concentration and carrier transport phenomenon – electrical – optical - thermal and high field properties of semiconductors.

Module II: Fabrication Techniques **12 Hours**

Crystal Growth and Wafer Preparation - epitaxy - dielectric film deposition and oxidization techniques - masking and lithography techniques (optical, e-beam and other advanced lithography techniques) - diffusion - ion implantation - metallization - bipolar and CMOS integration techniques .

Module III: MOS Devices **12 Hours**

M-S Junction: Structure – operation - characteristics; MOS Diode: Structure - band diagram - operation - C–V characteristics - effects of oxide charges - high field effects and breakdown; MOSFET: Band diagram - structure – operation - I–V characteristics (analytical expressions) ; Advanced MOSFET: MOSFET breakdown and punch through - sub- threshold current - scaling down - High k-dielectric materials - SOI MOSFET - buried channel MOSFET - charge coupled devices.

Module IV: High Speed Semiconductor Devices **12 Hours**

HBT and HEMT Devices: AlGaAs/ GaAs and Si/SiGe based HBT and HEMT structure - band diagram - operation - I–V characteristics (analytical expressions) - small signal switching models - benefits of hetero-junction transistor for high speed applications; Nano devices: Resonant tunneling diode - SET - FinFET - nanowire FET.

Module V: Instructional Activity **12 Hours**

Simulation study: MOSFET - HBT /HEMT- FinFET – SET using related tools.

Reference Books:

1. Nandita Das Gupta and Amitava Das Gupta, “Semiconductor Devices: Modeling and Technology”, Prentice Hall of India, 2004.
2. M. S. Tyagi, “Introduction to Semiconductor Materials and Devices”, John Wiley and Sons, 2008.
3. S. M. Sze, “Physics of Semiconductor Devices”, 3rd Edition, John Wiley and Sons, 2008.
4. J. Singh, “Semiconductor Devices: Basic Principles”, John Wiley and Sons, 2007.
5. Waser R, “Nanoelectronics and Information Technology” 2nd Edition, Wiley, 2012.

Hyperlinks:

1. http://nptel.iitm.ac.in/courses/Webcoursecontents/IITDelhi/Semiconductor%20Devices/index.html
2. http://nptel.iitm.ac.in/video.php/subjectId/117106093
3. http://nptel.iitk.ac.in/courses/Webcoursecontents/IITKANPUR/HighSpeed_SemiconductorDevices/ ui/Course_home-32.html.

ECEICS 513

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 514	VLSI DESIGN AND EMBEDDED SYSTEMS	3	1	0	4	60

Prerequisite : Knowledge of digital electronics, microprocessor architecture and assembly language, C programming language

Objective : To make the students to understand the basics of embedded system and also the VLSI design using CMOS.

Outcome : Students will be aware of principles and design issues of various embedded processors and VLSI circuits.

Module I: Digital VLSI Design using CMOS **12 Hours**

Principles of circuit design using pass transistors and transmission gates - combinational logic circuit design - sequential logic circuit design - Flip Flops - synchronous sequential circuits.

Module II: Layout Analysis **12 Hours**

Resistive and inductive interconnect delays - network delay - layouts - simulation - switch logic networks - gate and network testing - memory cells and arrays - clocking disciplines - power optimization.

Module III: Embedded System **12 Hours**

Overview, embedded hardware units - embedded software - embedded System on Chip (SoC) - design process - classification of embedded system - bus - memory devices - component interfacing - networks for embedded systems; Communication interfacings: RS232/UART-RS422/RS485 - IEEE 488 bus.

Module IV: Embedded Processors **12 Hours**

Architecture of the Kernel- types of Kernal - PIC Processor - ARM processor - SHARC processor - design methodologies- specifications - architecture design and system analysis.

Module V: Instructional Activity **12 Hours**

Study on embedded system design: Telephone PBX - ink jet printer - water tank monitoring system- GPRS - Personal Digital Assistants; Simulation of VLSI Circuits: Basic gates using logic families - CMOS inverter layout.

Reference Books:

1. Marilyn W, “Computers as components: principles of embedded computing system design”, 4th Edition, Morgan Kaufmann, 2016.
2. David E S,“An embedded software premier”, Addison-Wesley, 1999.
3. Prasad K V K K, “Embedded / real time systems: Concepts, Design and Programming”, Dreamtech press, 2003.
4. Kamran E, Douglas A P, Sholeh E, “Essentials of VLSI Circuits and Systems”, 1st Edition, PH Learning, 2009.
5. Wayne W, “Modern VLSI Design: IP Based Design”, 4th Edition, Prentice Hall, 2008.
6. Jacob R B, “CMOS Circuit Design, Layout and Simulation”, 3rd Edition, Wiley-IEEE Press, 2010.
7. Douglas A P, Kamran E, “Basic VLS I Design”, 3rd Edition, Pearson College Division, 1995.
8. Sung Mo K, Yosuf L, ChulwooK, “CMOS Digital Integrated Circuits: Analysis and Design”, 4th Edition, McGraw-Hill, 2014.
9. John P U, “Introduction to VLSI Circuits and Systems”, 1st Edition, Wiley, 2001.

Hyperlinks:

1. http://ecee.colorado.edu/~mcclurel/index.html
2. http://mysite.du.edu/~rvoyles/
3. http://courses.cs.washington.edu/courses/cse477/01sp/admin/schedule.html
4. http://codesign.cs.tamu.edu/teaching/csce617/labs-projects-s13
5. http://www.onlinevideolecture.com/electrical-engineering/nptel-iit-delhi/embedded-systems
6. http://web.ewu.edu
7. http://ic.sjtu.edu
8. http://nptel.iitm.ac.in

ECEICS 514

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 520	Intelligent Communication Systems Laboratory	0	0	4	2	60

Objective : Hands on experience on various simulation tools to design and analyze the various Intelligent Communication Technologies.

LIST OF EXPERIMENTS: (Given the list is minimal, however, the course teacher can decide the level of experiments)

1. **Optical Experiments (Optisim):**
   a. Measurement of Coupling Loss
   b. Measurement of Bending Loss
   c. Measurement of Attenuation Loss
   d. Measurement of Numerical Aperture
2. **Microwave Experiments**
   a. Microwave IC – Power Divider
   b. Microwave IC – Directional Coupler
   c. Microwave IC -
   d. Microwave IC – Filter Characterization
3. **Communication Experiments (MATLAB & NETSim)**
   a. Frequency Hopping Spread Spectrum (FHSS) Modulation and Demodulation Techniques
   b. Simulation of WIFI Network
   c. Simulation of IOT
   d. Simulation of 5G
   e. Simulation of SDR
   f. Simulation of OFDM
4. **Artificial Intelligence Experiments (Python)**
   a. Implementation of Breadth First Search
   b. Implementation of Depth First Search
   c. Implementation of Travelling Salesman problem
   d. Implementation of N-Queens Problem

ECEICS 520

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 521	5G TECHNOLOGIES	3	1	0	4	60

Prerequisite: Wireless communication

Objective : To develop an understanding of the basic concepts , accessing technologies and mobility management of 5G

Outcome : Students will be able to understand the importance and in-depth functioning of 5G Technology

Module I : Overview of 5G Wireless Communications **12 Hours**

Evaluation of mobile technologies 1G to 4G; D2D: From 4G to 5G; An overview of 5G requirements, Regulations for 5G, Radio Resource Management and its techniques for 5G; Propagation Channels: Channel modeling requirements, propagation scenarios (Relaying and Co-operative Communication and challenges in the 5G modeling, Channel Models for mmWave MIMO Systems.

Module II : 5G Architecture **12 Hours**

Introduction, NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Functional split criteria, Functional split alternatives, Functional optimization for specific applications; Integration of LTE and new air interface to fulfill 5G Requirements, Enhanced Multi-RAT coordination features, Physical architecture and 5G deployment.

Module III : 5G Radio-Access Technologies **12 Hours**

Access design principles for multi-user communications, Orthogonal multiple-access systems, Spread spectrum multiple access systems, Capacity limits of multiple-access methods, SCMA, IDMA, Radio access for dense deployments, OFDM numerology for small-cell deployments, Radio access for V2X communication, Radio access for massive MIMO.

Module IV : Interference And Mobility Management **12 Hours**

Network deployment types, UDN, Moving networks, Heterogeneous networks, Interference management in 5G and UDN moving relay nodes, Interference cancelation; Mobility management in 5G and heterogeneous networks, User equipment controlled versus network-controlled handover.

Module V: Instructional Activity **12 Hours**

Simulation of 5G Communications Link Analysis with Ray Tracing/ Wireless Connectivity in the 5G Era for WLAN/ Factors affecting deployment of 5G on Indian Scenario using open source software tool

Reference Books:

1. Afif Osseiran, Jose F.Monserrat, Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press Second Edition 2011.
2. Erik Dahlman, Stefan Parkvall, Johan Sko¨ld , “5G NR: The Next Generation Wireless Access Technology” Elsevier First Edition 2016.
3. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, First Edition,2010

Hyperlinks:

1. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SECA3020.pdf
2. https://www.cisco.com/c/en/us/solutions/what-is-5g.html

ECEICS 521

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 522	COMPUTATIONAL METHODS FOR INTELLIGENT COMMUNICATION SYSTEMS	3	1	0	4	60

Prerequisite : Knowledge in Engineering Mathematics

Objective : To familiarize the student with the different computational methods for communication systems

Outcome : Students will be able to apply the mathematics concepts to intelligent communication systems and subsystems.

Module I: Probability and Stochastic Process **12 Hours**

Random variables: conditional probability - discrete and continuous random variables, Cumulative Distribution Function (CDF) - Probability Mass Function (PMF) - Probability Density Function (PDF) - conditional PMF/PDF - classification of stochastic process - stationary process (SSS and WSS).

Module II: Integral Equations **12 Hours**

Formulation of typical problems in terms of integral equations: wire antennas – scattering - apertures in conducting screens and waveguides - discontinuities in waveguides and microstrip lines; Solution of Integral equations: General Method of Moments (MoM) for the solution of integral-differential equations - choice of expansion and weighting functions - application of MoM to typical electromagnetic problems.

Module III: Finite Element Method **12 Hours**

Typical finite elements - Solution of two-dimensional Laplace and Poisson's equations - solution of scalar Helmholtz equation and applications of FEM in typical electromagnetic problems.

Module IV: Finite-difference Time-domain Method **12 Hours**

Finite differences - finite difference representation of Maxwell's equations and wave equation - numerical dispersion - Yee's finite difference algorithm - stability conditions - programming aspects - absorbing boundary conditions- applications of FDTD in patch antenna.

Module V: Instructional Activity **12 Hours**

Modeling - simulation and analysis of applications of different computational methods with related tools.

Reference Books:

1. Michel K.O, “Applied Probability and Stochastic Processes”, John Wiley and Sons, 2008.
2. Paboulis A, Unnikrishna P S, “Probability, Random Variables and Stochastic Processes”, 4th Edition, Tata McGraw Hill, 2002.
3. Harrington, R.F., "Field Computation by Moment Methods", Wiley- IEEE Press. 1993
4. Y. M. Desai , T. I. Eldho, “Finite Element Method with Applications in Communication Engineering”, Pearson Education, 2011.
5. Stephen D. Gedney, “Introduction to Finite Difference Time Domain Method”, Springer, 2011.
6. L. M. Delves, J. L. Mohamed, “Computational Methods for Integral Equations”, Cambridge University Press, 2011.
7. Peterson, A.F, Ray, S.L. and Mittra, R., "Computational Methods”, Wiley-IEEE Press. 1998

Hyperlinks:

1. https://nptel.ac.in/courses/108106152
2. https://onlinecourses.nptel.ac.in/noc22_ee105/preview
3. http://www.learnerstv.com/Free-engineering-Video-lectures-ltv122-Page1.html

ECEICS 522

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 523	INTELLIGENT COMMUNICATION SYSTEMS	3	1	0	4	60

Prerequisite : Basics of analog and digital communication systems and elementary knowledge of all communication systems.

Objective : To impart the new concepts of different intelligent communication systems.

Outcome : Students will aware of the principles and techniques used in intelligent communication systems

Module I: Microwave and Satellite Communication Systems **12 Hours**

Microwave communication systems - transmitters - receivers - line of sight propagation; Orbits of satellite - orbital effects on communication system's performance - satellite earth stations - satellite antennas and earth coverage - system noise temperature and G/T ratio - design of downlinks - uplink design - link design for specified C/N - VSAT systems.

Module II: Optical Communication System **12 Hours**

Prologue: Historical perspective - light sources - photodiodes - fiber losses - signal dispersion - pulse propagation - multichannel propagation - signal propagation - modulation schemes; OFDM for optical communications - MIMO optical communications - Detection Schemes; Coherent optical OFDM detection - optical MIMO detection.

Module III: Cellular Communication System **12 Hours**

Uniqueness of mobile radio environment - basic cellular system - analog and digital cellular systems - cell coverage - frequency reuse - channel interferences - cell splitting and handoffs - mobile antennas.

Module IV: Computer Communication **12 Hours**

Transmission modes - serial and parallel transmission - asynchronous – synchronous – simplex - half duplex - full duplex communication. Switching: circuit switching and packet switching - Networks: Network criteria - physical structures - network models - categories of networks - Interconnection of Networks: Internetwork - Network models: Layered tasks - OSI model - Layers in OSI model - TCP/IP protocol suite.

Module V: Instructional Activity **12 Hours**

Performance analysis of minimum of four communication systems through simulation using related platforms.

Reference Books:

1. Rappaport T S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson India, 2010.
2. Keiser G, "Optical Fiber Communication", 3rd Edition, Mc Graw Hill, 2003.
3. Pratt T, Bostian C W and Allnut J E, "Satellite Communications", 2nd Edition, John Willey and Sons, 2003.
4. Andrew S.Taneubauw and David J. Wethrall, "Computer Networks" , 5th edition, Prentice Hall, 2011.

Hyperlinks:

1. nptel.ac.in/courses/117104099/
2. nptel.ac.in/courses/117101002/
3. nptel.ac.in/courses/117104127/
4. nptel.ac.in/courses/117105131/
5. nptel.ac.in/courses/117102062/

ECEICS 523

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 524	MULTIMEDIA TECHNOLOGIES	3	1	0	4	60

Prerequisite : Advanced Digital Signal Processing

Objective : Students will be able to acquire knowledge about multimedia techniques and the methods to enhance quality of service in the multimedia systems.

Outcome : Develop effective strategies to deliver quality-of-experience in multimedia applications.

Module I: Introduction to Multimedia **12 Hours**

Introduction - Characteristics of multimedia presentation - Multimedia Components - Digital representation - media and data stream- Multimedia documents-task-production-sharing and distribution- Properties of a Multimedia system.

Module II: Multimedia Architectures **12 Hours**

User Interfaces - OS Multimedia Support - Multimedia Extensions - Hardware Support - Distributed Multimedia Applications - Real Time Protocols - Play Back Architectures - Synchronization - Document architecture - Hypermedia Concepts - Hypermedia Design - Digital Copyrights - Digital Library - Multimedia Archives.

Module III: Multimedia Compression Techniques **12 Hours**

Compression types and techniques - CODEC ;Text Compression - GIF coding standards; Audio Compression - ADPCM ; JPEG standards - JPEG 2000 compression - H.261 ; MPEG- MPEG 3- MPEG 7- MPEG 21 .

Module IV: Multimedia Communication & Applications **12 Hours**

Tele Services - Implementation of Conversational Services - Messaging Services - Retrieval Services - Tele Action Services - Tele Operation Services - Media Consumption - Media Entertainment - Virtual Reality.

Module V: Instructional Activity **12 Hours**

Simulation Using: Editing Tools - Image - sound- video; Painting and drawing Tools - 3D Modeling and animation Tools.

Reference Books:

1. Ralf Steinmetz, Klara Nahrstedt, “Multimedia Computing, Communications, and Applications”, Pearson India, 2009.
2. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw Hill Education, 2017.
3. Ralf Steinmetz, Klara Nahrstedt, “Multimedia Systems”, Springer, 2004.
4. Tay Vaughan, “Multimedia: Making it Work”, McGraw – Hill Education, Ninth Edition, 2014.
5. Jerry D. Gibson, Toby Berger, Tom Lookabaugh, Dave Lindergh, Richard L. “Baker Digital Compression for Multimedia: Principles and Standards”, Elsevier, 2006.

Hyperlinks:

1. https://www.tutorialspoint.com/multimedia/multimedia_introduction.htm
2. https://nptel.ac.in/courses/117105083

ECEICS 524

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 531	ADVANCED WIRELESS COMMUNICATIONS	3	1	0	4	60

Prerequisite : Basics of analog, digital and wireless communication.

Objective : To impart the new concepts in Advanced Wireless Communications.

Outcome : Students will able to understand the latest technologies used in advanced wireless communication systems.

Module I: Introduction **12 Hours**

Introduction about wireless communication : technical challenges of wireless communication - Structure of a wireless communication link - applications; Cellular architecture - frequency reuse - channel assignment - handoff - coverage and capacity improvement; Multiple access : FDMA/CDMA/TDMA/SDMA.

Module II: Propagation Principles **12 Hours**

Propagation principles: Propagation mechanisms - Path Loss Models ; Mobile Radio Propagation : Large Scale Path Loss - Ground Reflection Model – Shadowing - Outdoor Propagation Models - Indoor Propagation Models; Small Scale fading - types of small scale fading - parameters of mobile multipath channels - small scale multipath measurements - statistical models for multipath fading channels

Module III: Modulation and Detection **12 Hours**

Digital modulation: linear and constant envelope modulation techniques for wireless communication - error performance in fading channel; Detection: Equalization - different detection techniques used in wireless communication.

Module IV: MIMO Systems **12 Hours**

Types of MIMO Systems: Beam forming - spatial multiplexing - basic space time code: design principles - Alamouti scheme – STBC - STTC - representation of space - comparison of space - time block and trellis codes.

Module V: Instructional Activity **12 Hours**

Simulation of minimum of (two) modulation - multiple access technique and MIMO schemes for wireless communication using related tools.

Reference Books:

1. Andreas Molisch F, “Wireless Communications”, John Wiley and Sons Ltd., 2011.
2. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, Cambridge University Press, 2005.
3. Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, 2nd Edition, Prentice Hall of India, 2005.
4. Guillaume De La Roche, Andres Alayon Glazunov and Ben Allen, “LTE – Advanced and Next Generation Wireless Networks: Channel Modelling and Propagation”, John Wiley and Sons Ltd., 2013
5. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.
6. Michel DaoudYacoub, “Wireless Technology: Protocols, Standards, and Techniques”, CRC Press, 2002.
7. Jafarkhani H, “Space-Time Coding: Theory & Practice”, Cambridge University Press, 2005.

Hyperlinks:

1. https://saravanyablog.files.wordpress.com/2017/04/andreas-f-molisch-wireless-comm.pdf
2. http://freevideolectures.com/Course/2329/Wireless-Communication
3. https://videoken.com/search-results
4. http://ee.sharif.edu/~wireless.comm.net/references/Tse, Fundamentals of Wireless Communication.pdf
5. http://ee.sharif.edu/~pr.wireless.comm/references/Goldsmith.pdf

ECEICS 531

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 532	ANALOG AND DIGITAL IC DESIGN	2	1	0	3	45

Prerequisite : VLSI systems and design

Objective : Students will be able to understand the basic concepts of Analog and Digital IC design.

Outcome : Students will be able to build, design and analyze the Combinational and Sequential circuit.

Module I: Analog Integrated Circuit **9 Hours**

Introduction to Analog Integrated Circuits: Analog Integrated Circuit design- Notation - Symbols and Terminology - CMOS Technology: Basic MOS semiconductor fabrication process -The MOS Transistor- Integrated Circuit Layout - CMOS Device Modeling- Simple MOS Large Signal Model- Small Signal Model for the MOS Transistor.

Module II: CMOS Operational Amplifier **9 Hours**

CMOS Operational Amplifier: Introduction and analysis of Cascode Amplifier and Telescopic Cascode Amplifier - Design of CMOS op-amps - Compensation of Op-amps -Design of Two stage op-amps, Cascode op-amps.

Module III: Combinational MOS Logic Circuits **9 Hours**

Introduction - MOS logic circuits with depletion NMOS loads: two - input NOR gate, generalized NOR structure with multiple inputs - transient analysis of NOR gate - two-input NAND gate - generalized NAND structure with multiple inputs - transient analysis of NAND gate - CMOS logic circuits.

Module: Sequential MOS Logic Circuits **9 Hours**

Introduction -SR latch circuit - clocked SR latch - clocked JK latch - master-slave flip-flop - CMOS D-latch and Edge- triggered flip-flop - Schmitt trigger circuit.

Module V: Instructional Activity **9 Hours**

Simulation: CMOS operational Amplifier- MOS: Combinational and Sequential Circuits.

Reference Books:

1. P. Allen and D. Holberg, “CMOS Analog Circuit Design”, Oxford University Press, Second Edition, 2012.
2. B. Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2003.
3. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley Publishers, Fifth Edition, 2009.

Hyperlinks:

1. https://nptel.ac.in/courses/117106030
2. https://nptel.ac.in/courses/108106158

ECEICS 532

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 533	ANTENNA ENGINEERING	2	1	0	3	45

Prerequisite : Electromagnetics and antenna theory.

Objective : To learn the antenna radiation concepts, different types of antenna and their design methodology.

Outcome : Students will be able to design different types of antenna for various applications.

Module I: Concepts of Radiation and Antenna Fundamentals **9 Hours**

Physical concept of Radiation: Radiation from surface and line current distributions - fundamental parameters of antennas - Friss Transmission Equation - radiation integrals and auxiliary potential functions - Near and Far Field regions - Reciprocity and reaction theorems - radiation hazards and solutions

Module II: Aperture and Reflector Antennas **9 Hours**

Huygens's principle - radiation from rectangular and circular apertures - design considerations - Babinets principle - radiation from sectoral - pyramidal - conical and corrugated Horns - design concepts of parabolic reflectors and cassegrain antennas.

Module III: Broadband Antennas **9 Hours**

Principles - frequency independent antennas - design and properties of log periodic - Yagi-Uda antennas - loop antennas - helical antennas - biconical antennas - broadcast antenna - spiral antenna and slot antennas.

Module IV: Microstrip Antennas **9 Hours**

Microstrip Antennas: Radiation mechanism - parameters and applications - feeding methods - design of rectangular and circular patch - impedance matching of microstrip antennas - broadband - compact and tunable microstrip antennas.

Module V: Instructional Activity **9 Hours**

Design, simulation and analysis of different antennas for wireless applications using related simulation tools.

Reference Books:

1. Jordan E C and Balmain K G, “Electromagnetic Waves and Radiating Systems”, 2nd Edition, Pearson Education, 2015.
2. Balanis C A, “Antenna Theory: Analysis and Design”, 4th Edition, John Wiley and Sons, New Jersey, 2016.
3. Kraus J D and Marhefka R J, “Antennas for All Applications”, 3rd Edition, Tata McGraw Hill, 2002.
4. Elliot R S, “Antenna Theory and Design”, Revised Edition, John Wiley and Sons, India, 2006.
5. Girish Kumar and Ray K P, “Broadband Microstrip Antennas”, Artech House, 2003.

Hyperlinks:

1. http://www.nptel.ac.in/courses/117107035/
2. http://www.nptel.ac.in/courses/108101092/
3. http://www.nptel.ac.in/courses/108104099/
4. http://www.nptel.ac.in/courses/108104087/

ECEICS 533

Course Code	Name of the Course	Periods			Credits	Total Hours
ECEICS 534	ARTIFICAL INTELLIGENCE	L	T	P	3	45
		2	1	0		

Prerequisite : Digital Signal processing and Pattern Recognition

Objective : To understand the basic concepts and algorithms of Artificial Intelligence.

Outcome : Students will be able to design and implement Artificial Intelligent techniques for various applications

Module I: Introduction and Problem Solving **9 Hours**

Artificial Intelligence -Introduction - Problem-solving - Solving Problems by Searching - Uninformed Search Strategies - Informed (Heuristic) Search Strategies - Local Search - Search in Partially Observable Environments.

Module II: Adversarial Search and Constraint Satisfaction Problems **9 Hours**

Game Theory - Optimal Decisions in Games - Heuristic Alpha-Beta Tree Search - Monte Carlo Tree Search - Stochastic Games - Partially Observable Games - Limitations of Game Search Algorithms Constraint Satisfaction Problems (CSP) - Examples - Constraint Propagation -Backtracking Search for CSPs - Local Search for CSPs

Module III: Knowledge, Reasoning and Planning **9 Hours**

First Order Logic - Inference in First Order Logic - Using Predicate Logic - Knowledge Representation - Issues - Categories and Objects - Reasoning Systems for Categories - Planning - Definition - Algorithms - Heuristics for Planning - Hierarchical Planning

Module IV: Uncertain Knowledge and Reasoning **9 Hours**

Quantifying Uncertainty - Probabilistic Reasoning - Probabilistic Reasoning over Time Probabilistic Programming - Making Simple Decisions - Making Complex Decisions - Case Based Reasoning - Evolutionary Computation

Module V: Instructional Activity **9 Hours**

Solve puzzles with uninformed and informed searches - Reasoning methods through puzzles and real life scenarios - Give example scenarios where probabilistic reasoning and case based reasoning can be applied-Discuss some case studies and their ethical issue

Reference Books:

1. Stuart Russell, Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson, 4th Edition, 2020.
2. Zhong zhi Shi “Advanced Artificial Intelligence”, World Scientific; 2019.
3. Kevin Knight, Elaine Rich, Shiva Shankar B. Nair, “Artificial Intelligence”, McGraw Hill Education; 3rd edition, 2017
4. Richard E. Neapolitan, Xia Jiang, “Artificial Intelligence with an Introduction to Machine Learning”, Chapman and Hall/CRC; 2nd edition, 2018
5. Deepak Khemani, “A first course in Artificial Intelligence”, McGraw Hill Education Pvt Ltd., New Delhi, 2013.
6. Nils J. Nilsson, “Artificial Intelligence: A New Synthesis”, Morgan Kaufmann Publishers Inc; Second Edition, 2003.

Hyperlinks:

1. https://nptel.ac.in/courses/106102220
2. https://nptel.ac.in/courses/106105077

ECEICS 534

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 535	BIOSENSORS	2	1	0	3	45

Prerequisite: Semiconductor Devices and MEMS

Objective : To make the students to understand the usage of different sensors for various biomedical applications.

Outcome : Students will able to analyze different bio sensors and its effective usage for the real time applications.

Module I: Introduction to Biosensors **9 Hours**

Basic principle of bio sensor- components of bio sensor- classification of biosensors - applications.

Module II: Semiconductors substrates **9 Hours**

Semiconductor substrates for bio electronics - silicon - diamond - chemical functionalization - covalent attachment of biomolecules to silicon surfaces - DNA modified silicon and diamond surfaces.

Module III: Immune sensors **9 Hours**

Anti body as bio recognition element: Types of anti-bodies and anti-body fragments; Types of immune sensors - labeled and label-free sensors - immune sensor applications.

Module IV: Transducers in Biosensors **9 Hours**

Piezoelectric semiconductor - impedimetric - mechanical and molecular electronics based transducers - Chemi - luminescence based bio sensors.

Module V: Instructional Activity **9 Hours**

Simulation of biosensors for various applications: clinical chemistry-medicine and health care-veterinary - industrial processes - environmental monitoring using related tools.

Reference Books:

1. Itamar W and Eugenii K, “Bio electronics: From Theory to Applications”, Wiley VCH, 2005.
2. Chandran K, Kalpana B and Robson B, “Bio sensors and Bio electronics”, Elsevier, 2015.
3. Brian R E, “Biosensors an Introduction”, 1st Edition, Wiley, 1996.
4. Loic J B and Pierre R C, “Biosensors Principles and Applications”, 1st Edition, Marcel Dekker Inc, New York, 1991.
5. Donald G B, “Biosensors Theory and Applications”, 1st Edition, Technomic Co. Inc, Lancaster, 1993.

Hyperlinks:

1. http://freevideolectures.com/blog/2010/11/130-nptel-iit-online-courses/#
2. http://biomedikal.in/2011/02/lecture-notes-on-mems-technology/
3. http://www.learnerstv.com/Free-engineering-Video-lectures-ltv122-Page1.html

ECEICS 535

Course Code	Name of the Course	Periods			Credits	Total Hours
ECEICS 536	DIGITAL IMAGE PROCESSING AND PATTERN RECOGINTION	L	T	P	3	45
		2	1	0		

Prerequisite: Digital Image Processing

Objective : To understand the basic concepts and algorithms of Digital Image processing and Pattern Recognition

Outcome : Explore the possibility of applying image processing and pattern recognition concepts in various domains

Module I: Introduction to Digital Image Processing **9 Hours**

Introduction - Elements of visual perception - Digital Imaging System - Image Acquisition - Sampling and Quantization - Pixel Relationships - File Formats - Colour images and models - Image Operations - Arithmetic, logical, statistical and spatial operations.

Module II: Image Enhancement and Segmentation **9 Hours**

Spatial Domain - Gray level Transformations -Histogram Processing- Spatial Filtering - Smoothing and Sharpening. Frequency Domain: Filtering in Frequency Domain - Smoothing and Sharpening filters - Homomorphic Filtering; Segmentation: Detection of Discontinuities - Edge Operators - Edge Linking and Boundary Detection - Thresholding - Region Based Segmentation

Module III: Introduction to Pattern Recognition **9 Hours**

Learning paradigms - Supervised and unsupervised learning - Bayesian decision theory: Minimum error rate classifier; Parameter estimation: Maximum likelihood and Bayesian Estimation - Hidden Markov models - Nonparametric techniques: Nearest neighbor rules, Parzen windows; Decision trees: Axis-parallel, Oblique, Impurity measures.

Module IV: Statistical Pattern Recognition **9 Hours**

Introduction- Classification and Regression - Features - Feature vectors and Classifiers - Pre-processing and feature extraction - The curse of dimensionality - Polynomial curve fitting- Clustering-Hierarchical Clustering -K-means- Support Vector Machine.

Module V: Instructional Activity **9 Hours**

Simulation of preprocessing techniques - Implementation of image processing techniques for real time applications - Feature extraction techniques - Clustering techniques.

Reference Books:

1. Anil J Jain, “Fundamentals of Digital Image Processing”, PHI, 2011.
2. Rafael Gonzalez and Richard E.Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2008, New Delhi.
3. R. O. Duda, P. E. Hart and D. G. Stork, Pattern classification, John Wiley & Sons, 2002.
4. Theodoridis S and Koutroumbas K, “Pattern Recognition”, 4th edition, Academic Press,2009.

Hyperlinks:

1. https://nptel.ac.in/courses/108/105/108105134/

ECEICS 536

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 537	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	2	1	0	3	45

Prerequisite : Electromagnetic theory.

Objective : To expose the students on the fundamentals of electromagnetic interference and compatibility in the electronic system design.

Outcome : Students will able to know the EMI environment, coupling principles, specifications, standards and limits, measurements and control techniques, and EMC design of PCBs.

Module I: EMI Environment **9 Hours**

EMI/ EMC concepts and definitions: Sources of EMI - conducted and radiated EMI- transient EMI - time domain vs frequency domain EMI - units of measurement parameters.

Module II: EMI Coupling Principles and Standards **9 Hours**

Principles: Conducted, radiated and transient coupling - common impedance ground coupling- radiated common mode and ground loop coupling - radiated differential mode coupling - Near and Far Field cable to cable coupling - power mains and power supply coupling - units of specifications; Civilian Standards: FCC - CISPR - IEC - EN; Military Standards: MIL STD461D/ 462.

Module III: EMI Measurements **9 Hours**

EMI test instruments/ systems: EMI shielded chamber - open area test site - TEM cell - sensors/ Injectors/ Couplers - test beds for ESD and EFT.

Module IV: EMI Control Techniques **9 Hours**

Techniques: Shielding - filtering - grounding - bonding - isolation transformer - transient suppressors - cable routing - signal control - component selection and mounting.

Module V: Instructional Activity **9 Hours**

Simulation of minimum of (two) EMI coupling methods and controlling techniques with their performance analysis using related tools.

Reference Books:

1. V. P. Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press, 2001.
2. Henry W. Ott, “Noise Reduction Techniques in Electronic Systems”, Wiley, 1988.
3. C. R. Paul, “Introduction to Electromagnetic Compatibility”, Wiley, 2006.
4. Bernhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Edition, Artech house, 1986.

Hyperlinks:

1. http://www.nptel.iitm.ac.in/syllabus/syllabus.php?subjectId=117108043.
2. http://www.ieee.li/emc/

ECEICS 537

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 538	EMBEDDED SYSTEMS FOR NETWORKING	2	1	0	3	45

Prerequisite : Basics of Embedded Systems and Networking

Objective : To impart the Embedded Systems for Communication designs

Outcome : Students will be able to analyze the advanced technical design details behind the Embedded Systems and Networking.

Module I: Embedded Communication Protocols **9 Hours**

Embedded Networking: Introduction–Serial / Parallel Communication–Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols - Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming -ISA/PCI Bus protocols – Firewire

Module II : USB and CAN Bus USB Bus **9 Hours**

Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets – Data flow types –Enumeration –Descriptors –PIC 18 Microcontroller USB Interface – C Programs – CAN Bus – Introduction - Frames –Bit stuffing –Types of errors – Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN

Module III: Controller Area Network **9 Hours**

Controller Area Network – Underlying Technology, CAN Overview – Selecting a CAN Controller – CAN development tools. Implementing CAN open Communication layout and requirements – Comparison of implementation methods – Micro CAN open – CAN open source code – Conformance test – Entire design life cycle.

Module IV: Wireless Embedded Networking **9 Hours**

Wireless sensor networks – Introduction – Applications – Network Topology – Localization – Time Synchronization - Energy efficient MAC protocols –SMAC – Energy Efficient and robust routing – Data Centric routing.

Module V: Instructional Activity **9 Hours**

Design 8051, PIC and 16 bit processors for I/O programming, serial port programming for PWM generation, motor control, LCD, RTC and Sensor interfacing and to design and analyse wired/wireless networks using NS2 simulator.

Reference Books

1. Frank Vahid, Givargis 'Embedded Systems Design: A Unified Hardware/Software Introduction', Wiley Publications
2. Jan Axelson, 'Parallel Port Complete', Penram publications
3. Dogan Ibrahim, 'Advanced PIC microcontroller projects in C', Elsevier 2008
4. Jan Axelson 'Embedded Ethernet and Internet Complete', Penram publications
5. Bhaskar Krishnamachari, 'Networking wireless sensors', Cambridge press 2005

Hyperlinks:

1. http://advancedengineering.umd.edu/node/2320
2. http://ece564web.groups.et.byu.net
3. http://personal.stevens.edu/~yyao/syllabus-674.html
4. http://staff.um.edu.mt/carl.debono/lectures.html

ECEICS 538

Course Code	Name of the Course	Periods			Credits	Total Hours
ECEICS 539	HIGH PERFORMANCE COMMUNICATION NETWORKS	L	T	P	3	45
		2	1	0		

Prerequisite : Fundamentals of computer networks and wireless networks.

Objective : To learn the architecture and uniqueness of high performance networks.

Outcome : Students will be able to understand the various topologies, services offered by broadband, WiMAX, UWB and LTE networks.

Module I: Introduction **9 HOURS**

Communication Networks: Telephone and Computer Networks - Cable Television Networks - Wireless Networks; Networking principles : Network Mechanisms - Network Elements - digitalization - network externalities - traffic characterization and QoS - service integration - Network bottle Necks; Layered architecture: OSI/ISO - TCP/IP - BISDN architecture

Module II: Flow Control And Traffic Management **9 Hours**

Link-level flow and error control: Main objectives of flow and error control - Window flow control - Rate control schemes - FEC and ARQ Schemes; Traffic Management: Traffic and Congestion control in high speed networks; Queuing models

Module III: Internet And TCP / IP Networks **9 Hours**

Internet Protocol (IP): Technology trends in IP networks - IP packet communications in mobile communication networks; TCP and UDP: performance of TCP/ IP networks; Circuit switched networks: SONET - DWDM - fiber to the home - DSL; Intelligent Network (IN) scheme : comparison with conventional systems - merits of the IN scheme; CATV network: System and Layered Architecture - services over CATV.

Module IV: Enabling Networks **9 Hours**

WiMAX overview : system architecture - frame structure - PMP mode - mesh mode - multihop relay mode; UWB : overview - time hopping UWB - direct sequence UWB - multiband UWB; LTE and LTE- A overview - system model - frame structure - comparison with broadband technologies.

Module V: Instructional Activity **9 Hours**

Simulation study: WiMAX network in mesh mode and multihop relay mode - integration of LTE - and WiMAX network with single IP network.

Reference Books:

1. Jean Warland and Pravin Varaiya, “High Performance Communication Networks”, 2nd Edition, Harcourt and Morgan Kanffman Publishers, London, 2008.
2. Leon Gracia and Widjaja, “Communication Networks”, Tata Mc Graw Hill, 2008.
3. Jeffrey G. Andrews, Arunabha Ghosh and Rias Muhamed, “Fundamentals of WiMAX Understanding Broadband Wireless Networking”, Prentice Hall of India, 2008.
4. AmitabhaGhosh and Rapeepat Ratasuk, “Essentials of LTE and LTE-A”, Cambridge University, 2011.
5. David Tung Chong Wong, Peng-Yong Kong, Ying-Chang Liang, Kee Chaing Chua and Jon W. Mark, “Wireless Broadband Networks”, John Wiley and Sons, 2009.
6. Ada Gavrilovska, “Attaining High Performance Communications: A Vertical Approach”, CRC Press, 2016.
7. Dimitris N. Chorafas, “High-Performance Networks, Personal Communications and Mobile Computing”, Springer, 2016.

Hyperlinks:

1. http:// www.ece.gmu.edu/.../high performance communication networks_1.pdf
2. http://www.amazon.com/dp/1558605746/ref=rdr_ext_tmb

ECEICS 539

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 540	INFORMATION SECURITY	2	1	0	3	45

Prerequisite : Digital Image Processing

Objective : To understand the basic security algorithms required by any computing system.

Outcome : The students may be now aware of the security challenges and issues that may arise in any digital system.

Module I: Basics of Digital Cryptography **9 Hours**

Classical Cryptography-The Shift Cipher, The Substitution Cipher, The Affine Cipher Cryptanalysis Techniques - Encryption Evaluation metrics.

Module II: Introduction To Digital Steganography **9 Hours**

Types of Steganography - Applications of Steganography - Embedding Security and Imperceptibility -The Visual Steganalytic System - IQM-Based Steganalytic System - Learning Strategies -The Frequency-Domain Steganalytic System.

Module III: Digital Watermarking **9 Hours**

Digital Watermarking - Differences between Watermarking and Steganography - A Brief History of Watermarking – Classification in Digital Watermarking – Least Significant-Bit Substitution - Discrete Fourier Transform (DFT) - Discrete Cosine Transform – Discrete Wavelet Transform - Random Sequence Generation - The Chaotic Map - Error Correction Code – Set Partitioning in Hierarchical Tree

Module IV: Cyber Security Attack **9 Hours**

Attacks and Tools - Image Processing Attacks – Cryptographic Attack Protocol Attacks - Steganographic Attack.

Module V: Instructional Activity **9 Hours**

Simulation: Cryptographic techniques – Steganographic techniques – Role of digital watermarking in real time applications.

Reference Books:

1. Frank Shih, “Digital Watermarking and Steganography: Fundamentals and Techniques, CRC Press, 2014.
2. Douglas R. Stinson, “Cryptography Theory and Practice”, Third Edition, Chapman &Hall/CRC, 2006
3. Fathi E. Abd El-Samie, HossamEldin H. Ahmed, Ibrahim F. Elashry, Mai H. Shahieen, Osama S. Faragallah, El-Sayed M. El-Rabaie, “Image Encryption: A Communication Perspective”, CRC Press, 2013.
4. Wenbo Mao, “Modern Cryptography – Theory and Practice”, Pearson Education, First Edition, 2006.

Hyperlinks:

1. https://nptel.ac.in/courses/106105031
2. https://freevideolectures.com/course/4070/nptel-ethical-hacking/36

ECEICS 540

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 541	LOW POWER DIGITAL VLSI DESIGN	2	1	0	3	45

Prerequisite : Fundamentals of VLSI design.

Objective : To discuss low power design methodologies at various design levels from the circuit level to the system level and also power estimation with optimization techniques.

Outcome : Students will be able to design low power VLSI circuits.

Module I: Power Dissipation **9 Hours**

Introduction: Need for low power circuit design - sources of power consumption - design methodology - low power figure of merits - limits and applications of low power VLSI Design.

Module II: Power Analysis **9 Hours**

Power Analysis: SPICE circuit simulation - discrete transistor modeling and analysis - gate level logic simulation - architecture level analysis - data correlation analysis; Probabilistic Power Analysis: Random logic signals - probabilistic power analysis techniques - signal entropy.

Module III: Circuit and Logic Level **9 Hours**

Circuit Level: Transistor and gate sizing - equivalent pin ordering - network restructuring and reorganization - special latches and flip flops; Logic level: Gate reorganization - signal gating - logic encoding - precomputation logic- FINFET logic.

Module IV: Energy Recovery Techniques **9 Hours**

Energy recovery techniques: Energy dissipation using the RC model - energy recovery circuit design - power reduction in clock networks - low power bus - delay balancing.

Module V: Instructional Activity **9 Hours**

Simulation study: Sources of power dissipation in SRAMs - low power SRAM circuit techniques; Sources of power dissipation in DRAMs - low power DRAM circuit techniques using related tools

Reference Books:

1. Kaushik R and Sharat C P, “Low-Power CMOS VLSI Circuit Design”, Wiley Student Edition, 2009.
2. Gary K Y, “Practical Low Power Digital VLSI Design”, Kluwer Academic Publishers, 1998.
3. Bellaouar A and Elmasry M, “Low-Power Digital VLSI Design: Circuits and Systems”, Kluwer Academic Publishers, 1995.
4. Chandrakasan A and Robert W B, “Low-Power CMOS Design”, Wiley-IEEE Press, 1998.
5. Rabaey J M and Massoud P, “Low Power Design Methodologies”, Kluwer Academic Publishers, 1995.
6. Kiat-Seng Y and Kaushik R, “Low-Voltage, Low-Power VLSI Subsystems”, TMH Professional Engineering, 2009.
7. Soudris D, Piguet C and Goutis C, “Designing CMOS Circuits for Low Power”, Kluwer Academic Publishers, 2002.

Hyperlinks:

1. http://www.nptel.iitm.ac.in/courses/106105034/
2. http://www.eeherald.com/section/design-guide/Low-Power-VLSI-Design.html

ECEICS 541

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 542	MEMS and NEMS	2	1	0	3	45

Prerequisite : Knowledge in basic sensors, actuators and various fabrication techniques.

Objective : To teach the principles in respect of micro and nano electronics, and MEMS /NEMS.

Outcome : The students will come out with a complete knowledge of micro and nano fabrication concepts, micro and nano sensors. MEMS/NEMS for real- time application.

Module I: MEMS **9 Hours**

Introduction: Need for miniaturization technology - from perception to realization - overall MEMS market size - MEMS market character – Silicon MEMS - non-Silicon MEMS - MEMS versus traditional precision engineering.

Module II: Micro Sensors and Actuators **9 Hours**

Sensing and actuation - case studies of real devices; Sensing mechanisms: piezoelectric - piezoresistive - capacitive; Actuation mechanisms: piezoelectric - electrostatic - magnetic and thermal; Physical sensors - opto - fluids - sensors for turbulence measurement and control - micro - actuators for flow control.

Module III: Nanomaterials and Nano devices **9 Hours**

Introduction to nanomaterials : properties of nanomaterials - role of size in nanomaterials and nanoparticles - semiconducting nanoparticles; Nanowires - nanoclusters - quantum wells - conductivity - Carbon Nanotube (CNT): structure of CNT and its properties; Nanosensors- structure- applications

Module IV: Micro and Nano Fabrication Techniques **9 Hours**

Introduction to Lithography: Pattern transfer with different techniques - E beam lithography; Micromachining: Size effect in micromachining - mechanical micromachining; Oxidation - CVD of nanostructures - CVD diamond technology for NEMS and MEMS applications - nano crystals - nanowires - nanolithography - etching techniques.

Module V: Instructional Activity **9 Hours**

Simulation of minimum of five MEMS/ NEMS using related tools.

Reference Books:

1. Marc J M, “Fundamentals of Microfabrication: The Science of Miniaturization”, 2nd Edition, CRC Press, 2002.
2. Groffrey A O, Andre C A and Ludovico C, “Nanochemistry: A chemical approach to nanomaterials”, 2nd Edition, RSC Publishing, 2009.
3. Schmidt G, “Nanoparticles: From theory to applications”, Wiley, 2006.
4. Jackson M J, “Microfabrication and Nanomanufacturing”, CRC Press, 2005.
5. Nadim M and Williams K, “An introduction to Microelectromechanical Systems Engineering”, 2nd Edition, Artech House, 2004.
6. Stephen B, Graham E, Michael K and Neil W, “MEMS Mechancial Sensors”, Artech House, 2004.
7. Stephen D S, “Microsystem Design”, Kluwer Academic Publishers, 2002.
8. Michael J O, “Carbon Nanotubes: Properties and Applications”, CRC Press, 2006.
9. Rao C N R and Govindaraj A, “Nanotubes and Nanowires”, RCS Publishing, 2005.
10. Kouroush K, Benjamin F, “Nanotechnology enabled sensors”, Springer, 2008.
11. Jackson M J, “Micro fabrication and Nanomanufacturing”, CRC press, 2005.
12. Cao G and Wang Y, “Nanostructures and Nanomaterials: Synthesis, properties and applications”, 2nd Edition, World Scientific, 2011.

Hyperlinks:

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-152j-micro-nano-processing-technology-fall-2005/
2. http://www.lithoguru.com/scientist/CHE323/
3. http://www.iap.uni-jena.de/iapmedia/de/Lecture /Micro_+and+Nano_Technology1505685600/MNT2017_1_Introduction.pdf

ECEICS 542

Course Code	Name of the Course	Periods			Credits	Total Hours
ECEICS 543	MICROWAVE THEORY AND TECHNOLOGY	L	T	P	3	45
		2	1	0		

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Prerequisite : Knowledge in electromagnetic waves, transmission lines and circuit

Objective : To make the students to have a clear knowledge about different concepts of microwave circuits.

Outcome : Students will be aware of different microwave circuits' and their working principles.

Module I: Introduction **9 Hours**

Two port network characterization: Scattering matrix representation of microwave components - maximum power transfer theorem; Transmission lines: Need - quarter wave transformer - smith chart.

Module II: Planar Transmission lines **9 Hours**

Strip line - microstrip line - coplanar waveguide - coplanar strips - slot line - Fin line and characteristics - properties - design parameters and its applications

Module: Microstrip Components **9 Hours**

3dB hybrid design - backward directional coupler - hybrid ring and power dividers - MIC filters - Kuroda transformation - K inverter - J inverter - resonator filters - realization using microstrip lines.

Module IV: Substrate Integrated Waveguide **9 Hours**

Substrate Integrated Waveguide: Substrate integrated waveguide technology - design of SIW - losses in SIW - SIW circuits composed of metallic posts - SIW circuits with dielectric posts.

Module V: Instructional Activity **9 Hours**

Simulation of (minimum of four) two port networks using various microwave circuits with the help of related tools; Assignments on applications of microwave circuits: space/defense/wireless.

Reference Books:

1. Hoffman R K, “Handbook of Microwave Integrated Circuits”, Artech House, 1987.
2. Gupta. K. C and R. Garg, “Microstrip Line and Slot Line”, Artech House, 1996.
3. Ravender Goyal, “Monolithic MIC Technology & Design”, Artech House, 1989.
4. Gupta K C and Amarjit S, “Microwave Integrated Circuits”, John Wiley, 1974.
5. Ramesh G, Inder B, Maurizio B, “Microstrip Line and Slot Line”, Artech House, 3rd Edition, 2013.

Hyperlinks:

1. http://nptel.iitm.ac.in/syllabus/117105029/
2. http://www.microwaves101.com/encyclopedia/
3. ieeexplore.ieee.org/iel5/4126157/5936981/05936990.pdf
4. ieeexplore.ieee.org/document/7546658/
5. journal.utem.edu.my/index.php/jtec/article/view/836
6. downloads.hindawi.com/journals/ijap/2013/746920.pdf

ECEICS 543

Course Code	Name of the Course	Periods			Credits	Total Hours
ECEICS 544	OPTICAL COMMUNICATION AND NETWORKS	L	T	P	3	45
		2	1	0		

Prerequisite : Fiber Optics

Objective : To enable the student to understand the basic principles of operation of optical system components, the different network architectures and issues associated with network design.

Outcome : At the end of the course the student would be able to demonstrate an understanding of the differences and challenges involved in the design of optical systems and networks.

Module I: Optical System Components **9 Hours**

Optical System Components – MZIM, Multiplexers; filters; switches; wavelength converters; optical amplifiers – EDFA, Raman Amplifiers and hybrid; Transmission system Engineering – System Model, transmitter, receiver, cross talk, dispersion compensation, wavelength stabilization, FWM.

Module II: Coherent Systems **9 Hours**

Basic principles of Coherent detections – Practical constraints – Injection laser line width state of polarization, local oscillator power, fiber limitations; Modulation formats – ASK, FSK, PSK, DPSK and polarization shift keying (POL SK); Demodulation schemes – Homodyne - Heterodyne – Synchronous and Non synchronous detection; Comparison; Carrier recovery in Coherent detection.

Module III: Optical Network Architectures **9 Hours**

Introduction to Optical Networks; First Generation optical networks –SONET / SDH Network - Second Generation (WDM) Optical Networks - Need for Multilayered Architecture - Layers and Sub-layers - Spectrum partitioning - Optical Network Nodes - Network Access Stations - Overlay Processor - Logical network overlays.

Module IV: Optical Network Survivability **9 Hours**

Protection and Restoration Objectives - Fault Protection and Restoration Techniques in the Logical Layer – Point-to-Point Systems - SONET Self-Healing Rings - Interconnection Techniques - Architectures with Arbitrary Mesh Topologies - Optical-Layer Protection: Point-to-Point and Ring Architectures - Mesh Architectures.

Module V: Instructional Activity **9 Hours**

Simulate and study at least two of the above-mentioned concepts using the appropriate simulator - Design and analysis of a particular sub-system and comparison with others - Numerical computation of the above concepts.

Reference Books:

1. Max Ming-Kang Liu, —Principles and Applications of Optical Communication‖, Tata McGraw Hill Education Pvt., Ltd., New Delhi, 2012.
2. Thomas E. Stern, Georgios Ellinas, Krishna Bala, —Multiwavelength Optical Networks – Architecture, Design and control —, Cambridge University Press, 2nd Edition, 2009.
3. Rajiv Ramaswami and Kumar N. Sivarajan, —Optical Networks : A Practical Perspective‖, Harcourt Asia Pte Ltd., Second Edition 2006.
4. P.E. Green, Jr., —Fiber Optic Networks‖, Prentice Hall, NJ, 1993.

Hyperlinks:

1.https://www.frontiersin.org/journals/communications-and-networks/sections/optical-communications-and-networks

ECEICS 544

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 545	OPTO ELECTRONIC DEVICES	2	1	0	3	45

Prerequisite: Fiber Optics

Objective : To enable the student to understand the basic principles of operation of opto-electronic devices

Outcome : At the end of the course the student would be able to demonstrate an understanding of the differences and challenges involved in the design of opto-electronic devices.

Module I:Elements of Light And Solid State Physics **9 Hours**

Wave nature of light - Polarization - Interference - Diffraction - Light Source - review of Quantum Mechanical concept - Review of Solid State Physics - Review of Semiconductor Physics and Semiconductor Junction Device.

Module II: Display Devices And Lasers **9 Hours**

Introduction - Photo Luminescence - Cathode Luminescence - Electro Luminescence - Injection Luminescence - Injection Luminescence - LED - Plasma Display - Liquid Crystal Displays Numeric Displays - Laser Emission - Absorption - Radiation - Population Inversion - Optical Feedback - Threshold condition - Laser Modes - Classes of Lasers - Mode Locking - laser applications.

Module III: Optoelectronic Modulator **9 Hours**

Introduction - Analog and Digital Modulation - Electro-optic modulators - Magneto Optic Devices - Acoustoptic devices - Optical - Switching and Logic Devices - Photo detector - Thermal detector - Photo Devices - Photo Conductors - Photo diodes - Detector Performance.

Module IV: Optoelectronic Integrated Circuits **9 Hours**

Introduction - hybrid and Monolithic Integration - Application of Opto Electronic Integrated Circuits - Integrated transmitters and Receivers - Guided wave devices.

Module V: Instructional Activity **9 Hours**

Simulate and study at least two of the above-mentioned concepts using the appropriate simulator - Design and analysis of a particular sub-system and comparison with others. Numerical computation of the above concepts.

Reference Books:

2. J. Wilson and J.Haukes, “Opto Electronics – An Introduction”, Prentice Hall of India Pvt. Ltd., New Delhi, 1995.
3. Bhattacharya “Semiconductor Opto Electronic Devices”, Prentice Hall of India Pvt., Ltd., New Delhi, 1995.
4. Jasprit Singh, “Opto Electronics – As Introduction to materials and devices”, McGraw-Hill International Edition, 1998.

Hyperlinks:

1.https://ece.mst.edu/media/academic/ece/documents/coursenotes/ee2200introductiontoelectronicdevices/EE_2200_Lecture_C-2.pdf

ECEICS 545

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 546	REAL TIME EMBEDDED SYSTEM DESIGN	2	1	0	3	45

Prerequisite : Fundamentals in advanced microcontrollers and embedded systems

Objective : To study various SOC, RTOS concept, programming of various communication interfaces for automatic systems

Outcome : Students will be able to understand the SOC concepts and the programming for automatic systems.

Module I:Introduction to Embedded Automatic Systems **9 Hours**

Embedded Automatic Systems (EAC): Overview - architecture; Components of the system: Processors-memories and interconnects - processor architectures - memory and addressing: SOC memory examples - addressing.

Module II: System On Chip **9 Hours**

Introduction to Arduino :Types of Arduino devices - common Arduino shields - Beagle Bone ; Introduction to Raspberry Pi

Module III: Communication Interfaces and Python Basics **9 Hours**

Communication interfaces: I2C- SPI Bus- UART- RS-232- RS-485- USB- IEEE 139.4 (Firewire) - Infrared (IRDA) - Bluetooth - Wi-Fi - ZigBee – GPRS; Python basics: Introduction - variables - displaying output - reading user input - arithmetic - operations on strings - running commands conditionally - comparing values - logical operators- loops.

Module IV: RTOS Programming **9 Hours**

Tasks and Task states - semaphores - shared data - message queues - mail boxes and pipes - memory management - interrupt routines - encapsulating semaphore and queues - task management - inter task communication - process input/ output.

Module V: Instructional Activity **9 Hours**

RFID based attendance management system - embedded video processing - home automation systems using Raspberry Pi/ Arduino /any other SOC.

Reference Books:

1. Michael J F and Wayne L. “Computer System Design: System-on-Chip”, John Wiley and Sons, 2011.
2. Hughes M J, “Arduino: A Technical Reference”, 1st Edition, O’REILY, 2016.
3. David E S, “An Embedded software premier”, Pearson Education, 1999.
4. Shibu, “Introduction to Embedded Systems”, 1st Edition, Tata McGraw Hill, 2009.
5. Simon M, “Raspberry Pi Cookbook”, 2nd Edition, O’REILY, 2014.
6. Richardson M and Shawn W, “Make: Getting Started with Raspberry Pi”, 3rd Edition, O’REILY, 2016.
7. Prasad K V K K, “Embedded/ Real-Time Systems”, Dream Tech Press, 2003.
8. Hermann K, “Real–Time systems – Design Principles for Distributed Embedded Applications”, 2nd Edition, Springer, 2011.
9. Derek M, “Top of Form Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux”, Wiley, 2015.

Hyper Links:

1. https://makezine.com/2013/04/15/arduino-uno-vs-beaglebone-vs-raspberry-pi/
2. https://www.arduino.cc/en/Main/Boards

ECEICS 546

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 711	INTERNET OF EVERY THINGS (IoE)	2	1	0	3	45

Prerequisite : Basics of computer communication networks and wireless sensor networks

Objective : To study the architecture and security principles of Internet of Everything's (IoE).

Outcome : Students will be able to design efficient IoE based projects.

Module I: Introduction **9 Hours**

IoT: Architectural overview - main design principles - standards considerations; M2M and IoT technology fundamentals: devices and gateways - data management - business processes in IoT - everything as a service - M2M and IoT analytics - knowledge management.

Module II : IoE Sensors **9 Hours**

Sensors for IoE: Wireless sensor structure - energy storage module - power management module - RF Module - sensing module.

Module III: IoE Security **9 Hours**

Security requirements in IoE architecture - security in enabling technologies - security concerns in IoE applications: Architecture - insufficient authentication/authorization - insecure access control - threats to access control, privacy, and availability - attacks specific to IoE.

Module IV: IoE Testbed **9 Hours**

ACOEM Eagle - EnOcean Push Button - NEST sensor - Ninja blocks focus on wearable electronics.

Module V: Instructional Activity **9 Hours**

Simulation of (minimum of any five) IoE applications - home and office infrastructures - security - home appliances and other IoE electronic equipment- interfacing of sensor with sensor node using any embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino).

Reference Books:

1. Asoke K Talukder and Roopa R Yavagal, “Mobile Computing: Technology, Application and Service Creation”, Tata McGraw Hill, 2010.
2. William Stallings, “Data and Computer Communications”, 8th Edition, Pearson Education Pte. Ltd., 2009.
3. Adelstein F and Gupta S.K.S, “Fundamentals of Mobile and Pervasive Computing”, McGraw Hill, 2009.
4. Barrie Sosinsky, “Cloud Computing Bible”, Wiley-India, 2010.
5. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015.
6. Manoel Carlos Ramon, “Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 2014.
7. Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014.

Hyperlinks:

1. https://www.ibm.com/developerworks/library/iot-top-tutorials-aug2017/index.html
2. https://www.codeproject.com/Learn/IoT/
3. https://www.edureka.co/blog/iot-tutorial/
4. https://www.bbvaopenmind.com/en/the-internet-of-everything-ioe/

ECEICS 711

Course Code	Name of the Course	Periods			Credits	Total Hours
ECEICS 712	MACHINE LEARNING AND DEEP LEARNING	L	T	P	3	45
		2	1	0		

Prerequisite : Digital Image Processing and Pattern Recognition

Objective : To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning

Outcome : Students will be able to understand and outline problems for various applications.

Module I: Supervised Learning **9 Hours**

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

Module II : Unsupervised Learning and Reinforcement Learning **9 Hours**

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.

Module III: Neural Networks **8 Hours**

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

Module IV : Convolutional Neural Network **10 Hours**

About CNN - Building a Convolutional Neural Network- Input Layers - Convolution Layers- Pooling Layers - Dense Layers - Backpropagation through the Convolutional Layer and pooling layer - Various Optimizers: LeNet - AlexNet - VGG16 - ResNet. 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 V: Instructional Activity **9 Hours**

Study at least 3 Tools available for Machine Learning and discuss pros & cons of each- 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-Develop a CNN - R-CNN - Fast R-CNN - Faster-R-CNN - Mask-RCNN for detection and recognition.

Reference Books:

1. Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman & Hall/CRC, 2nd Edition, 2014.
2. Kevin Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012
3. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014.
4. Josh Patterson and Adam Gibson, “Deep Learning A Practitioner’s Approach” O’Reilly Media, Inc.2017.

Hyperlink:

1. https://nptel.ac.in/courses/106106139
2. https://nptel.ac.in/courses/106106184

ECEICS 712

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 713	MILLIMETER WAVE TECHNOLOGY	2	1	0	3	45

Prerequisite : Microwave Engineering.

Objective : To understand the fundamentals and various components of Millimeter wave devices and circuits.

Outcome : Ability to understand Millimeter devices and circuits.

Unit I: Introduction **9 Hours**

Millimetre wave characteristics- millimetre wave wireless- implementation challenges- radio wave propagation for mm wave: large scale propagation channel effects -small scale channel effects -outdoor and indoor channel models-emerging applications of millimetre wave communications.

Unit II: MM Wave Circuits **9 Hours**

Millimetre wave generation and amplification: peniotrons – ubitrons - gyrotrons - free electron lasers; HEMT models for mm wave transistors- transistor configurations- analog mm wave components: amplifiers- mixers-VCO - PLL.

Unit III: Millimeter Wave Technology **9 Hours**

Millimeter wave characteristics – applications – challenges – material properties – sources of losses – different guiding modes – guiding structure at millimeter wave frequencies: rectangular and circular waveguides – microstrip lines – CPW – SIW.

Unit IV: Millimeter Wave Components and Devices **9 Hours**

Passive components: dielectric resonators – filters – power dividers – couplers – active devices: BJT and HBT – Schottky and PIN diodes – GUNN diode – avalanche transit time devices – FET – HEMT.

Unit V: Instructional Activity **9 Hours**

Assignments on millimetre wave link budget - transceiver architecture - transceiver without mixer - receiver without oscillator.

Reference Books:

1. Huang K C and Wang Z, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.
2. I. J. Bahl and P. Bhartia, “Millimeter wave Engineering and Applications”, Wiley, 1984.
3. Robert W H, Robert C. D and James N M, Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
4. Xiang W, Zheng K, Shen X.S, "5G Mobile Communications”, Springer, 2016.
5. Theodore S R, Robert W H, Robert C D and James N M, “Millimeter Wave Wireless Communications", Pearson Education, 2015.
6. Nguyen C, “Analysis methods for RF, microwave and millimeter wave planar transmission line structures”, Wiley, 1st Edition, 2000.
7. Yu Jian Cheng, “Substrate interated antennas and arrays”, Taylor Series Group, 2015

Hyperlinks:

1. http://nptel.ac.in/courses/117105139/
2. https://www.youtube.com/watch?v=9HGUkvrurVc

ECEICS 713

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 714	MOBILE AD-HOC NETWORKS	2	1	0	3	45

Prerequisite: Introduction to Computer Communications or an equivalent networking course

Objective : This course covers major aspects of ad hoc networks, from design through performance issues to application requirements.

Outcome : Students will able to understand the basic principles, standards, and system and protocol architecture of Mobile Ad-hoc Networks

Module I: Introduction **9 Hours**

Introduction to Ad-hoc networks: definition - characteristics features - applications; Ad-hoc mobility models: indoor and outdoor models; Channel Characteristics

Module II: Medium Access Protocols **9 Hours**

MAC Protocols: Design issues - goals and classification; Contention based protocols with reservation - scheduling algorithms - protocols using directional antennas; IEEE standards: 802.11a - 802.11b - 802.11g - 802.15. HIPERLAN- recent standards in IEEE.

Module III: Routing Protocols **9 Hours**

Routing Protocols: Design issues and goals ; Classification; Proactive Vs reactive routing - unicast routing algorithms - Multicast routing algorithms - hybrid routing algorithm - hierarchical routing - QoS aware routing; Security issues in adhoc networks: issues and challenges - network security attacks - secured routing protocols

Module IV: End – End Delivery And Cross Layer Design **9 Hours**

Transport Layer: Issues in designing Transport layer classification - adhoc transport protocols; Cross layer Design: Need - cross layer optimization - parameter optimization techniques - cross layer cautionary perspective; Integration of adhoc with Mobile IP networks

Module V: Instructional Activity **9 Hours**

Simulation of Adhoc Network Scenario with any one of the MAC /Routing Protocols using open source network simulation tool

Reference Books:

1. C. Siva Ram Murthy and B. S. Manoj, “Ad hoc Wireless Networks Architecture and Protocols” , 2nd Edition, Pearson Publishers, 2007.
2. Charles E. Perkins, “ Ad hoc Networking” , Addison – Wesley, 2000.
3. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, “Mobile Adhoc Networking”, Wiley-IEEE Press, 2004.
4. Mohammad Ilyas,” The handbook of ad-hoc wireless networks” , CRC press, 2002.
5. T. Camp, J. Boleng, and V. Davies , “ A Survey of Mobility Models for Ad-hoc Network” , Wireless Communication and Mobile Computing, August 2022
6. Fekri M. bduljalil and Shrikant K. Bodhe, “A survey of integrating IP mobility protocols and Mobile Ad-hoc networks”, IEEE communication Survey and Tutorials, 2007

Hyperlinks:

1. http/www.winlab.rutgers.edu/~crose/dimacs03/kumar.pdf

ECEICS 714

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 715	MULTIMEDIA COMPRESSION	2	1	0	3	45

Prerequisite : Digital Image Processing

Objective : To understand the various algorithms used for different data compression.

Outcome : Students will be able to implement compression techniques for various applications.

Module I : Fundamentals of Compression **9 Hours**

Introduction to multimedia - Graphics, Image and Video representations - Fundamental concepts of video, digital audio - Storage requirements of multimedia applications - Need for compression - Taxonomy of compression Algorithms - Elements of Information Theory - Error Free Compression - Lossy Compression.

Module II : Text Compression **9 Hours**

Huffman coding - Adaptive Huffman coding - Arithmetic coding - Shannon - Fano coding- Dictionary techniques - LZW family algorithms.

Module III : Image Compression **9 Hours**

Image Compression: Fundamentals - Compression Standards - JPEG Standard - Sub-band coding – Wavelet Based compression - Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards.

Module IV: Audio Compression and Video Compression **9 Hours**

Audio compression Techniques - law, A-Law companding - Frequency domain and filtering - Basic sub-band coding - G.722 - Video compression techniques and Standards - MPEG video coding: MPEG-1 and MPEG2 video coding - H.261 standard

Module V: Instructional Activity **9 Hours**

Simulation - Implementation of various compression techniques for real time applications.

Reference Books:

1. Darrel Hankerson, Greg A Harris, Peter D Johnson, “Introduction to Information Theory and Data Compression”, Second Edition, Chapman and Hall, CRC press, 2003
2. David Solomon, “Data Compression – The Complete Reference”, Fourth Edition, Springer Verlog, New York, 2006.
3. Khalid Sayood, “Introduction to Data Compression”, Morgan Kauffman Harcourt India, Third Edition, 2010.
4. Peter Symes , “Digital Video Compression”, McGraw Hill Pub., 2004.
5. Yun Q.Shi, Huifang Sun, “Image and Video Compression for Multimedia Engineering, Algorithms and Fundamentals”, CRC Press, 2003.

Hyperlinks:

1. https://onlinecourses.nptel.ac.in/noc22_ee49/preview
2. https://www.nptelvideos.com/video.php?id=989

ECEICS 715

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 716	NETWORK SECURITY	2	1	0	3	45

Prerequisite : Computer Networks and Information Security

Objective : This course covers major aspects of cryptography techniques, network security and system security mechanism

Outcome : Students will able to understand the basic principles and various algorithms related to network security to mitigate the effects of attacks

Module 1: Introduction To Network Security **9 Hours**

Need for Network Security - Attacks (Passive, Active, Layerwise attacks) Security Goals and Mechanisms; A model for Internetwork security - Internet Standards and RFCs - Buffer overflow and format string vulnerabilities

Module 2: Cryptographic Techniques **9 Hours**

Conventional Encryption Principles and Algorithms - Message Authentication - Secure Hash Functions and HMAC - Digital signatures - Digital Certificates - Certificate Authority and Key management Kerberos - X.509 Directory Authentication Service.

Module 3: Network Security **9 Hours**

Email privacy: Pretty Good Privacy (PGP) and S/MIME; IP Security Overview - IP Security Architecture - Authentication Header - Encapsulating Security Payload - Combining Security Associations and Key Management - Web Security Requirement - SSL - TLS and SET

Module 4: System Security **9 Hours**

Basic concepts of SNMP - Advanced SNMP Versions; Intruders - Viruses and related threats - Firewall; Design principles - Trusted Systems - Intrusion Detection Systems and its types.

Module 5: Instructional Activity **9 Hours**

Simulation of any of the network security aalgorithms using open-source software.

Reference Books:

1. William Stallings , “Network Security Essentials :Applications and Standards, Pearson Education, 4th Edition ,2011
2. Bernard Menezes, “Network Security and Cryptography”, CENGAGE Learning, 2011
3. Atul Kahate, “Cryptography and Network Security”, Mc Graw Hill ,2016
4. Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn Ido Dubrawsky, Steve W.Manzuik and Ryan Permeh, “Hack Proofing your network”, Syngress Publisher, 2nd Edition, 2002.
5. William Stallings,“Cryptography and Network Security -Principles and Practices”, Prentice Hall, 4th Edition, 2005

Hyperlinks:

1. https://www.engppt.com/2012/10/cryptography-and-network-security.html
2. https://www.skylineuniversity.ac.ae/pdf/computer/ Network security essentials applications and standards 17376.pdf

ECEICS 716

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 717	OPTICAL WIRELESS COMMUNICATIONS	2	1	0	3	45

Prerequisite : Fiber Optics and Wireless Communication

Objective : This subject provides the in-depth knowledge in Optical Wireless Communication systems.

Outcome : Students are able to Interpret the principles of Optical wireless communication devices and systems.

Module I: OWC Theory **9 Hours**

Optical communication systems- wireless access- Need of Optical Wireless Communication-block diagram-challenges - applications. Indoor optical wireless communication channel-LOS propagation model-Spherical and Guassian wave model-outdoor channel- Attenuation-Beam Wander-Turbulence –Turbidity - Cloud-free line of sight-log normal negative exponential- gamma-gamma turbulence model-modulation schemes for optical wireless -Digital base band-pulse modulation-subcarrier intensity modulation –optical polarization shift keying- BER performance analysis.

Module II: Free Space Optical Communications **9 Hours**

Introduction-operating principles-characteristics-Qos and availability-- FSO OFDM communication-FSO underwater- Free space optical networks-laser satellite communication.

Module III: Coded Modulation Techniques for OWC **9 Hours**

Coded MIMO for OWC- Indoor OWC MIMO channel-Point to point OW MIMO communications-MIMO FSO-Wireless optical CDMA Communication system-System description-indoor wireless optical CDMA-FSO CDMA.

Module IV: Visible Light Communications **9 Hours**

VLC principle- VLC system model- system implementation-VLC applications Infrared optical wireless communications - Optical wireless in sensor networks- FSO Sensor networks – LiFi.

Module V Instructional Activity **9 Hours**

Simulate and study at least two of the above-mentioned concepts using the appropriate simulator. Design and analysis of a particular sub-system and comparison with others. Numerical computation of the above concepts.

Reference Books:

1. Z. Ghassemlooy, W.Popoola, S. Rajbhandari “Optical Wireless Communications- Systems and channel modelling with MATLAB” CRC press, Taylor & Francis, 2013.
2. Shlomi Armon, John R. Barry, Geroge K. Karagiannidis, Robert Schober, Murat Uysal “Advanced Optical Wireless Communication Systems” Cambridge university press, 2012.
3. Heinz, Phd. Willebrand, “Free Space Optics,” Sams, 1st Ed., 2001.
4. Stamatioas V. Kartalopouls “Free space optical Networks for Ultra Broadband services” John Wiley & Sons, 2011.
5. Morris Katzman, “Laser Satellite Communication,” Prentice Hall Inc., New York, 1991.
6. Roberto Ramirez-Iniguez, Sevia M.Idrus, Ziran sun “Optical wireless communications: IR for wireless connectivity” CRC Press, Taylor and Francis Group, 2007.
7. Recent literature in Optical Wireless Communication.

Hyperlinks:

1. https://Optical_wireless_communications

ECEICS 717

Course Code	Name of the Course	Periods			Credits	Total Hours
ECEICS 718	PHOTONIC INTEGRATED CIRCUITS	L	T	P	3	45
		2	1	0		

Prerequisite : Photonics

Objective : To introduce essential concepts required to understand the operation of various integrated photonic components and draws a parallel with bulk components.

Outcome : On successful completion of the module students will be able to understand different types of integrated photonic resonators and the properties of their resonant modes

Module I: Introduction to Photonic Integrated Circuits **9 Hours**

Brief history of optical communication -Advantages of integrated optics configuration - Analysis of optical waveguides and devices - Planar waveguides - channel waveguides - graded index - waveguides - coupled mode theory - variational method - beam propagation method.

Module II: Materials and fabrication Technology **9 Hours**

Materials: glass - lithium niobate – silicon - compound semiconductors – polymers; General fabrication steps – Photolithography - Ti: LiNbO3 process - Proton exchange process - Silicon based IC process - Compound semicondutor process - Solgel and other processes.

Module III: Dynamic and active Devices **9 Hours**

Electro-optic devices - acousto-optic devices - thermo-optic and magneto-optic device - integrated optical amplifiers - optical resonators - input-output coupling in integrated optics; Applications to communication – sensors - optical computing.

Module IV: Photonic Crystal Structures **9 Hours**

Introduction to 1D and 2D photonic crystal structures – dispersion properties – Brilluion zone – band gap – band structure calculations; Photonic crystal waveguides – bends – cavities; Photonic crystal integrated circuits: waveguide couplers – add/drop filters - delay lines.

Module V: Instructional Activity **9 Hours**

Study of Numerical methods (FDTD, BPM etc) for optical waveguide simulations and their limitations using OPTIFDTD software; Simulate and study the optical waveguide devices such as directional couplers and splitters based on photonic crystals.

Reference Books:

1. C. R. Pollock and M. Lip Son, “Integrated Photonics”, Kluwer Publisher, 2003.
2. H. Nishihara, M. Haruna, and T. Suhara, “Optical Integrated Circuits”, McGraw-Hill, 1988.
3. H Nishihara, M Haruna and T Suhara, “Optical Integrated Circuits”, Mc Graw-Hill Book Company, New York, 1989.
4. A Ghatak and K Thyagarajan, “Optical Electronics”, Cambridge University Press, 1989.

Hyperlinks:

1. https://www.synopsys.com/glossary/what-is-a-photonic-integrated-circuit.html
2. https://en.wikipedia.org/wiki/Photonic_integrated_circuit
3. https://www.rp-photonics.com/photonic_integrated_circuits.html

ECEICS 718

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 719	RADAR ENGINEERING	2	1	0	3	45

Prerequisite : Electromagnetics and communication theory.

Objective : To learn in-depth understanding of Radar and its components.

Outcome : The students are expected to have the ability to describe the radar fundamentals, Analyze the radar signals.

Module I: Introduction to RADAR Systems **9 Hours**

Basic Radar Equation - Radar Frequencies and Waveforms - Radar Range Equation - Radar Cross Section.

Module II: RADAR System Components **9 Hours**

Random Antennas - Transmitters and Receivers - Waveguides and Transmission Lines - Duplexers and Circulators - Radar Signal Processing.

Module III: RADAR Signal Analysis **9 Hours**

Matched Filters - Ambiguity Function - Doppler Processing - Clutter and Jamming - Pulse Compression

Module IV: RADAR Imaging **9 Hours**

Synthetic Aperture Radar (SAR) - Inverse Synthetic Aperture Radar (ISAR) - Multistatic and Passive Radar - FMCW Radar - MIMO Radar.

Module V: Instructional Activity **9 Hours**

Design and Simulation of RADAR Components using related Tools.

Reference Books:

1. "Introduction to Radar Systems" by Merrill Skolnik.
2. "Radar Principles" by Peebles and Richards.
3. "Radar Systems Analysis and Design Using MATLAB" by Bassem R. Mahafza.
4. "Radar Handbook" by Merrill Skolnik.
5. "Principles of Modern Radar" by Mark Richards.
6. "Radar and Electronic Warfare Principles for the Non-Specialist" by C. Rino and M. Currie.

Hyperlinks:

1. http://www.nptel.ac.in/courses/117107035/
2. http://www.nptel.ac.in/courses/108101092/
3. http://www.nptel.ac.in/courses/108104099/
4. http://www.nptel.ac.in/courses/108104087/

ECEICS 719

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 720	RADIO FREQUENCY INTEGRATED CIRCUIT DESIGN	2	1	0	3	45

Prerequisite : Electromagnetics and microwave theory.

Objective : To learn the RFIC design concepts, different types of RFIC and their design methodology.

Outcome : Students will be able to design different types of RFIC design for various applications.

Module I: Fundamentals of Architectures **9 Hours**

Transmitter and Receiver architectures: Review of modulation schemes - Receiver architectures - Transmitter architectures

Module II: Passive and Active Components for CMOS RFIC **9 Hours**

Review of MOSFET - RF transistor layout - CMOS process - Capacitors - Varactors - Resistors - Inductors - Transformers - Transmission lines Resonance - Matching - S-parameters - etc. Noise in electrical circuits and NF calculations - Two port noise theory.

Module III: Low Noise Amplifiers **9 Hours**

Resistive terminated CS and CG LNA - Inductive degenerated LNA - Shunt feedback LNA - Noise canceling LNAs - Linearity improvement techniques.

Module IV: Power Amplifiers **9 Hours**

Basics and Class A, B, C, AB, D, E, F and other configurations - Power combining - Linearity improvement techniques

Module V: Instructional Activity **9 Hours**

Design - simulation and analysis of different RFIC for wireless applications using related simulation tools.

Reference Books:

1. B.Razavi,"RF Microelectronics", 2nd Ed., Pearson, 2012.
2. Thomas H. Lee, "The design of CMOS radio-frequency integrated circuits", 2nd Ed., Cambridge University Press, 2004.

Hyperlinks:

1. http://www.nptel.ac.in/courses/117107035/
2. http://www.nptel.ac.in/courses/108101092/
3. http://www.nptel.ac.in/courses/108104099/
4. http://www.nptel.ac.in/courses/108104087/

ECEICS 720

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 721	RF MEMS DESIGN AND TECHNOLOGY	2	1	0	3	45

Prerequisite : Microwave Theory and Technology and MEMS

Objective : To familiarize the student with the technology and applications of Micro-Electro Mechanical Systems (MEMS).

Outcome : Students will be able to design different types of MEMS based devices, circuits and subsystems.

Module I: Introduction to MEMS **9 Hours**

Evolution of Micro Electro Mechanical Systems (MEMS): Driving force for MEMS development - MEMS material properties - microelectronics technology for MEMS; The Finite Element Method (FEM): Important mathematical and physical concept in FEM - discretization and other approximation.

Module II: Micromachining Technology for MEMS **9 Hours**

Fabrication Process: MEMS fabrication technologies - bulk micro machining - surface micro machining - LIGA process; Bonding and packaging of MEMS - MEMS reliability - scaling in MEMS; Recent research direction in MEMS: CMOS- MEMS integration - polymer MEMS - NEMS etc.

Module III: Sensor and Actuators **9 Hours**

Sensors: Classifications - principle - design and characterization of thermal – micro-machined - mechanical - pressure - flow sensor - bio– sensor; Actuation in MEMS Devices: Electrostatic actuation - parallel plate capacitor - cantilever beam based movement; MEMS accelerometers; optical MEMS: Micro mirror.

Module IV: RF MEMS **9 Hours**

Switches: Cantilever MEMS based switch; Inductors and Capacitors: Modeling and design issues of planar inductor and capacitors; RF Filters: Modeling of mechanical filters; Phase Shifters: Classifications and limitations; Micro machined antennas: Micro-strip antennas - design parameters.

Module V: Instructional Activity **9 Hours**

Modeling - simulation and analysis of applications of MEMS switch - sensors and actuators using related platform.

Reference Books:

1 Madou M, “Fundamentals of Micro Fabrication” CRC Press, 3rd Edition, 2011.

2 Senturia, “Micro System Design”, Kluwer, 2007.

3 *Maluf N ,* Williams K, “An Introduction to Micro- electromechanical Systems Engineering*”, Artech House,* 2nd Edition, 2004.

4 Varadan V K, Vinoy K J, Jose K A, “RF MEMS and Their Applications” Wiley & Sons, 2003.

5 Rebeiz G, “RF MEMS: Theory, Design, and Technology”, Wiley/ IEEE Press, 2004.

6 Robert D C, “Finite Element Modeling for Stress Analysis”, John Wiley and Sons, 1995.

Hyperlinks:

1. https://www.ece.ucsd.edu/faculty-research/books-by-faculty/rf-mems-theory-design-and-technology
2. https://www.meripustak.com/Rf-Mems-Theory-Design-And-Technology-230241

ECEICS 721

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 722	ROBOTICS	2	1	0	3	45

Prerequisite : Engineering Mathematics

Objective : On completion of this course, the students will have a knowledge of different types of robots, their operations, control, programming and applications.

Outcome : Students will be able to analyze the advanced technical details behind the Robotics.

Module I: Introduction and Types of Robotics **9 Hours**

Automation and Robotics- Robot Anatomy- Classification of Robots by DOF motion- platform- power source- intelligence and application area.

Module II: Basic Components of Robots **9 Hours**

Manipulators: Wrists- End effectors- control units- power units- Robot sensors- proximity sensors- range sensors- tactile sensors- visual sensors- sensors for mobile robots.

Module III: Robot Motion Analysis and Control **9 Hours**

Introduction to manipulator kinematics- Homogeneous transformations and Robot Kinematics- manipulator path control- robot dynamics- configuration of a Robot controller- Obstacle avoidance.

Module IV: Robot Programming and Applications **9 Hours**

Method of Robot Programming- lead through programming methods- A robot program as a path in space- motion interpolation- weight- signal and delay commands- branching- capabilities and limitations of lead through methods - Material handling- processing operations- Assembly and inspection- future applications

Module V: Instructional Activity **9 Hours**

Design and Analysis of IoT-Based Intelligent Robot for Practical Monitoring and Control. Design drone in simple way with minimal components.

Reference Books:

1. Timothy Pratt and Charles W. Bostain, “Satellite Communications”, 2nd Edition, Wiley, 2012.
2. D. Roddy, “Satellite Communication”, 4th Edition (Reprint), McGraw Hill, 2009.
3. Wilbur L. Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, “Satellite Communication Systems Engineering”, Prentice Hall/ Pearson, 2007.
4. Tri T. Ha, “Digital Satellite Communication”, 2nd Edition, McGraw Hill, 1990.
5. Brian Ackroyd, “World Satellite Communication and Earth Station Design”, BSP Professional Books, 1990.

Hyperlinks:

1. http://advancedengineering.umd.edu/node/2320
2. http://ece564web.groups.et.byu.net
3. http://personal.stevens.edu/~yyao/syllabus-674.html
4. http://staff.um.edu.mt/carl.debono/lectures.htm

ECEICS 722

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 723	TERAHERTZ TECHNOLOGY	2	1	0	3	45

Prerequisite : Electromagnetics and microwave theory.

Objective : To impart RF system design for different applications. To learn the high power source design concepts, different types of mm/THz wave sources and their design methodology.

Outcome : Students will be able to design different types of mm/THz sources for various applications.

Module I: Introduction **9 Hours**

THz Terminologies - Physical Principles of THz Interaction with Matter - Electromagnetic Waves in Matter - THz Radiation and Elementary Excitations - Laser Basics.

Module II: THz Detectors and Sources **9 Hours**

Ultrafast Optics - THz Emitters and Detectors based on Photoconductive Antennas - Optical Rectification - Free-space Electro-optic Sampling - Ultrabroadband Terahertz Pulses - Terahertz Radiation from Electron Accelerators - Novel Techniques for Generating Terahertz Pulses - Continuous-Wave Terahertz Sources and Detectors.

Module III: Materials and THz Components **9 Hours**

Graphene - Carbone Nano Tubes - Plasma - Photoconductive materials and properties - Terahertz Components: Antenna - Filters - Oscillators etc.

Module IV: THz Imaging **9 Hours**

Imaging with Broadband THz Pulses. Imaging with Continuous-Wave THz Radiation. millimeter-Wave Imaging for Security. Medical Applications of T-Ray Imaging. Concealed Objects Real-Time Imaging for Security.

Module V: Instructional Activity **9 Hours**

Design - simulation and analysis of different RFIC for wireless applications using related simulation tools.

Reference Books:

1. Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009.
2. Erik Bründermann, Et Al., Terahertz Techniques, Springer 2012.
3. R. A. Lewis, Terahertz Physics, Cambridge University Press 2012.
4. Handbook of Terahertz Technologies: Devices and Applications, Edited By Ho-Jin Song And Tadao Nagatsuma, Jenny Stanford Publisher, New York, 2015
5. Handbook of Terahertz Technology for Imaging, Sensing and Communications, Edited By D. Saeedkia, Woodhead Publisher, 2013.

Hyperlinks:

1. http://www.nptel.ac.in/courses/117107035/
2. http://www.nptel.ac.in/courses/108101092/
3. http://www.nptel.ac.in/courses/108104099/
4. http://www.nptel.ac.in/courses/108104087/

ECEICS 723

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 724	UNDER WATER COMMUNICATION	2	1	0	3	45

Prerequisite : Sensor Networks and Acoustics Communication

Objective : To acquire knowledge on basics of Underwater Acoustics and basics concept of underwater sensors and noises

Outcome : Students will be able to understand the benefits and in-depth functioning of underwater communication

Module I : Fundamentals of Underwater Acoustics **9 Hours**

The ocean acoustic environment - measuring sound level - sound velocity in sea water - sources and detectors - relevant units; sound propagation in the Ocean-; characteristic of sound propagation paths-deep water and shallow water; Range dependent environment - sound attenuation in sea water - surface bottom loss and volume scattering - Snell's law for range dependent Ocean.

Module II: Characteristics of Sonar Systems **9 Hours**

Sonar systems - active and passive sonar equations - transducers and their directivities; Sensor array characteristics: array gain - receiving directivity index - beam patterns - shading and super directivity - adaptive beamforming

Module III: Underwater Sensors **9 Hours**

Sonars - hydrophones - DAS - ROV - AUV - Side scan sonar - Echo sounder - MBEC - Sub bottom profiler - magnetometer - dredger - sensors application in shallow water and deep water.

Module IV: Underwater Noises **9 Hours**

Basic Concept of noises in underwater - Types of noises : natural - man made - ambient noise types –seismic - wind - biological - lobsters - dolphin - shipping, turbulence noise - rain etc. - Study on location based noises - Comparison between various noises in underwater.

Module V: Instructional Activity **9 Hours**

Study the performance analysis of underwater communication wireless model for different types of noise effects/ simulate the underwater wireless communication model for nodes placed in different positions and determine its data rate using open source software tool.

Reference Books:

1. Robert J Urick, “Principles of Underwater Sound” 3rd Edition, Peninsula Publications, 2013
2. L.M.Brekhovskikh & Yu.P.Lysanov, “Fundamental of ocean acoustics”, Springer, 2002.
3. Gross M.G., “Principles of Oceanography”, 7th Edition, Prentice-Hall, 1995.
4. Ask T., “Handbook of Marine Surveying”, Sheridan House, 2007.

Hyperlinks:

1. https://www.ssn.edu.in/wp-content/uploads/2020/02/Impulse_Jan-2017.pdf
2. https://www.science.gov/topicpages/u/underwater+communication+systems

ECEICS 724

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 725	VEHICULAR NETWORK	2	1	0	3	45

Prerequisite : Introduction to Data Communications or an equivalent networking course

Objective : To develop an understanding of the basic concepts of vehicular networks and their communications protocols.

Outcome : Students will able to understand the basic principles, standards, and system and protocol architecture of Vehicular Networks.

Module I: Introduction **9 Hours**

ITS & IVC - V2V & V2I communication - Motivation, Common Terms - past and ongoing VANET activities - Issues and Challenges - Vehicle Localization - Applications of V2X: Safety vs. non-safety; Use cases: Traffic information systems; Mapping service requirements to communication technologies

Module II: Architecture **9 Hours**

Network Architecture ; Protocols Stack: Layering and Standards - Fundamental principles of layering - DSRC/WAVE - ETSI ITS-G5 and ARIB architectures; IEEE 802.11p ; PHY and MAC ; Security Mechanism; IEEE 1609 WAVE multi-channel operation

Module III: Channel Modelling And Modulation Schemes **9 Hours**

Vehicular channel characteristics; Impact of channel impairments on system design; Techniques for combating channel impairments; Design of OFDM parameters in 802.11p ; Digital modulation schemes in 802.11p; Transmit power control and transmit masks

Module IV: Routing Protocols **9 Hours**

Routing in VANETs: Flooding and the 'Broadcast Storm Problem' - Opportunistic packet forwarding - topology based routing - geographic routing; Beaconing; DTN and peer-to-peer ideas for VANET routing; Mobility models - Traffic flow models

Module V: Instructional Activity **9 Hours**

Simulation of VANET scenario with any one of channel model/modulation/ routing protocols using any of the open source network simulation tool

Reference Books:

1. Luca Delgrossi, Tao Zhang, "Vehicle Safety Communications: Protocols, Security, and Privacy",1st Edition, John Wiley & Sons Ltd., 2012.
2. Hannes Hartenstein and Kenneth P. Labarteaux, "VANET: Vehicular Applications and Inter-Networking Technologies",1st Edition, John Wiley & Sons Ltd., 2010.
3. Christophe Sommer and Falko Dressler, "Vehicular Networking", Cambridge University Press, 2014.
4. Claudia Campolo, Antonella Molinaro and Riccardo Scopigno, "Vehicular ad hoc Networks: Standards, Solutions and Research", Springer, 2015.
5. Moustafa H, Zhang Y, "Vehicular Networks: Techniques, Standards, and Applications", CRC Press, 2009.
6. K. Sampigethaya et al.," CARAVAN: Providing Location Privacy for VANET", ESCAR 2005.
7. I. Chisalita and N. Shahmehri, " A Novel Architecture for Supporting Vehicular Communication", VTC Fall 2002.

Hyperlinks:

1. http://www.irma-international.org/viewtitle/43163/
2. https://en.wikipedia.org/wiki/Vehicular_ad_hoc_network
3. http://comp.ist.utl.pt/~rmr/WSN/CaseStudies2007-no/WSN_Transportation

ECEICS 725

Course Code	Name of the Course	Periods			Credits	Total Hours
		L	T	P		
ECEICS 726	WIRLESS NETWORKS	2	1	0	3	45

Prerequisite: Wireless Communication

Objective : To study the different types of wireless networks

Outcome : Students able to design different types of wireless networks

Module I: Wide Area Networks **9 Hours**

Introduction:WLAN technologies - IEEE802.11: System architecture - protocol architecture - 802.11b - 802.11a - Hiper LAN: WATM – BRAN - HiperLAN2 : Architecture; WPAN : Bluetooth - IEEE 802.15.4 - Wireless USB – Zigbee - 6LoWPAN - Wireless HART: Characteristics and Architecture; WiMAX: BWA - issues and challenges of WiMAX - network architecture - protocol stack of IEEE 802.16 - differences between IEEE 802.11 and IEEE 802.16

Module II: Wireless Internet **9 Hours**

Introduction: Mobile IP - IP packet delivery - Agent discovery - tunneling and encapsulation - IPV6- Network layer in the internet - Mobile IP session initiation protocol ; Wireless TCP: Limitations of Conventional TCP - Classification of Wireless TCP; IoT: CoAP

Module III: Wireless Sensor Network and IOT **9 Hours**

WSN: Issues and Challenges - Architecture: System - Protocol Stack; Characteristics; MAC Protocols - Routing Protocols; Enabling Technologies: IoT - Issues and Challenges- Characteristics - Network and Protocol Architecture- Applications

Module IV: 5G Networks **9 Hours**

Introduction: 5G vision - 5G features and issues - Applications of 5G - 5G Technologies: Multicarrier Modulation – NOMA - Smart antenna techniques - System Architecture and Protocol Stack

Module V: Instructional Activity **9 Hours**

Simulation of WLAN/WiMAX/ WSN/ IoT /5G Network using open source network simulation tool

Reference Books:

1. KavehPahlavan and Prashant Krishnamurthy, “Principle of Wireless Networks - A Unified Approach”, Prentice Hall of India, 2006.
2. William Stallings, “Wireless Communication and Networks”, 2nd Edition, Prentice Hall, 2005.
3. Clint Smith and Daniel Collins, “3G Wireless Networks”, 2nd Edition, Tata McGraw Hill, 2007.
4. Vijay Garg K, “Wireless Communications and Networks”, 2nd Edition, Morgan Kaufmann Publishers (Elsevier), 2007.
5. AmitabhaGhosh and RapeepatRatasuk, “Essentials of LTE and LTE-A,” Cambridge University Press, 2011.

Hyperlinks:

1. http://doktora.kirbas.com/Kitaplar/Wireless Networking /Complete.pdf
2. www.tutorialspoint.com/wimax/
3. http://www.infotech.monash.edu.au/units/archive/2012/s2/fit5083.html
4. http://www.utdallas.edu/~venky/

ECEICS 726

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