KUMARAGURU COLLEGE OF TECHNOLOGY

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

B.E., ELECTRONICS AND COMMUNICATION ENGINEERING

REGULATIONS 2018A - v2

(2021 Batch onwards)

CURRICULUM AND SYLLABI

III to VIII Semesters

Department of Electronics and Communication Engineering

VISION

To be a centre of repute for learning and research with internationally accredited curriculum, state-of-the-art infrastructure and laboratories to enable the students to succeed in globally competitive environments in academics and industry.

MISSION

The Department is committed to:

- Motivate students to develop professional ethics, self-confidence and leadership quality.
- Facilitate the students to acquire knowledge and skills innovatively to meet evolving global challenges and societal needs.
- Achieve excellence in academics, core engineering and research.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives of Electronics and Communication Engineering Undergraduate Programme are:

PEO1: Graduates will be successful as Professionals, Researchers or Entrepreneurs in Electronics, Information and Communication Engineering disciplines.

PEO2: Graduates will continuously be updated with the state-of the art technology through formal and informal education to provide sustainable solutions.

PEO3: Graduates will demonstrate ethical and social responsibilities as an individual and in a team of diverse culture.

PROGRAMME OUTCOMES (POs)

PO1: The graduates would be able to apply the knowledge of mathematics, sciences, engineering fundamentals and skills to solve problems in electronics and communication

PO2: The graduates would acquire skills to analyse complex problems in the domain of electronics and communication engineering.

PO3: The graduates would be able to design, develop and validate solutions for electronics and communication systems meeting the specifications vis-à-vis the society.

PO4: The graduates will have proficiency to acquire, analyse data and interpret results leading to relevant research.

PO5: The graduates would be able to use appropriate modern engineering/simulation tools including modelling and forecasting for complex technological entities.

PO6: The graduates would have awareness of and the need to uphold professional responsibilities and also be aware of health, safety, social and legal aspects of their work.

PO7: The graduates would have an understanding of the societal and human context in which their engineering contributions will provide sustainable development.

PO8: The graduates would carry out professional responsibilities adhering to ethical and standard norms of engineering practices.

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PO9: The graduates would have ability to function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary environment.
PO10: The graduates would be capable of communicating effectively with the engineering community and society at large.
PO11: The graduates would demonstrate knowledge and understanding of engineering and management principles for technological and socially relevant projects.
PO12: The graduates would recognize the need for and also have ability to engage in continual, life-long learning.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Graduates of the Electronics and Communication Engineering Programme will have the ability to:
PSO1: Analyze and Design, verify and validate VLSI Systems by selecting appropriate hardware and software tools.
PSO2: Design, develop and validate inter disciplinary products/ process by applying the knowledge and skills of Embedded Systems, Signal Processing, Electromagnetics and Communication Engineering.

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REGULATIONS 2018A

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM

Semester I										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18ENI1201	Fundamentals of Communication -I	Embedded - Theory & Lab	BS	2	0	2	0	3	-
2	U18MAI1202	Linear Algebra and Calculus	Embedded - Theory & Lab	HS	3	0	2	0	4	-
3	U18CHI1202	Engineering Chemistry	Embedded - Theory & Lab	BS	3	0	2	0	4	-
4	U18EEI1202	Electrical Machines and Drives	Embedded - Theory & Lab	ES	3	0	2	0	4	-
5	U18CSI1202	Problem Solving and Programming using C	Embedded - Theory & Lab	ES	2	0	2	0	3	-
6	U18INI1600	Engineering Clinic I	Practical & Project	ES	0	0	4	2	3	-
								Total Credits	21	
								Total Contact Hours/week	29	

Semester II										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18ENI2201	Fundamentals of Communication-II	Embedded - Theory & Lab	BS	2	0	2	0	3	U18ENI1201
2	U18MAI2201	Advanced Calculus and Laplace Transform	Embedded - Theory & Lab	HS	3	0	2	0	4	-
3	U18PHI2202	Engineering Physics	Embedded - Theory & Lab	BS	3	0	2	0	4	-
4	U18MEI2201	Engineering Graphics	Embedded - Theory & Lab	BS	2	0	2	0	3	-
5	U18CSI2201	Python Programming	Embedded - Theory & Lab	ES	2	0	2	0	3	-
6	U18INI2600	Engineering Clinic II	Practical & Project	ES	0	0	4	2	3	U18INI1600
								Total Credits	20	
								Total Contact Hours/week	28	

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Semester III										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18ECT3101	Signals and Systems	Theory	BS	3	1	0	0	4	-
2	U18ECI3202	Electron Devices and Circuits	Embedded - Theory & Lab	PC	3	0	2	0	4	-
3	U18ECI3203	Digital System Design	Embedded - Theory & Lab	PC	3	0	2	0	4	-
4	U18ECT3004	Electro Magnetic Fields	Theory	PC	3	0	0	0	3	-
5	U18ECT3105	Network theory	Theory	PC	3	1	0	0	4	-
6	U18INI3600	Engineering Clinic III	Practical & Project	ES	0	0	4	2	3	U18INI2600
Total Credits									22	
Total Contact Hours/week									27	

Semester IV										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18ECI4201	Digital Signal Processing	Embedded - Theory & Lab	PC	3	0	2	0	4	U18ECT3101
2	U18ECI4202	Analog Electronics and Integrated Circuits	Embedded - Theory & Lab	PC	3	0	2	0	4	U18ECI3202
3	U18MAT4103	Probability and Random Processes	Theory	BS	3	1	0	0	4	-
4	U18ECT4104	Transmission Lines and Waveguides	Theory	PC	3	1	0	0	4	U18ECT3004
5	U18INI4600	Engineering Clinic IV	Practical & Project	ES	0	0	4	2	3	U18INI3600
6	U18……	Open Elective I	Theory	OE	3	0	0	0	3	-
Total Credits									22	
Total Contact Hours/week									28	

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Semester V										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18ECI5201	Communication Engineering- I	Embedded - Theory & Lab	PC	3	0	2	0	4	U18ECT3101
2	U18ECI5203	Communication Networks	Embedded - Theory & Lab	PC	3	0	2	0	4	-
3	U18ECT5004	Control Systems	Theory	PC	3	0	0	0	3	-
4	U18ECT5005	Antennas and wave propagation	Theory	PC	3	0	0	0	3	U18ECT4104
5	U18ECI5206	Embedded Processor Architecture	Embedded - Theory & Lab	PC	3	0	2	0	4	U18ECI3203
6	U18ECE…	Professional Elective I	Theory	PE	3	0	0	0	3	-
Total Credits									21	
Total Contact Hours/week									27	

Semester VI										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18ECI6201	Communication Engineering- II	Embedded - Theory & Lab	PC	3	0	2	0	4	U18ECI5201
2	U18ECI6203	VLSI and HDL Programming	Embedded - Theory & Lab	PC	3	0	2	0	4	U18ECI3203
3	U18ECI6204	Microcontroller and its Applications	Embedded - Theory & Lab	PC	2	0	2	0	3	U18ECI5206
4	U18..…	Open Elective II	Theory	OE	3	0	0	0	3	-
5	U18ECE…	Professional Elective II	Theory	PE	3	0	0	0	3	-
6	U18ECE…	Professional Elective III	Theory	PE	3	0	0	0	3	-
Total Credits									20	
Total Contact Hours/week									23	

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Semester VII										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18ECP7701	Project Phase I	Project only Course	PW	0	0	0	6	3	-
2	U18ECT7002	Wireless Communication	Theory	PC	3	0	0	0	3	U18ECI6201
3	U18ECI7203	Optical Communication	Embedded - Theory & Lab	PC	3	0	2	0	4	-
4	U18ECI7204	RF and Microwave Engineering	Embedded - Theory & Lab	PC	3	0	2	0	4	U18ECT4104
5	U18ECE…	Professional Elective IV	Theory	PE	3	0	0	0	3	-
6	U18ECE…	Professional Elective V	Theory	PE	3	0	0	0	3	-
7	U18ECE…	Professional Elective VI	Theory	PE	3	0	0	0	3	-
								Total Credits	23	
								Total Contact Hours/week	28	

Semester VIII									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
1	U18ECP8701	Project Phase II	Project only Course	PW	0	0	0	24	12
								Total Credits	12
								Total Contact Hours/week	24

Total Credits	161

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List of Mandatory Non-Credit Courses					
S. No	**Course Code**	**Course Title**	**Course Mode**	**CT**	**Semester**
1	U18CHT3000	Environmental Science and Engineering	Theory	MC	3
2	U18INT4000	Constitution of India	Theory	MC	4

List of Mandatory Courses with credit					
S. No	**Course Code**	**Course Title**	**Course Mode**	**Credit**	**Semester**
1	U18TLR1001	Heritage of Tamils	Theory	1	1
2	U18TLR2001	Tamils and Technology	Theory	1	2
3	U18VET4101	Universal Human Values 2: Understanding Harmony	Theory	3	4

Open Elective Courses

S. No	Course Code	Course Title	Credit
1	U18ECO0001	Virtual Instrumentation	3
2.	U18ECO0002	Autotronics - An Introduction to Smart Vehicles	3
3.	U18ECO0003	Advanced Mobile Technology: NFV, LTE & 5G	3
4.	U18ECO0004	CCNA-CICCO Certified Network Associate	3
5.	U18ECO0005	Introduction to Neural Networks and Deep Learning	3
6.	U18ECO0006	Cyber Security	3

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PROFESSIONAL ELECTIVES									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
Communication System									
1	U18ECE0001	Cognitive Radio	Theory	PE	3	0	0	0	3
2	U18ECE0002	Satellite Communication	Theory	PE	3	0	0	0	3
3	U18ECE0003	MIMO systems	Theory	PE	3	0	0	0	3
4	U18ECE0004	Advanced Wireless Communication	Theory	PE	3	0	0	0	3
5	U18ECE0005	RADAR and Navigational Aids	Theory	PE	3	0	0	0	3
6	U18ECE0006	Radar System Design	Theory	PE	3	0	0	0	3
7	U18ECE0007	Avionic System Design	Theory	PE	3	0	0	0	3
8	U18ECE0008	Electronic Warfare and ECM/ECCM Technologies	Theory	PE	3	0	0	0	3
Signal Processing									
1	U18ECE0011	Digital Image Processing	Theory	PE	3	0	0	0	3
2	U18ECE0012	Multimedia and Compression	Theory	PE	3	0	0	0	3
3	U18ECE0013	Biomedical Signal Processing	Theory	PE	3	0	0	0	3
4	U18ECE0014	Machine Learning	Theory	PE	3	0	0	0	3
5	U18ECE0015	Statistical Signal Processing	Theory	PE	3	0	0	0	3
Communication Networks									
1	U18ECE0021	Adhoc wireless networks	Theory	PE	3	0	0	0	3
2	U18ECE0022	High speed networks	Theory	PE	3	0	0	0	3
3	U18ECE0023	Network security	Theory	PE	3	0	0	0	3
4	U18ECE0024	Wireless system and standards	Theory	PE	3	0	0	0	3
5	U18ECE0025	Graph theory and its applications	Theory	PE	3	0	0	0	3
RF and Antenna									
1	U18ECE0031	RF MEMS	Theory	PE	3	0	0	0	3
2	U18ECE0032	RF System Design	Theory	PE	3	0	0	0	3
3	U18ECE0033	Electromagnetic Interference and Compatibility	Theory	PE	3	0	0	0	3
4	U18ECE0034	Computational Electromagnetics	Theory	PE	3	0	0	0	3
VLSI									
1	U18ECE0041	VLSI testing and testability	Theory	PE	3	0	0	0	3
2	U18ECE0042	System design with FPGA	Theory	PE	3	0	0	0	3
3	U18ECE0043	System on Chip	Theory	PE	3	0	0	0	3
4	U18ECE0044	Nano Electronics	Theory	PE	3	0	0	0	3
5	U18ECE0045	Low power VLSI	Theory	PE	3	0	0	0	3
Embedded System									
1	U18ECE0051	Industrial Robotics	Theory	PE	3	0	0	0	3
2	U18ECE0052	Industrial Automation	Theory	PE	3	0	0	0	3
3	U18ECE0053	Virtual Instrumentation	Theory	PE	3	0	0	0	3
4	U18ECE0054	Real time Embedded Systems	Theory	PE	3	0	0	0	3
5	U18ECE0055	Automotive Electronics	Theory	PE	3	0	0	0	3
6	U18ECE0056	Multicore Architecture and Programming for Embedded Systems	Theory	PE	3	0	0	0	3
7	U18ECE0057	Introduction to HMI	Theory	PE	3	0	0	0	3
8	U18ECE0058	Advanced HMI	Theory	PE	2	0	2	0	3

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PROFESSIONAL ELECTIVES									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
Management Studies									
1	U18ECE0061	Product Design and Development	Theory	PE	3	0	0	0	3
2	U18ECE0062	Total Quality Management	Theory	PE	3	0	0	0	3
3	U18ECE0063	Operations Research	Theory	PE	3	0	0	0	3
4	U18ECE0064	Professional Ethics	Theory	PE	3	0	0	0	3
5	U18ECE0065	Engineering Economics and Financial Management	Theory	PE	3	0	0	0	3

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One Credit Course									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
1.	U18ECC0001	Advance System Design using 16 bit Ultra Low Power Microcontrollers	Theory	OCC	1	0	0	0	1
2.	U18ECC0002	Advanced Motor Control Application using 32 Bit Real Time Controllers	Theory	OCC	1	0	0	0	1
3.	U18ECC0003	Energy Efficient Microcontrollers and its Applications	Theory	OCC	1	0	0	0	1
4.	U18ECC0004	Internet of Things (IoT) using CC3200	Theory	OCC	1	0	0	0	1
5.	U18ECC0005	Automotive Communication Systems	Theory	OCC	1	0	0	0	1
6.	U18ECC0006	Urban Mining and Electronic Resource from E-Waste	Theory	OCC	1	0	0	0	1
7.	U18ECC0506	Hands-On Course in Digital System Design using HDL	Practical	OCC	0	0	2	0	1

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Details of changes made in curriculum R2018 and R2018A

R2018	R2018A	Category	Course Mode	Credit
U18ECI5202 - Computer Architecture and Microprocessors	U18ECI5206 - Embedded Processor Architecture	PC	Embedded - Theory & Lab	4
U18ECI6202 - Microcontrollers	U18ECI6204 - Microcontroller and its Applications	PC	Embedded - Theory & Lab	3
-	U18ECE0006 - Radar System Design	PE	Theory	3
-	U18ECE0007 - Avionic System Design	PE	Theory	3
-	U18ECE0008 - Electronic Warfare and ECM/ECCM Technologies	PE	Theory	3

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Category wise Credit Distribution

Credits in Each Category	Revised AICTE Model Curriculum-2023	Anna University R-2021	R2018A
Basic Science-BS	23	25	27
Engineering Science-ES	17	21	25
Humanities and Social Sciences-HS	15	12	6
Professional Core-PC	61	58	67
Project Work-PW	20	16	15
Open Elective-OE	12	12	6
Professional Elective-PE	12	18	15
TOTAL CREDITS	**160**	**162**	**161**

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SEMESTER III

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U18ECT3101 **SIGNALS AND SYSTEMS**

L	T	P	J	C
3	1	0	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Solve problems involving continuous-time and discrete-time signals and systems.	K3
CO2	Analyze continuous time signals and systems using Fourier Techniques.	K4
CO3	Apply sampling theorem in representation and reconstruction of CT signals.	K3
CO4	Analyze discrete time signals and systems using Fourier Techniques.	K4
CO5	Analyze discrete time signals and systems using Z-transform.	K4

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	PROGRAMME OUTCOMES													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1				1					1		1
CO2	1	1	1				1					1		2
CO3	2	1	1				1					1		2
CO4	1	1	1				1					1		2
CO5	2	1	1				1					1		1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

CONTINUOUS AND DISCRETE TIME SIGNALS AND SYSTEMS **17 Hours**

Continuous Time (CT) &Discrete Time (DT) signals- Classification - standard signals – basic operations on signals - Continuous time and discrete time systems - properties - Linear Time Invariant (LTI) systems- Stability- Causality- Continuous and discrete convolution.

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FOURIER ANALYSIS OF CT SIGNALS AND SYSTEMS **12 Hours**

Fourier series analysis of periodic signals- spectrum - Properties of Continuous Time Fourier Series (CTFS) - Convergence of CTFS - Representation of aperiodic signals by Continuous Time Fourier Transform (CTFT)- spectrum - Properties of CTFT - Convergence of CTFT - CT system representation by differential equation - Frequency response of systems characterized by differential equations.

SAMPLING **06 hours**

Representation of continuous time signals by its samples - Sampling theorem – Reconstruction of a signal from its samples, aliasing-bandpass sampling.

FOURIER ANALYSIS OF DT SIGNALS AND SYSTEMS **12 Hours**

Discrete Time Fourier Series (DTFS)-spectrum- –properties – Discrete Time Fourier Transform (DTFT) – Properties – discrete time system representation by difference equations – Frequency response of systems characterized by difference equations.

Z TRANSFORM ANALYSIS OF SIGNALS AND SYSTEMS **13 Hours**

Z transform – RoC –Forward and Inverse Transform use Residue, long Division, Partial Fraction methods - Properties of Z transform – Pole-zero plot- Analysis and characterization of LTI system using Z transform- frequency response of DT systems

Theory: 45	Tutorial: 15	Practical: 0	Project: 0	Total: 60 Hours

REFERENCES:

1. Alan V. Oppenheim, Alan S. Willsky, S.HamidNawab, “Signals and Systems”, Pearson Education, 2nd Edition, 2015.
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, John Wiley & Sons, 3rd Edition, 2012.
3. H. P. Hsu, “Signals and Systems” Schaum’s Outline Series, McGraw Hill Professional, 3rd Edition,2013
4. John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Pearson Education, 4th Edition, 2014.
5. M. J. Roberts, “Signals and Systems Analysis using Transform method and MATLAB”, McGraw-Hill Education, Second Edition, 2011.
6. K. Lindner, “Signals and Systems”, McGraw Hill International,1999.

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U18ECI3202 ELECTRON DEVICES AND CIRCUITS

L	T	P	J	C
3	0	2	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the basics of semiconductor diodes and special purpose diodes to analyze their VI characteristics and diode models.	K3
CO2	Analyze the working principles of bipolar transistors and field-effect transistors to differentiate their configurations and biasing methods.	K4
CO3	Apply small signal models of BJTs and FETs to design multistage amplifiers and analyze their frequency response.	K3
CO4	Evaluate different types of power amplifiers and tuned amplifiers to design circuits meeting specified requirements.	K5
CO5	Analyze rectifiers, filters, and voltage regulators to assess their efficiency and ripple factor in DC power supplies.	K4
CO6	Demonstrate the characteristics of semiconductor devices and verification of network theorems.	K3

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2			2							2	2	
CO2	2	2	2									2	2	
CO3	2			2	2								2	
CO4	2		2	2	2								2	
CO5	2	2		2						2			2	
CO6	2			2					2				2	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

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SEMICONDUCTOR DIODES AND SPECIAL PURPOSE DIODES 09 Hours

Formation of PN junction – working principle – VI characteristics – PN diode currents – diode current equation – diode resistance – transition and diffusion capacitance – diode models – voltage breakdown in diodes.

Special purpose diodes: Zener diode – Varactor diode – Tunnel diode– Schottky diode, PNPN diode - Thyristors– RF diode.

BIPOLAR TRANSISTORS 12 Hours

Construction – working – transistor currents – transistor configurations and input-output characteristics – Early effect (base-width modulation) – Ebers Moll model -Field-Effect Transistors: construction,working and VI characteristics of JFET.

MOSFET – enhancement MOSFET, depletion MOSFET, their working principle and VI characteristics, CMOS, MESFET, CCD.

Various biasing methods of BJT and stability factors-JFET & MOSFET biasing.

SMALL-SIGNAL AMPLIFIERS - ANALYSIS AND FREQUENCY RESPONSE 11 Hours

Small signal model of BJT, BJT amplifiers: CE, CB and CC amplifiers – multistage amplifiers - differential amplifier – designing BJT amplifier (analysis using hybrid –π model)

FET amplifiers: CS, CG and CD amplifiers –designing FET amplifier.

Frequency response: Low frequency response of BJT and FET amplifiers – Miller effect capacitance – high frequency response of BJT and FET amplifiers.

POWER AMPLIFIERS AND TUNED AMPLIFIERS 07 Hours

Power amplifiers: definitions and amplifier types –Class A amplifier – Class B and Class AB push-pull amplifiers – Class C amplifiers- heat sink – designing power amplifier circuits.

Tuned amplifiers– single tuned – double tuned –staggered tuned amplifiers-design of basic tuned amplifier.

DC POWER SUPPLIES 06 Hours

Rectifiers and Filters: HWR, FWR, full-wave bridge rectifier, power supply filters (ripple factor and efficiency analysis), bleeder resistor.

Voltage regulators: voltage regulation, Zener diode shunt regulator, transistor series regulator, transistor shunt regulator, switching regulators, design of complete DC power supply circuit.

REFERENCES:

1. Jacob Millman, Christos C Halkias, Satyabrata Jit, "Electron Devices and Circuits", TataMcGraw Hill, 4th Edition ,2015
2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education,11th Edition, 2015.
3. Thomas L. Floyd, "Electronic Devices", 9th Edition, Pearson Education, 2012.
4. David A Bell, "Fundamentals of Electronic Devices and Circuits", Fifth edition Oxford Press, 2009.
5. Adel.S. Sedra, Kenneth C. Smith, Micro Electronic circuits, 6th Edition, Oxford University Press, 2000.

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LAB COMPONENT:

LIST OF EXPERIMENTS:

1. Characteristics of PN Junction diode and Zener diode& Regulator using Zener diode
2. Common Emitter/ Common base/Common Collector input-output Characteristics.
3. Characteristics of FET
4. Transfer characteristics of MOSFET
5. Frequency response of single-stage BJT & FET amplifiers.
6. Design of power and tuned amplifier
7. Verifications Of KVL & KCL
8. Verifications of Theorems
9. Development of power supply circuits using devices in PCB

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hours

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L	T	P	J	C
3	0	2	0	4

U18ECI3203 DIGITAL SYSTEM DESIGN

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the basics of digital systems including number systems, logic gates, and Boolean algebra.	K3
CO2	Analyze and design combinational circuits such as adders, subtractors, encoders, and decoders.	K4
CO3	Evaluate synchronous sequential circuits including flip-flops, shift registers, and counters.	K5
CO4	Analyze asynchronous sequential circuits using ASM, identify hazards, and ensure race-free assignments.	K4
CO5	Apply different logic families and programmable devices for implementing combinational logic circuits.	K3
CO6	Create and verify combinational logic functions, adders, subtractors, and counters in the laboratory.	K6

Pre-requisites: --

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1		2	1							1	
CO2	2	2	2	1	1								1	
CO3	2	2	2		2	1							1	
CO4	2	2	2	1	1								1	
CO5	1	1	1		2					1				1
CO6	2	1		1	1				2				1	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II (Theory Component) Assignment (Theory Component) Group Presentation (Theory Component) Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component) Model examination (lab component) End Semester Examination (Theory and lab component)
INDIRECT
Course-end survey

THEORY COMPONENT CONTENTS

BASIC CONCEPTS OF DIGITAL SYSTEMS **09 Hours**

Review of Number systems, Number Representation, Binary Arithmetic and Logic gates, Boolean algebra, Boolean postulates and laws - De-Morgan's Theorem - Principle of Duality, Simplification using Boolean algebra, Canonical forms - Sum of product and Product of sum - Minimization using Karnaugh map and Tabulation method.

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COMBINATIONAL CIRCUITS **09 Hours**

Realization of combinational logic using gates, Design of combinational circuits : Adder , Subtractor, Parallel adder / Subtractor, Carry look ahead adder, Magnitude Comparator, Parity generator and checker, Encoder, Decoder, Multiplexer, Demultiplexer - Function realization using Multiplexer, Decoder - Code converters.

SYNCHRONOUS SEQUENTIAL CIRCUITS **09 Hours**

Flip-flops - SR, JK, D and T- Master-Slave – Triggering - Analysis of clocked sequential circuits - State reduction and assignment - Excitation table – Design procedure - Shift registers - Universal shift registers – Ripple counters - Synchronous counters – Ring counter – Johnson Counter.

ASYNCHRONOUS SEQUENTIAL CIRCUITS **09 Hours**

Algorithmic State Machines (ASM) - Asynchronous sequential logic - Analysis procedure – Circuits with latches – Design procedure – Reduction of State and Flow tables – Race free state assignments – Hazards.

LOGIC FAMILIES AND PROGRAMMABLE DEVICES **09 Hours**

Introduction to Logic families – ECL, TTL &CMOS - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Implementation of combinational logic circuits using PLA, PAL.

REFERENCES:

1. M. Morris Mano, "Digital Logic and Computer Design", Pearson Education, 4th Edition, 2016.
2. Donald D.Givone, "Digital Principles and Design", Tata Mc-Graw Hill Publishing company limited, New Delhi, 2003.
3. Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education, New Delhi, 2009.
4. Leach D, Malvino A P & Saha, "Digital Principles and Applications" 8th Edition, Tata McGraw-Hill Publishing Company, 2014.
5. W H Gothman, "Digital Electronics: An introduction to theory and practice", 2nd Edition, Prentice Hall of India, 2000.
6. John.M Yarbrough, "Digital Logic Applications and Design", Thomson – Vikas Publishing House, New Delhi, 2002.

LAB COMPONENT CONTENTS

LIST OF EXPERIMENTS

Design and implementation of:

1. Combinational logic functions
2. Adders and Subtractors
3. Magnitude Comparator
4. Multiplexer and De-multiplexer / Encoders and Decoders
5. Synchronous Counters / Asynchronous Counters

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hours

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U18ECT3004 ELECTROMAGNETIC FIELDS

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the concepts of co-ordinate systems to analyze static electric field.	K3
CO2	Analyze the behavior of magnetic fields using Biot-Savart's Law and Ampere's circuital law.	K4
CO3	Analyze the effect of static electric and magnetic fields on materials.	K4
CO4	Apply the implications of electromagnetic (EM) concepts to derive Maxwell's equations in integral and differential form.	K3
CO5	Build solutions using wave equations for conducting and non-conducting media.	K3

Pre-requisites: --

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	2										2
CO2	2	2	2		2									
CO3	2			2			2							
CO4	2		2		2									
CO5	2	2	2		2									

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

STATIC ELECTRIC FIELD **09 Hours**

Co-ordinate Systems – Gradient, Divergence, Curl – Divergence theorem, Stokes theorem - Coulomb's Law– Electric Field Intensity – Electric Field due to discrete charges, charges distributed uniformly on an infinite line, finite line and infinite sheet.

Electric Scalar Potential – Electric Flux Density – Gauss Law and its applications.

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STATIC MAGNETIC FIELD **09 Hours**

Biot-Savart's Law– Magnetic Field intensity due to infinite and finite wire carrying current I – Ampere's circuital law. Magnetic flux density –Lorentz force equation – Force on a wire carrying a current placed in a magnetic field – Torque on a loop carrying a current – Magnetic moment – Magnetic Vector Potential

ELECTRIC AND MAGNETIC FIELDS IN MATERIALS **09 Hours**

Poisson's and Laplace's equation – Electric Polarization - Capacitance – Capacitance of parallel plate capacitor and coaxial cable – Capacitance of parallel plate capacitor with two dielectrics – Electrostatic energy - Energydensity – Boundary conditions for electric fields – Electric current – Current density – Point form of ohm's law – Continuity equation for current. Inductance – Inductance of loops and solenoids – Mutual inductance –Energy density in magnetic fields – Magnetization and Permeability - Magnetic boundary conditions.

TIME VARYING ELECTRIC AND MAGNETIC FIELDS **09 Hours**

Faraday's law – Transformer and Motional electromotive forces - Displacement current – Maxwell's equationsin integral form and differential form –Maxwell's equation in Phasor form - Poynting Vector and the flow of power – Poynting theorem.
Introduction to field computation methods-FDM, FEM, MOM.

ELECTROMAGNETIC WAVES **09 Hours**

Wave equations for conducting and non-conducting media - Wave equations in Phasor form –Uniform plane waves in perfect dielectrics, conductors and free space - Skin effect- Introduction to EM Shielding
Case Study: Biological Effects of Electromagnetic Waves

Theory: 45 Hours	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. William H.Hayt, J A Buck, "Engineering Electromagnetics" Tata McGraw Hill Education Private Limited, Seventh Edition, 2012.
2. E.C. Jordan & K.G. Balmain, "Electromagnetic Waves and Radiating Systems," Prentice Hall of India, Second Edition, 2011.
3. S.Ramo, J.R.Whinnery and T.VanDuzer: "Fields and Waves in Communications Electronics" John Wiley & Sons, Third edition, 2003.
4. M.N.O.Sadiku, "Elements of Engineering Electromagnetics", Oxford University Press, Fourth Edition, 2006.
5. Clayton.R.Paul, Keith W.Whites, Syed.A.Nasar "Introduction to Electro Magnetic Fields", WCB/McGraw-Hill, Third Edition, 2007.
6. David K.Cheng "Field and Wave Electromagnetics" Second Edition, Pearson Education Limited, 2014

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L	T	P	J	C
3	1	0	0	4

U18ECT3105 **NETWORK THEORY**

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the basics of DC circuits analysis to differentiate between circuit elements and apply Ohm's Law, Kirchhoff's Laws, and various circuit techniques.	K4
CO2	Apply network theorems to evaluate and verify circuit behavior under different conditions.	K3
CO3	Evaluate sinusoidal steady-state analysis techniques and network parameters to analyze AC circuits and determine power characteristics.	K5
CO4	Analyze first-order and second-order circuits to predict their transient responses and frequency characteristics.	K4
CO5	Apply resonance and coupled circuits principles to design and analyze resonant circuits and understand the behavior of coupled circuits.	K3

Pre-requisites: --

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2												
CO2	2	2												
CO3				2			2							
CO4	2		2											
CO5													1	1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

DC CIRCUITS ANALYSIS **11 Hours**

Basic Definitions: Charge, Current, Voltage and Power, Circuit elements: Resistors, Inductors, capacitors, Voltage and Current Sources - Ohm's Law, Kirchhoff's Current Law, Kirchhoff's Voltage Law, Circuit elements (R, L, C, Voltage and Current Sources) in Series and Parallel, Voltage and Current Division, Source Transformation, Delta-Star and Star- Delta transformation, Mesh Analysis, super mesh, Nodal analysis, Super node.

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NETWORK THEOREMS **10 Hours**

Superposition Theorem, Thevenin's Theorem and Norton's Theorem, Maximum Power Transfer Theorem, Reciprocity Theorem, Verification of Theorems.

SINUSOIDAL STEADY STATE ANALYSIS **10 Hours**

Sinusoids, Phasors, Phasor representation of R, L and C, Phasor Diagrams, Impedance, Admittance, Susceptance, Conductance and Reactance-Two port networks-Impedance Parameters-Admittance Parameters-Hybrid Parameters-Transmission Parameters, Relation between parameters-

AC CIRCUIT POWER ANALYSIS **08 Hours**

Instantaneous Power, Average Power, RMS Power, Apparent Power and Power Factor, Complex Power, Mesh Analysis & Nodal Analysis, Verification of Maximum Power Transfer theorem.

FIRST ORDER AND SECOND ORDER CIRCUITS **11 Hours**

Basic RL and RC Circuits: The Source-Free RL Circuit, the Source-Free RC Circuit, The Unit Step Function, Driven RL Circuits, Driven RC Circuits- Source free series and parallel RLC circuits.

RESONANCE AND COUPLED CIRCUITS **10 Hours**

Frequency Response of Parallel and Series Resonance circuits-determination of Resonant Frequency, Q – Factor and Bandwidth. Magnetically Coupled Circuits - Self Inductance, Mutual Inductance, Coefficient of Coupling, Energy in a coupled circuit, Linear Transformer, Ideal Transformer.

Theory: 45	Tutorial: 15	Practical: 0	Project: 0	Total: 60 Hours

REFERENCES:

1. Charles K. Alexander and Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", 3rd Edition, McGraw-Hill, 2008.
2. David E. Johnson, Johny R. Johnson and John L. Hilburn, "Electric Circuit Analysis", 2nd Edition, Prentice-Hall Int.
3. Murthy K.V.V., Kamath M.S., "Basic Circuit Analysis", Jaico Publishing House, 1999.
4. Norman Balabanian, "Electric Circuits", Int. Edition, McGraw-Hill, 1994.
5. Decarlo R.A. and Lin P.M.," Linear circuit analysis - The time domain, Phasor and Laplace transform approach", Oxford press, 2nd Edition, 2003.
6. William H. Hayt, Jr Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis", 7th Edition, Tata McGraw Hill, 2010
7. Joseph Edministor and Nahvi (Mohmood)," Theory & Problems of Electric Circuits", 5th Edition, MC Graw Hill, 2011.

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U18INI3600 **ENGINEERING CLINIC -III**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and teamwork
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students will be able to

CO1	Identify a practical problem and find a solution	K3
CO2	Summarize the project management techniques	K2
CO3	Demonstrate their technical report writing and presentation skills	K2

Pre-requisite: U18INI2600 - Engineering Clinic II

CO/PO MAPPING

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	1		3			3		
CO2											3			
CO3										3				

Course Assessment methods:

Direct	Indirect
1.Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

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Content:

The course will offer the students an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the III semester, students will focus primarily on Design project combining concepts learnt in Engineering clinics I and II

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific task, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Theory: 0	**Tutorial: 0**	**Practical: 60**	**Project: 30**	**Total: 90 Hours**

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U18CHT3000 **Environmental Science and Engineering (Common to All branches)**

L	T	P	J	C
3	0	0	0	0

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply knowledge of natural resources to analyze the impact of human activities on forest, water, and mineral resources.	K4
CO2	Analyze the structure and function of ecosystems to evaluate their role in maintaining biodiversity.	K5
CO3	Examine the causes and effects of different types of environmental pollution to recommend effective control measures.	K5
CO4	Compare the social issues related to environmental sustainability to assess the effectiveness of environmental legislation.	K5
CO5	Evaluate the relationship between human population growth and environmental health to develop strategies for sustainable development.	K6

Pre-requisites: --

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2											1	
CO2			2				1							
CO3				3						2				1
CO4						2						1		
CO5							2		1				1	

Course Assessment methods

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation	Course end survey

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INTRODUCTION TO ENVIRONMENTAL STUDIES ANDNATURAL RESOURCES **14 Hours**

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies – Timber extraction, mining, dams and their effects on forests and tribal people.
Water resources: Use and overutilization of surface and ground water, conflicts over water, dams – benefits and problems – Water conservation, rainwater harvesting, watershed management. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, case studies.
Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies.
Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification, Wasteland reclamation – Role of an individual in conservation of natural resources.

ECOSYSTEMS AND BIODIVERSITY **9 Hours**

ECOSYSTEM: Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Food chain, Food web, Energy flow in the ecosystem and Ecological pyramids – Ecological succession – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem
(d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

BIODIVERSITY: Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Bio geographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION **8 Hours**

Definition – Causes, effects and control measures of: (a) Air pollution – Organic and inorganic pollution – cyclone separator, electrostatic precipitator (b) Water pollution (c) Heavy metal pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards – Role of an individual in prevention of pollution – Pollution case studies – Solid waste and hazardous Management: Causes, effects and control measures from factories, small scale and large scale industries – Waste minimization – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT **7 Hours**

From Unsustainable to Sustainable development – Urban problems related to energy – Resettlement and rehabilitation of people; its problems and concerns, case studies – Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act –Issues involved in enforcement of environmental legislation – Human Rights.

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HUMAN POPULATION AND THE ENVIRONMENT **7 Hours**

Population growth and explosion – Welfare Program – Environment and human health – Communicable disease – Role of Information Technology in Environment and human health – Case studies.

Theory: 45 Hours **Total: 45 Hours**

REFERENCES

1. G. Tyler Miller and Scott Spoolman, 'Environmental Science', Fourteenth Edition, Brooks Cole, 2012.
2. Gilbert M. Masters and Wendell P. Ela, 'Introduction to Environmental Engineering and Science', Third Edition, Pearson Education, 2013.
3. Bharucha Erach, 'The Biodiversity of India', Mapin Publishing Pvt. Ltd., Ahmedabad, 2002.
4. Trivedi R.K and P.K.Goel, 'Introduction to Air Pollution', Techno-Science Publications, 2003.
5. Trivedi R.K., 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media, 1996.
6. Cunningham, W.P.Cooper and T.H.Gorhani, 'Environmental Encyclopedia', Jaico Publication House, Mumbai, 2001.
7. Wager K.D., 'Environmental Management', W.B. Saunders Co., Philadelphia, USA, 1998.
8. Colin R. Townsend, Michael Begon and John L. Harper, 'Essentials of Ecology', Third Edition, Blackwell Publishing, 2008.

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SEMESTER IV

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U18ECI4201 **DIGITAL SIGNAL PROCESSING**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze DFT algorithm and properties and its applications in signal processing	K4
CO2	Compare and contrast analog filter design techniques and realize IIR filters.	K4
CO3	Assess the design methods and implementation of FIR filters.	K5
CO4	Examine the effects of quantization and round-off in digital filters and their impact on filter performance.	K4
CO5	Evaluate the architecture of DSP processor.	K4
CO6	Create and verify DSP concepts for signal processing applications through simulation and DSP processor.	K6

Pre-requisites:

1. U18ECT3101 - Signals and Systems

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2												1
CO2	2		2				1							2
CO3		2			2									2
CO4				2										2
CO5	2											2		1
CO6			2											2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II (Theory Component) Assignment (Theory Component) Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) Model examination (lab component) End Semester Examination (Theory and lab component)
INDIRECT
Course-end survey

DISCRETE FOURIER TRANSFORM **09 Hours**

DFT and its properties, Relation between DTFT and DFT, Radix-2 FFT algorithms –DFT computation using Decimation in time and Decimation in frequency algorithms, Overlap-add and save Methods.

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INFINITE IMPULSE RESPONSE DIGITAL FILTERS **12 Hours**

Design of analog Butterworth and Chebyshev Filters – Frequency transformation in analog domain – Design of IIR digital filters - Impulse invariance techniques, Bilinear transform – Prewarping – Realization of IIR filters - Direct, cascade and parallel forms, Lattice structure.

FINITE IMPULSE RESPONSE DIGITAL FILTERS **12 Hours**

Linear phase FIR filters – Design using Rectangular, Hamming, Hanning and Blackmann Windows – Frequency sampling method – Realization of FIR filters – Direct form and Lattice structure

FINITE WORD LENGTH EFFECTS **06 Hours**

Representation of numbers, Quantization of filter coefficients in IIR and FIR filters, Round off effects in digital filters –Limit cycle Oscillations, Scaling, Quantization effect in fixed point realization of digital filters.

DSP ARCHITECTURE **06 Hours**

Comparison of Von-Neumann and Harvard architecture - Architecture of TMS320C67XX Processors- Addressing modes- Memory organization - Program Control – Pipelining- On-Chip Peripherals- Interrupts.

REFERENCES:

1. John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson, Fourth Edition, 2014.
2. Venkataramani B, and Bhaskar M, "Digital Signal Processors: Architecture, Programming & Applications", Tata McGraw Hill, New Delhi, 2011.
3. Monson H.Hayes, "Digital Signal Processing "Schaum's Outline Series, McGraw Hill Professional, 2nd Edition,2011
4. Johny R. Johnson, "Introduction to Digital Signal Processing", PHI, 2006.
5. S.K. Mitra, "Digital Signal Processing, A Computer Based approach", Tata McGraw Hill, 4th Edition, 2013.
6. E.C. Ifeachor and B.W. Jervis, "Digital signal processing – A Practical approach", Second edition, Pearson, 2002.

LAB COMPONENT

LIST OF EXPERIMENTS

1. Generate and perform operations on signals
2. Pole Zero plot and stability analysis of systems.
3. Convolution and correlation.
4. Implementation of algorithms for DFT/IDFT.
5. Spectral analysis of Sampled signal
6. Design of FIR filters.
7. Design of IIR filters.

Experiments using TMS320C67XX

8. Filter implementation
9. Verify DSP concepts with real time signals.

Theory: 45	**Tutorial:0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

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U18ECI4202 ANALOG ELECTRONICS AND INTEGRATED CIRCUITS

L	T	P	J	C
3	0	2	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the feedback amplifier concepts and evaluate the performance of different feedback amplifier topologies and oscillators.	K4
CO2	Evaluate the fundamentals and performance characteristics of operational amplifiers.	K5
CO3	Apply operational amplifier techniques to design and analyze various circuits such as amplifiers, filters, and voltage multipliers.	K3
CO4	Analyze waveform generator circuits and phase-locked loops (PLLs) and evaluate their operation and applications.	K4
CO5	Evaluate data conversion methods including DACs and ADCs and compare their specifications.	K5
CO6	Demonstrate the design and implementation of various analog electronics circuits using BJTs and Op-amps.	K3

Pre-requisites:

1.U18ECI3202 - Electron Devices and circuits

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3		2								2	1	
CO2	1		3		2	2							2	
CO3	1	2					3			2			1	
CO4	2		2					2			2			
CO5	1			2			2					2		
CO6	2				2				2				2	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

FEEDBACK AMPLIFIER & OSCILLATORS **09 Hours**

Feedback Concepts – gain with feedback – effect of feedback on gain stability, distortion, bandwidth, input and output impedances; topologies of feedback amplifiers – analysis of series-series, shunt-shunt and shunt- series feedback amplifiers-Oscillators: Hartley & Colpitts oscillators- Phase shift & Wien bridge.

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BASICS OF OPERATIONAL AMPLIFIERS **09 Hours**

Current mirror and current sources, Current sources as active loads- BJT Differential amplifier with active loads, Ideal Operational Amplifier - General operational amplifier stages -and internal circuit diagrams of IC 741, Open and closed loop configurations, DC and AC performance characteristics, slew rate, Frequency compensation.

APPLICATIONS OF OPERATIONAL AMPLIFIERS **12 Hours**

Inverting & Non-inverting voltage amplifiers - Voltage follower - Summing, scaling & averaging amplifiers - AC amplifiers. Instrumentation Amplifiers -Differentiators and Integrators -Second order active filters Precision Rectifiers – Wave Shaping Circuits (Clipper and Clampers) – Log and Antilog Amplifiers – Analog voltage multiplier circuit and its applications –Comparators, Schmitt trigger and its applications – Sample and Hold circuit.

WAVEFORM GENERATORS AND PLL **08 Hours**

Waveform Generators: Sine-wave Generators – Square / Triangle / Saw-tooth Wave generators. IC 555 Timer: Monostable operation and its applications – Astable operation and its applications. PLL: Operation of the Basic PLL-Closed loop analysis of PLL-Voltage Controlled Oscillator-PLL applications**.**

DATA CONVERTORS **07 Hours**

Digital to Analog Conversion: DAC Specifications – DAC circuits – Weighted Resistor DAC-R-2R Ladder Analog to Digital conversion: ADC specifications-ADC circuits-Ramp Type ADC-Successive Approximation ADC-Dual Slope ADC-Flash Type ADC.

REFERENCES:

1. Millman and Halkias. C., Integrated Electronics, Second edition TMH, 2009.
2 D.Roy Choudhry, Shail Jain, ―Linear Integrated Circuits, New Age International Pvt. Ltd., Fifth Edition, 2018.
3. Ramakant A. Gayakwad, ―OP-AMP and Linear ICs‖, 4th Edition, Prentice Hall / Pearson Education, 2015.
4. Robert F.Coughlin, Frederick F.Driscoll,-Operational Amplifiers and Linear Integrated Circuits, Sixth Edition, PHI, 2001.
5. S.Salivahanan & V.S. Kanchana Bhaskaran, ―Linear Integrated Circuits‖, TMH, 2nd Edition, 4th Reprint, 2016.
6. Sergio Franco, ―Design with Operational Amplifiers and Analog Integrated Circuits, 4th Edition, Tata Mc Graw-Hill, 2016

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LAB COMPONENT:

LIST OF EXPERIMENTS:

1. Frequency response of Feedback Amplifier.
2. Design of Oscillator circuits
3. Basic op-amp circuits inverting & non-inverting amplifiers, adders and subtractors.
4. Linear applications of op-amp: Integrator and Differentiator.
5. Non-linear application of op-amp: precision rectifiers and comparators.
6. 555 Timer – Astable and Monostable Multivibrator.
7. Design of Active Filters LPF& HPF.
8. Simulation experiments using PSPICE or Multisim.
9. Development of application circuits using ICs

Theory: 45	**Tutorial:0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

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U18MAT4103 **PROBABILITY AND RANDOM PROCESSES**

L	T	P	J	C
3	1	0	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the fundamental concepts of probability to solve problems involving joint and conditional probabilities.	K3
CO2	Analyze the properties of various probability distributions to categorize different types of random variables.	K4
CO3	Evaluate random processes to justify their classification as stationary or ergodic processes.	K5
CO4	Compare the properties of correlation and spectral densities to infer relationships between power spectra and correlations.	K4
CO5	Design optimum linear time-invariant systems using matched filters to achieve spectral characterization.	K6

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2											
CO2	2	2	2											
CO3	2	2	2											
CO4	1		2		1									
CO5	1		2		1								1	1

Course Assessment Methods

DIRECT
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
INDIRECT
Course-end survey

BASIC CONCEPTS OF PROBABILITY **09 Hours**

Sets: Definition and Operations, Probability: Definition through Sets, Joint and Conditional Probabilities, Baye's theorem.

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RANDOM VARIABLES **09 Hours**

Random variable – Definition, Discrete and Continuous Random Variables – Probability Density Functions,Probability Distribution Functions – Properties – Gaussian, Binominal, Poisson, Uniform, Exponential Distributions and their properties – Operations on one random variable.

Multiple Random Variables: - Joint Density and Distribution Functions –Marginal and conditional distributions

–Properties – Operations on multiple random variables.

RANDOM PROCESSES **09 Hours**

Random Process – Stationary Process – Wide sense stationary and Ergodic processes– GaussianRandom Process – Markov process–Markov chain–Poisson process

CORRELATION AND SPECTRAL DENSITIES **09 Hours**

Correlation: Autocorrelation, Cross Correlation and their properties – Covariance– R egression – Central Limit Theorem.

Power spectral density and its properties – Cross power spectral density and its properties –Relationship between power spectrum and correlations – Wiener-Khintchine relation.

OPTIMUM FILTERING **09 Hours**

Linear time invariant system – System transfer function – Properties – Linear systems with random inputs – Autocorrelation and Cross Correlation of inputs and outputs – Spectral Characterization – Optimum linear timeinvariant systems – Matched Filter – Properties.

Theory: 45	**Tutorial: 15**	**Practical: 0**	**Project: 0**	**Total: 60**

REFERENCES:

1. Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill, 4th Edition, 2002.
2. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", 3rd Indian Edition, Oxford University Press, New Delhi, 2012.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2004.
4. Stark. H, and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", 3rd Edition, Pearson Education, Asia, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., 2012.

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U18ECT4104 **TRANSMISSION LINES AND WAVEGUIDES**

L	T	P	J	C
3	1	0	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the concepts of line parameters and standard forms for voltage and current in transmission lines.	K3
CO2	Analyze standing waves and standing wave ratio on transmission lines and apply the Smith Chart for problem-solving.	K4
CO3	Apply the characteristics of TE and TM waves in parallel planes of perfect conductors and analyze wave impedances.	K4
CO4	Evaluate the characteristics and modes of TM and TE waves in rectangular waveguides and microwave cavities.	K5
CO5	Create solutions using Bessel functions and analyze the excitation of modes in circular waveguides and cavity resonators.	K6

Pre-requisites:

1. U18ECT3004 - Electromagnetic Fields

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2			2									
CO2		2	2		2									
CO3	2			2	2									
CO4		2		2	2									
CO5			2	2	2									

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

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TRANSMISSION LINE THEORY **12 Hours**

Transmission lines – Line parameters - General Solution of the transmission line – Standard forms for voltage and current - The infinite line – The two standard forms for the input impedance of a transmission line. Characteristic impedance and Propagation Constant.
Waveform distortion – distortion less transmission line – Loading of transmission lines, Transfer impedance - Reflection factor, reflection loss, return loss, Insertion loss

TRANSMISSION LINE AT RADIO FREQUENCIES **12 Hours**

Standing waves and standing wave ratio on a line – Eighth wave line – Quarter wave line and the half wave line – Smith Chart – Applications of the Smith Chart –Problem solving using Smith chart– Single stub matching and Double stub matching.

GUIDED WAVES **12 Hours**

Waves between parallel planes of perfect conductors – Transverse electric and transverse magnetic waves – characteristics of TE and TM Waves – Transverse Electromagnetic waves – Velocities of propagation –component uniform plane waves between parallel planes –Wave impedance.

RECTANGULAR WAVEGUIDES **12 Hours**

Transverse Magnetic Waves in Rectangular Wave guides – Transverse Electric Waves in Rectangular Waveguides – characteristic of TE and TM Waves – Cutoff wavelength and phase velocity – Impossibility of TEM waves in waveguides – Dominant mode in rectangular waveguide – Attenuation of TE and TM modes in rectangular waveguides – Wave impedances– Excitation of modes.

CIRCULAR WAVE GUIDES AND RESONATORS **12 Hours**

Bessel functions – Solution of field equations in cylindrical co-ordinates – TM and TE waves in circular guides – Wave impedances– Dominant mode in circular waveguide – excitation of modes – Microwave cavities, Rectangular cavity resonators, Q factor of rectangular cavity resonator for TE101 mode.

Theory: 45	**Tutorial: 15**	**Practical: 0**	**Project: 0**	**Total: 60 Hours**

REFERENCES:

1. J.D.Ryder "Networks, Lines and Fields", PHI, New Delhi, 2003
2. E.C. Jordan and K.G.Balmain "Electro Magnetic Waves and Radiating System", PHI, New Delhi, 2003.
3. Mathew N. O. Sadiku "Elements of Electro Magnetics", Seventh edition, Oxford, New York, 2010.
4. Ramo, Whineery and Van Duzer: "Fields and Waves in Communication Electronics" John Wiley, 2003.
5. Clayton. R. Paul, Keith W. Whites, Syed. A. Nasar "Introduction to Electro Magnetic Fields", Third edition, WCB/McGraw-Hill, 1998.

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U18INI4600 **ENGINEERING CLINIC IV**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and teamwork
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students will be able to

CO1	Identify a practical problem and find a solution	K3
CO2	Summarize the project management techniques	K2
CO3	Demonstrate their technical report writing and presentation skills	K2

Pre-requisite: U18INI2600 - Engineering Clinic III

CO/PO MAPPING

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	1		3			3		
CO2											3			
CO3										3				

Course Assessment methods:

Direct	Indirect
1.Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

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Content:

The course will offer the students an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the IV semester, students will focus primarily on Reverse engineering project to improve performance of a product.

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Theory: 0 Tutorial: 0	**Practical: 60**	**Project:30**	**Total: 90 Hours**

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U18INT4000 **CONSTITUTION OF INDIA**

L	T	P	J	C
2	0	0	0	0

Course Outcomes:

After successful completion of this course, the students will be able to

CO1	Apply the concepts of constitutional law to interpret the historical perspectives of the Indian Constitution.	K3
CO2	Analyze the scope and implementation of Fundamental Rights and Directive Principles of State Policy.	K4
CO3	Apply the concept of Federal structure of Indian Government	K3
CO4	Analyze the amendments and emergency provisions in the constitution	K4
CO5	Develop a holistic approach in their life as a Citizen of India	K3

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2		2										
CO2		2	3			1								
CO3	2	2		2										
CO4				2			2							
CO5													1	1

Course Assessment methods

Direct
1. Group Activity / Quiz/ Debate / Case studies 2. Class test / Assignment
Indirect
Surveys

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THEORY COMPONENT

Module 1: Introduction to Indian Constitution **4 hours**

Meaning of the constitution law and constitutionalism - Historical perspective of the Constitution - Salient features and characteristics of the Constitution of India

Module 2: Fundamental Rights **8 hours**

Scheme of the fundamental rights - Right to Equality - Fundamental Right under Article 19 - Scope of the Right to Life and Liberty - Fundamental Duties and its legal status - Directive Principles of State Policy – Its importance and implementation

Module 3: Federal Structure **8 hours**

Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary Form of Government in India - The constitutional powers and status of the President of India

Module 4: Amendment to Constitution **6 hours**

Amendment of the Constitutional Powers and Procedure - The historical perspectives of the constitutional amendments in India

Module 5: Emergency Provisions **4 hours**

National Emergency, President Rule, Financial Emergency Local Self Government – Constitutional Scheme in India

Theory: 30	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 30 hours**

REFERENCES

1. Constitution of India - Ministry of Law & Justice - PDF format awmin.nic.in/coi/coiason29july08.pdf
2. Introduction to the Constitution of India by Durgadas Basu
3. The Constitution of India-Google free material - www.constitution.org/cons/india/const.html
4. Parliament of India-PDF format. download.nos.org/srsec317newE/317EL11.pdf
5. The Role of the President of India – By Prof.Balkrishna
6. Local Government in India - E Book - Pradeep Sachdeva https://books.google.com/books/.../Local_Government_in_In.

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U18VET4101	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY	L	T	P	J	C
		2	1	0	0	3

COURSE OUTCOMES:

After successful completion of this course, the students shall be able to

CO1	Apply the concept of Self-Exploration to critically evaluate human aspirations of continuous happiness and prosperity.	K3
CO2	Analyze the relationship between 'I' and the Body to assess their roles in achieving harmony and health.	K4
CO3	Evaluate the foundational values of human-human relationships to justify the importance of trust and respect for mutual happiness.	K5
CO4	Analyze the interconnectedness among the four orders of nature to infer the impact of human activities on ecological balance.	K4
CO5	Create strategies to integrate professional ethics with human values to foster a Universal Human Order in professional conduct.	K6

Pre-requisites: Universal Human Values 1 (Desirable)

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2					1							
CO2	2	2					2							
CO3	1	2				2	2							
CO4	2	2					2							
CO5			2					2					1	1

COURSE ASSESSMENT METHODS:

Direct
1. Assessment by faculty mentor 2. Self-assessment 3. Socially relevant project/Group Activities/Assignments 4. End Semester Examination
Indirect
1. Assessment by peers (Survey form)

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COURSE CONTENTS:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for livingwith responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choicebased on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
4. Understanding the characteristics and activities of 'I' and harmony in 'I'.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me.Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing withdisease.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-HumanRelationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

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Include practice sessions to reflect on relationships in family, hostel and institute as extended family, reallife examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability andself-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasivespace.
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film"Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:

a. At the level of individual: as socially and ecologically responsible engineers,technologists and managers

b. At the level of society: as mutually enriching institutions and organizations

7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

COURSE DURATION:

No	MODULE	HOURS
1	Module 1	[7 Theory+ 3 Tutorial] 10 Hrs
2	Module 2	[6 Theory+ 3 Tutorial] 9 Hrs
3	Module 3	[7 Theory+ 3 Tutorial] 10 Hrs
4	Module 4	[5 Theory+ 3 Tutorial] 8 Hrs
5	Module 5	[5 Theory+ 3 Tutorial] 8 Hrs
	Total	**45**

Theory: 30 Hours	**Tutorial:15**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

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TEXTBOOK

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3pZ3yA7g_OAQz
15. https://www.youtube.com/channel/UCo8MpJB_aaVwB4LWLAx6AhQ
16. https://www.uhv.org.in/uhv-ii

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SEMESTER V

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L	T	P	J	C
3	0	2	0	4

U18ECI5201 COMMUNICATION ENGINEERING - I

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the fundamental concepts of electronic communication systems.	K4
CO2	Evaluate the principles of amplitude modulation.	K5
CO3	Apply the concepts of angle modulation.	K3
CO4	Demonstrate various pulse analog modulation schemes.	K2
CO5	Analyze the fundamentals of baseband digital pulse modulation schemes.	K4
CO6	Design, implement and analyze amplifiers, mixers, modulation and demodulation techniques using appropriate equipment and simulation tools.	K6

Pre-requisites:

1. U18ECT3101-Signals and Systems

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2		2							2			3
CO2	3		3				2				2			3
CO3	2	2			2							2		2
CO4	2			2		2			2					2
CO5	3	2						2					2	3
CO6			3		2					2		2		

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II (Theory Component) Assignment (Theory Component) Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) Model examination (lab component) End Semester Examination (Theory and lab component)
INDIRECT
Course-end survey

THEORY COMPONENT CONTENT:

INTRODUCTION **09 Hours**

Electronic Communication Systems – Electromagnetic Spectrum –Communication Channels. Representation of signals: Hilbert transform – I-Q Representation of pass-band signal.

Noise – Types of noise –Signal to noise ratio – Noise Factor – Noise Figure - Mathematical Representation of White noise and Narrowband Noise.

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AMPLITUDE MODULATION **12 Hours**

Linear summing, Nonlinear mixing - Multiplexing-Modulation, Need for Modulation - Principles of Amplitude modulation - Mathematical Representation, Waveforms – Spectrum – Bandwidth – Phasor representation, PowerRelations. Types - DSBFC, DSBSC, SSBSC, VSB – Square law, Switching Modulators, Generation of AM Signal

- Class A Modulator, Balanced Ring Modulator, Filter Method, Phase Shift Method, Demodulation of AM Signal - Coherent Detection– Costas Loop, Envelope Detector. AM Transmitter - Receiver Characteristics - Super heterodyne Receiver - Noise in AM receivers

ANGLE MODULATION **12 Hours**

Basic Principles – Types of Angle Modulation: Frequency Modulation, Phase Modulation – Mathematical Representation – Waveforms – Spectrum – Bandwidth – Power – Relationship between FM and PM – Narrowbandand Wideband FM – Phasor Representation.

Generation of FM signal - FM Reactance modulator – Direct and Indirect FM Transmitters-Demodulation of FMSignals: Tuned Circuit Frequency Discriminators – Balanced slope detector, Foster-Seely Discriminator – PLL – FM receiver. Noise in FM Receivers – Pre-emphasis and De-emphasis – Capture effect – Threshold effect – Performance Comparison of AM and FM Systems.

04 Hours

PULSE ANALOG MODULATION SCHEMES: Analog pulse modulation- PAM, PPM, PWM, Case study - Impulse Radio.

08 Hours

BASEBAND PULSE DIGITAL MODULATION SCHEMES: Pulse Code Modulation – Quantization-Companding- A-law & μ-law algorithms – Linear Prediction - Differential Pulse Code Modulation, Adaptive differential pulse code modulation – Delta Modulation-Adaptive Delta Modulation. Line coding techniques-NRZ / RZ – unipolar, polar, bipolar and biphase signals.

REFERENCES:

1. Simon Haykin, “Communication Systems”, John Wiley & Sons, Fifth Edition, 2009.
2. Herbert Taub, Donald L Schilling and Goutam Saha, “Principles of Communication Systems”, McGraw Hill, Fourth Edition, 2013.
3. B.P.Lathi, ZhiDing. “Modern Digital and Analog Communication Systems”, Oxford University Press, Fourth Edition, 2009.
4. John G. Proakis, Masoud Salehi, “Communication Systems Engineering”, Pearson Education, 2008.
5. Ferrel G. Stremler, “Introduction to Communication Systems”, Prentice-Hall, Fourth Edition, 2001.
6. W. Tomasi, “Electronic Communication Systems”, Prentice-Hall, Fourth Edition, 2001.

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LAB COMPONENT CONTENT:

LIST OF EXPERIMENTS

Design, Implementation/simulation analysis of the following:

1. Amplitude Modulation and demodulation.
2. Frequency Modulation and demodulation.
3. Pre-emphasis and de-emphasis.
4. RF mixer circuit and IF amplifier
5. Audio amplifier.
6. Analog Pulse Modulation.
7. AM and FM receiver characteristics
8. Line coding techniques.
9. Digital Pulse Modulation Techniques.

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

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U18ECI5203 COMMUNICATION NETWORKS

L	T	P	J	C
3	0	2	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply concepts of data communications, including network topologies and protocols, to analyze real-world scenarios.	K3
CO2	Analyze error detection and correction mechanisms in data link layer protocols to enhance network reliability.	K4
CO3	Evaluate routing algorithms and their effectiveness in optimizing network traffic and ensuring timely data delivery.	K5
CO4	Utilize transport layer protocols, such as TCP and UDP, in practical scenarios to ensure efficient data transmission.	K3
CO5	Illustrate the significance of network security measures, including encryption techniques, in safeguarding sensitive information transmission.	K3
CO6	Implement network protocols and configurations using appropriate tools in a laboratory environment to solve real-world networking problems.	K6

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	2		2								2	
CO2		2		2									1	
CO3		2	2											2
CO4	2				2									2
CO5						1	2							
CO6					2				2	2			2	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II (Theory Component) Assignment (Theory Component) Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) Model examination (lab component) End Semester Examination (Theory and lab component)
INDIRECT
Course-end survey

DATA COMMUNICATIONS **09 Hours**

Introduction to networks –Topologies – Protocols and Standards–ISO/OSI model-TCP/IP- Transmission Media and Connectors, Switching Techniques, Connecting devices – Switches, Routers, Gateways.

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DATA LINK LAYER **09 Hours**

LAN: Ethernet IEEE 802.3, IEEE802.5, IEEE802.11, FDDI, Bridges. Error detection and correction–Forward Error Correction –Flow Control and Error control techniques - Stop and wait – Go back N ARQ – Selective repeat ARQ - sliding window techniques – HDLC.

NETWORK LAYER **09 Hours**

Internetworks – Packet Switching and Datagram approach – IPv4 - addressing methods – Subnetting & Supernetting – IPv6. Routing – Distance Vector Routing, Link State Routing, Path Vector Routing. Quality of services (QOS) – methods to improve QOS parameters-Trunking, VPN.

TRANSPORT LAYER AND APPLICATION LAYER **09 Hours**

Functions of transport layer – Multiplexing – Sockets – User Datagram Protocol (UDP) –Transmission Control Protocol (TCP) – Congestion Control – Differentiated and Integrated Services - RSVP. Application layer: Domain Name Space (DNS), SMTP, FTP, HTTP, WWW.

NETWORK SECURITY **09 Hours**

Symmetric key cryptography – Data Encryption standard & Advanced Encryption Standard. Asymmetric key cryptography – RSA & Diffie-Hellman algorithms. Internet Security – Application layer security and firewalls-Case study on NV, SDN for IoT Systems.

REFERENCES:

1. Behrouz.A.Foruzan, ―Data communication and Networking, Fifth Edition, Tata McGraw-Hill, 2013.
2. Andrew S. Tannenbaum, ―Computer Networks, Fourth Edition, PHI, 2003
3. James. F. Kurouse & W.Rouse, ―Computer Networking: A Top down Approach Featuring, Addison Wesley, 2009.
4. Larry. L. Peterson & Peter. S. Davie, ―Computer Networks, third edition, Harcourt Asia Pvt. Ltd, 2007.

LAB COMPONENT:

LIST OF EXPERIMENTS

1. Implementation of CSMA/CD protocol for Ethernet LAN.
2. Implementation of CSMA/CA protocol for wireless LAN.
3. Implementation of Token passing access in BUS-LAN and RING-LAN.
4. Analysis of QoS parameters in ARQ Techniques
5. Simulation of Distance Vector Routing protocol
6. Simulation of Link State Routing protocol
7. Configuration of a Network Topology using Packet tracer.
8. Analysis of Network packets transmission using Wire shark.
9. Analysis of Encryption and Decryption algorithm.

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hours

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U18ECT5004 **CONTROL SYSTEMS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply modelling techniques for continuous time systems.	K3
CO2	Analyze the time response of control systems for different test inputs and determine time domain specifications.	K4
CO3	Analyze the continuous time systems in frequency domain using polar and Bode plots.	K4
CO4	Assess the stability of control systems using various stability criteria such as Routh-Hurwitz and Nyquist stability criteria.	K5
CO5	Design compensators using lag, lead, and lag-lead networks based on performance criteria and Bode plots.	K6

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		3		1			1						2
CO2	3		2		1		2							2
CO3	2		2											2
CO4	1		3	2										2
CO5	1		1		2		1							2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

CONTROL SYSTEM MODELLING **09 Hours**

Basic elements in control systems – Open and closed loop systems -Mathematical modelling of physical systems: Transfer function model of Mechanical and Electrical systems- Block diagram reduction techniques – Signal flow graphs.

TIME RESPONSE ANALYSIS **09 Hours**

Time response – Types of test input-step, ramp, impulse and parabolic inputs – I order system response for step, ramp and impulse input and II order system Response for step input– Time domain specifications -Error coefficients – Steady state error – P, PI, PID modes of feedback control

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FREQUENCY RESPONSE ANALYSIS **09 Hours**

Frequency response – Frequency domain specifications- Correlation between frequency domain and time domain specifications– Polar plot – Bode plot.

STABILITY OF CONTROL SYSTEM **09 Hours**

Definition of Stability - Location of roots of Characteristics equation in S plane for stability – Routh Hurwitz criterion – Root locus Techniques – Gain margin and phase margin – Statement of Nyquist stability criterions.

COMPENSATOR DESIGN **09 Hours**

Performance criteria – Lag, Lead and Lag-Lead networks Compensator design using Bode plots

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45Hours

REFERENCES:

1. K. Ogata, "Modern Control Engineering", 5th Edition, Pearson Education, 2010, New Delhi.
2. I.J. Nagrath& M. Gopal, "Control Systems Engineering", 5th Edition, New Age International Publishers, 2007.
3. B.C. Kuo, "Automatic Control Systems", 7th Edition, Prentice Hall of India Ltd., 2003, New Delhi.
4. M. Gopal, "Control Systems, Principles & Design", 4th Edition, Tata McGraw Hill, 2012, New Delhi.
5. R. Anandha Natarajan and B. Ramesh Babu, "Control System Engineering", 3rd Edition, Scitech Publication, 2009.

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L	T	P	J	C
3	0	0	0	3

U18ECT5005 ANTENNAS AND WAVE PROPAGATION

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply principles of antenna fundamentals to analyze radiation characteristics.	K4
CO2	Evaluate wire antennas and their characteristics.	K5
CO3	Apply knowledge of antenna arrays in design and analysis.	K3
CO4	Illustrate techniques used for antenna parameter measurements.	K3
CO5	Evaluate the performance of special antennas.	K5

Pre-requisites:

1. U18ECT4104 Transmission Lines and Waveguides

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2			2									2
CO2		2	2		2									1
CO3	2			2	2									
CO4		2		2	2									1
CO5			2	2	2									1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

ANTENNA FUNDAMENTALS **09 Hours**

Types of antennas- Radiation mechanism, Radiation Pattern**,** Radiation intensity, Beam solid angle, Gain, Directive gain, Power gain, Directivity, Beamwidth. Bandwidth, Reciprocity principle, Effective length, Effective area, Radiation Resistance, Friis Transmission formula, Antenna Field Zones, Polarization, Antenna noise temperature, Self and mutual impedances of antennas.

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WIRE ANTENNAS **09 Hours**

Concept of vector potential- Retarded vector potential-Fields associated with Hertzian dipole. Power radiated and radiation resistance of Hertzian dipole. Radiation from half-wave dipole and quarter-wave monopole, Power radiated and Radiation resistance of half wave dipole and quarter wave monopole- Folded dipole, Loopantenna, Helical antenna, Long wire antenna, V-antenna, Rhombic antenna, Yagi-uda antenna, Log periodic antenna.

ANTENNA ARRAYS AND MEASUREMENT **09 Hours**

Antenna Arrays - Broadside and End fire array -Expression for electric field from two and four element arrays - N element linear array – Pattern multiplication- Binomial array.
Antenna Measurement: Radiation Pattern, Gain, Directivity, Impedance, Beam width and Efficiency Measurements.

SPECIAL ANTENNAS **09 Hours**

Slot antenna-Relation between dipole and slot impedances, Horn antenna – Types, Parabolic reflector antennas and its feed systems, Microstrip antenna. Antennas for mobile handsets and base stations- Antennas for Satellite Communication- Antenna for Radar systems. Adaptive antenna, Ultra-Wideband Antennas, - Selection of antenna based on the frequency of operation.

WAVE PROPAGATION **9 Hours**

Modes of propagation -Ground wave propagation – Calculation of field strength at a distance. Sky wave propagation-Structure of ionosphere. Effective dielectric constant of ionized region-Refractive index, Critical frequency, Maximum usable frequency, Skip distance – Effect of earth's magnetic field. Space wave propagation-Resultant of direct and reflected wave at the receiver.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. John D. Kraus and Ronalatory Marhefka, "Antennas for all applications", Tata McGraw-Hill, Fifth Edition, 2017.
2. Edward. C. Jordan and Keith G Balmain, "Electro Magnetic Waves and Radiating Systems", Prentice Hall of India, Second Edition, Reprint, 2011.
3. K.D. Prasad, "Antennas and Wave Propagation", Sathyaprakasan Tech India Publications, New Delhi, 2009.
4. Robert. E. Collin, "Antennas and Radio Propagation", McGraw-Hill, 1987.
5. Constantine. A. Ballanis," Antenna Theory: Analysis and Design ", John Wiley & Sons, second Edition,2003.
6. A.R. Harish, M. Sachidanada, "Antennas and Wave propagation", Oxford University Press, 2007.

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U18ECI5206	EMBEDDED PROCESSOR ARCHITECTURE	L	T	P	J	C
		3	0	2	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply knowledge of microprocessor components and computer architecture to analyze different microprocessors.	K3
CO2	Demonstrate an understanding of ARM processor architecture, including instruction level registers, special function registers, and ALU design.	K3
CO3	Illustrate ARM and Thumb instruction sets, addressing modes, and assembly programming techniques.	K3
CO4	Organize memory hierarchy concepts to evaluate performance considerations and architectural support for system development.	K3
CO5	Generalize the concepts of pipelining and data hazards to analyze the influence of instruction sets on datapath and control considerations in embedded systems.	K3
CO6	Apply C programming skills to design and implement algorithms such as Booth's Multiplication and Recursive Division for embedded system applications.	K3

Pre-requisite

U18ECI3203 - Digital System Design

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2		2									2
CO2	2	2	2		2									2
CO3	2	2	2											
CO4	2		2	2			2							
CO5			2	2			2							
CO6	2				2									

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Written Assignment 3. Quiz 4. End Semester Examination	Course end survey

Introduction **9 Hours**

Introduction to Microprocessor – Microprocessor Components – Birds eye view of Computer Architecture – Different Microprocessor – 4004, 8085, 8086, ARM, MIPS – Microcontroller – System-on-chip- System-on-board – Single Board Computer – Buses – Address Bus – Data Bus – Control Bus

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Introduction to ARM Processor **9 Hours**

Architecture - Components - Instruction level registers and Special Function Registers - General Purpose Registers – Register Design – ALU – Multiplier – Multiplier Design - Barrel Shifter – Design of Barrel Shifter – Sequential Multiplication Algorithm - Booths Algorithm – Division Algorithm (Restoring and Non-Restoring)

Instruction Set Architecture **9 Hours**

ARM & Thumb Instructions – Addressing Modes – Types of Instructions – Endianness – Assembly Programming - Instruction Designing- Huffman Encoding technique for designing instruction sets – Control Unit – Hardwired and Microprogrammed Approach - Firmware –Coprocessor

Memory & Pipelining **9 Hours**

Types of Memory – Memory Hierarchy - ROM & ROM Types – Cache Memories –Performance Considerations - Virtual Memories - MMU & MPU - Secondary Storage - Introduction to Pipelining – Advantage – Data Hazards – Instruction Hazards – Influence of Instructions sets – Datapath and Control Considerations

Architectural Support for System Development **9 hours**

ARM memory interface - Advanced Microcontroller Bus Architecture (AMBA) - ARM reference peripheral specification - Hardware system prototyping tools - ARMulator-JTAG boundary scan test architecture- ARM debug architecture**.**

REFERENCES

1. ARM System-on-Chip Architecture, Steve Furber, Addison-Wesley, 2nd Edition, 2020.
2. Modern Computer Architecture, Rafiquzzman, Galgotia Publications, 1990.
3. Computer Organization, Hamacher, 5th Edition, McGraw Hill Education, 2011.
4. ARM Assembly Language Programming & Architecture, Muhammad Ali Mazidi, Microdigitaled.com; 2nd Edition, 2016.

LABORATORY COMPONENT

- ARM7 Assembly code using Keil.
- Algorithm implementation using C (algorithms) any GCC/ IDEs based on GCC.

LIST OF EXPERIMENTS

Assembly Language Programming

1. Working with arithmetic and logical instructions
2. Number conversion
3. Sorting operation
4. Subroutine

C/C++ programming

1. Basic C/C++ operator used in Digital logic.
2. C/C++ program to implement half adder.
3. C/C++ program to implement full adder.
4. Shifting operations using C programming.
5. C/C++ Program to implement Booth's Multiplication Algorithm
6. C/C++ Program to implement Recursive Division Algorithm

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References

1. ARM: Assembly Language Programming, Stephen Welsh, Peter Knaggs, 2003.
2. Let Us C, Yashavant Kanetkar, BPB Publications, 15th Edition, 2016.

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hours

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SEMESTER VI

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U18ECI6201 **COMMUNICATION ENGINEERING- II**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the fundamentals of digital communication systems, including channel models, detection techniques and synchronization techniques.	K4
CO2	Analyze the principles of information theory and source coding techniques.	K4
CO3	Apply error control coding techniques such as linear block codes, cyclic codes, and convolutional codes for reliable data transmission.	K3
CO4	Solve problems related to baseband binary transmission and equalization techniques.	K3
CO5	Illustrate digital modulation techniques including coherent and non-coherent modulation schemes for signal generation and detection.	K3
CO6	Implement and simulate digital modulation schemes, block codes, cyclic codes, source coding algorithms, convolutional codes, and channel equalizers using appropriate equipment/simulation tools.	K3

Pre-requisites:

1. U18ECI5201-Communication Engineering- I

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	2									2
CO2	2	3	2											2
CO3	1		2		1							1		1
CO4	2	2			1							1		1
CO5		2	2									1		1
CO6	1			2	2					1		2		1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II (Theory Component) Assignment (Theory Component) Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) Model examination (lab component) End Semester Examination (Theory and lab component)
INDIRECT
Course-end survey

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INTRODUCTION **09 Hours**

Block diagram of Digital Communication System – AWGN channel models: Wave form and vector channel models. Gram-Schmidt Orthogonalization Procedure- Geometric interpretation of signals- Maximum Likelihood detector - Probability of error-Correlation receiver, Matched Filter Receiver.

INFORMATION THEORY AND SOURCE CODING **09 Hours**

Uncertainty, Information and entropy, Source coding theorem, Data compaction: Shannon- Fano coding, Huffman coding, Discrete Memory less Channel, Mutual Information, Channel capacity, Channel coding theorem, Differential entropy and mutual information for continuous ensembles, Information capacity theorem, Implication of the information capacity theorem.

ERROR CONTROL CODING **09 Hours**

Linear block codes –Cyclic codes– Convolutional codes –Viterbi Algorithm.

BAND LIMITED SIGNALING SCHEMES **06 Hours**

Inter-symbol Interference- Nyquist Criterion for distortion less Baseband Binary Transmission–Correlative coding–Eye patterns– Equalization - Adaptive Equalization.

DIGITAL MODULATION TECHNIQUES **09 Hours**

Signaling scheme, Generation, Detection, Probability of error and Power Spectral Density of Coherent Modulation Techniques: BPSK-BFSK-QPSK- MSK- Non-Coherent Binary Modulation Techniques: FSK– Differential phase shift keying - Introduction to M-ary signaling.

SYNCHRONIZATION **03 Hours**

Carrier synchronization- M^{th} Powerloop – Costas loop-Symbol Synchronization-Early Late gate type.

REFERENCES:

1. Simon Haykin, "Digital Communication Systems", John Wiley& Sons, 2013.
2. Bernard Sklar, "Digital Communication, Fundamentals and Applications" Pearson Education Asia, Second Edition, reprint, 2002.
3. John G. Proakis, "Digital Communication" McGraw Hill, 4^{th} Edition, 2008
4. Herbert Taub, Donald L Schilling and Goutam Saha, "Principles of Communication Systems", McGraw Hill, Fourth Edition, 2013.
5. B.P.Lathi, Zhi Ding. "Modern Digital and Analog Communication Systems", Oxford University Press, Fourth Edition, 2009.
6. Ferrel G. Stremler, "Introduction to Communication Systems", Prentice-Hall, 4^{th} Edition, 2001.

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LAB COMPONENT:

LIST OF EXPERIMENTS

I Implementation and Simulation analysis of
1. Digital modulation schemes
2. Block codes and Cycliccodes
3. Radiation pattern of Antennas
4. Source coding algorithms.
5. Convolutional codes.
6. Channel Equalizers.

II Analysis of pass band signals using Vector Signal Generator, Vector Signal Analyzer and Spectrum Analyzer.

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

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U18ECI6203 **VLSI AND HDL PROGRAMMING**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Solve design challenges using various modeling techniques through Verilog HDL.	K3
CO2	Analyze the principle of MOSFETs and CMOS inverter.	K4
CO3	Identify different fabrication methodologies and techniques of CMOS.	K3
CO4	Categorize the different logic design styles for VLSI Circuit design.	K4
CO5	Illustrate FPGA-based system design and implementation strategies in SOC.	K2
CO6	Apply different levels of abstraction in Verilog HDL to model digital circuits and analyze the characteristics of basic gates using backend EDA tools.	K3

Pre-requisites:

1. U18ECI3203-Digital System Design

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2		2								1	
CO2	2	2	2										1	
CO3	2						2						1	
CO4	2		2				2						1	
CO5	2	2	2										1	
CO6	2	2	2		2								1	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

VERILOG HDL **09 Hours**

VLSI Circuit Design Flow-Hierarchical modeling concepts – Basic concepts: Lexical conventions – Datatypes – Modules and ports. Gate level modeling – Dataflow modeling – Behavioral modeling – Design examples of Combinational and Sequential circuits – Switch level modeling – Tasks and Functions – UDP concepts.

MOS CIRCUIT DESIGN PROCESS **09 Hours**

Introduction of MOSFET: Symbols, Enhancement mode-Depletion mode transistor operation – Threshold voltage derivation – Drain current Vs voltage derivation – Second order Effects. NMOS and CMOS inverter – Determination of pull up to pull down ratio.

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MOS TECHNOLOGY **09 Hours**

Chip Design Hierarchy – IC Layers – Photolithography and Pattern Transfers – Basic MOS Transistors – CMOS Fabrication: n-well – p-well – twin tub – Latch up and prevention (SOI) –BiCMOS technology-Submicron CMOS Process — CMOS Design Rules: Lambda based design rules-Stick diagrams-Masks and Layout

CMOS LOGIC GATES & OTHER COMPLEX CIRCUITS **10 Hours**

CMOS Static Logic – Transmission Gate Logic – Tri-State Logic – Pass Transistor Logic – Dynamic CMOS Logic – Domino CMOS Logic, NORA CMOS Logic, Differential Cascade Voltage Switch (DCVS) Logic, True Single Phase Clock (TSPC) Dynamic Logic. Arithmetic Circuits – Design of Adders: -carry select-carry save. Design of multipliers: Array multipliers.

VLSI IMPLEMENTATION STRATEGIES **08 Hours**

Introduction to FPGA-FPGA Design Flow- FPGA architecture- FPGA Devices- Xilinx 4000 series. Introduction to SoC: Driving Forces for SoC – Components of SoC – Design flow of SoC – Hardware/Software nature of SoC – Design Trade-offs – SoC Applications.

REFERENCES:

1. Douglas A. Pucknell, "Basic VLSI Systems and Circuits", Prentice Hall of India, 3rd Edition, reprint 2008.
2. Michael J Flynn and Wayne Luk, "Computer system Design: System-on-Chip", Wiley-India,
3. Samir Palnitkar, "Verilog HDL – Guide to Digital Design and Synthesis", Pearson Education, 3rd Edition, 2003.
4. John P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons, Reprint 2009
5. Weste&Eshraghian, "Principles of CMOS VLSI Design", Addison Wesley, 2nd Edition, 2008.
6. John P Uyemura, "Chip Design for Submicron VLSI: CMOS layout and simulation", Thomson India Edition, 2010.
7. Wayne Wolf, "FPGA-Based System Design", First Edition, Prentice Hall India Private Limited, 2004.

LAB COMPONENT:

LIST OF EXPERIMENTS

I Design and Simulation using HDL
1. Combinational logic circuits.
2. Sequential logic circuits.
3. VLSI multipliers.
4. Memory
5. FSM

II Implementation using Xilinx FPGA
1. FPGA Implementation of any two combinational and sequential circuits

III System design using IP core generator

IV Layout generation for VLSI circuits using backend tools.

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hour

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U18ECI6204	MICROCONTROLLER AND ITS APPLICATIONS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO1	Understand the design challenges and processors technology of embedded systems.	K3
CO2	Apply knowledge of ARM Cortex processor architecture and programming techniques.	K3
CO3	Analyze memory mapping and peripheral interfacing with Cortex M microcontroller.	K4
CO4	Demonstrate proficiency in implementing bus architectures like I2C and SPI.	K3
CO5	Evaluate the design and functionality of digital camera and elevator systems.	K5
CO6	Implement various hardware and software interactions using CORTEX M4 microcontroller in laboratory settings.	K3

Pre-requisite

U18ECI5206 - Embedded Processor Architecture

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	2									2
CO2	2	2	2		2									2
CO3	2	2	2											
CO4	2		2	2	2									
CO5			2	2			2							
CO6	2				2									

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Written Assignment 3. Quiz 4. End Semester Examination	Course end survey

THEORY COMPONENT

Introduction to Embedded Systems **10 Hours**

Design Challenges– Processors Technology – Design Technology- Introduction to ARM Cortex processor – Variants of Cortex and ARM versions – Comparison of M-series processor – Architecture – Programmers Model – APSR register – Memory Model – Exception – Interrupts – Reset – Memory Map – Bit banding and Bit Band Aliasing.

Introduction to ARM Cortex processor **10 Hours**

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More on Memory System – Exceptions and Interrupts – NVIC – Memory Protection Unit - Embedded C programming – Cortex Microcontroller System Interface (CMSIS) – Startup Code.

Introduction to Cortex M Microcontroller **10 Hours**

Memory Mapping – Registers involved and programming with GPIO – GPIO interfacing – LCD, LED, 7 – Segment, Stepper Motor, Keypad. Peripherals of Cortex M Microcontroller: PLL, Timer, UART, ADC, DAC.

Bus Architecture: Inter Integrated Circuit Bus (I2C), Serial Peripheral Interface (SPI)
Case Study: Digital Camera Design, Elevator design.

REFERENCES

1. The definitive guide to the ARM Cortex-M3, Joseph Yiu, 2nd Edition, Elsevier, 2010.
2. TI Tiva ARM Programming for Embedded Systems: Programming ARM Cortex-M4 TM4C123G with C, Mazidi & Naimi, ARM Series, 2017.
3. User Manual of Microcontroller
4. LPCzone Examples

LABORATORY COMPONENT

Embedded C applications using Keil / Energeia IDE for CORTEX M4 based microcontroller boards.

LIST OF EXPERIMENTS

1. Basic Arithmetic and Logical operations using CORTEX M4 microcontroller.
2. Square wave Generation using TIMER.
3. Serial Communication using UART.
4. LED interfacing with CORTEX M4 microcontroller
5. LCD interfacing with CORTEX M4 microcontroller
6. 7-Segment interfacing with CORTEX M4 microcontroller
7. Stepper Motor interfacing with CORTEX M4 microcontroller
8. Keypad interfacing with CORTEX M4 microcontroller
9. Sensor interfacing with CORTEX M4 microcontroller

Theory: 30	Tutorial: 0	Practical: 30	Project: 0	Total: 60 Hour

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SEMESTER VII

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U18ECP7701	PROJECT PHASE I	L	T	P	J	C
		0	0	0	6	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply design principles to develop a working prototype or software-oriented implementation to address a complex problem	K3
CO2	Analyze different hardware and software tools to choose the most suitable ones for project implementation.	K4
CO3	Evaluate the performance of the prototype or software implementation based on the project requirements.	K5
CO4	Create an organized team-based strategy to collaboratively design and implement the solution for the project.	K6
CO5	Justify the decisions made during the design and development process, based on testing and performance analysis.	K5

Pre-requisite

All the courses

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3		3	1	2	3		3	3	3	3
CO2	3	3	2	3		2			2		3	2	3	3
CO3	2	2	3		3	1	1	2			2		3	3
CO4	2	2	2	2	2						3	2	3	3
CO5		1		2		2			2	3		3	3	3

Course Assessment methods

Direct	Indirect
1. Project Review 2. End Semester Viva Voce Examination	1. Course-end survey 2. Programme Exit survey 3. Placement/Higher education record 4. Feedback (Students, Employers, Parents, Alumni)

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L	T	P	J	C
3	0	2	0	4

U18ECT7002 **WIRELESS COMMUNICATION**

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply the fundamentals of wireless communication systems to describe the evolution of mobile communication technologies.	K4
CO2	Analyze path loss models to evaluate their impact on wireless channel performance.	K3
CO3	Evaluate various cellular communication techniques to recommend the most efficient method for improving system capacity.	K5
CO4	Create a comprehensive signal processing model to address issues related to wireless signal fading.	K4
CO5	Design and compare multiple antenna techniques to improve system performance in different channel conditions.	K3

Pre-requisites:
1. U18ECI6201-Communication Engineering II

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	2			1					2		2
CO2	2	2		2			1					1		
CO3	2	2	2				1					1		
CO4	2		2	2			1					1		
CO5	2		2	2			1					1		

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **04 Hours**

Introduction to wireless communication systems- Evolution of mobile communication system- 2G, 3G,4G, UMTS, LTE, WLL, WLAN, WPAN, Bluetooth, Ultra wide band.

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WIRELESS CHANNEL **10 Hours**

Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters - Coherence bandwidth – Doppler spread & Coherence time, fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

CELLULAR COMMUNICATION **10 Hours**

Introduction, Frequency reuse, Cell Assignment techniques, Hand off Strategies, Interference and System Capacity, trunking and Grade of Service, Improving Coverage and capacity in cellular systems.
Multiple Access techniques: FDMA, TDMA, CDMA, SDMA.

SIGNAL PROCESSING FOR WIRELESS COMMUNICATION **12 Hours**

Modulation techniques: M-QAM, M-PSK, GMSK - Spread Spectrum Systems: PN sequence- m-sequence-Direct Sequence Spread Spectrum-Frequency Hopping Spread Spectrum, Synchronization techniques for Spread Spectrum signals - Diversity and Combining Techniques: Time Diversity, Frequency diversity, Space Diversity-combining techniques-Selection combining, Equal gain combining, Maximum ratio Combining - RAKE receiver- Multi carrier system-OFDM.

MULTIPLE ANTENNA TECHNIQUES **09 Hours**

MIMO systems – spatial multiplexing -System model -Pre-coding - Beam forming – Space Time Coding, Alamouti scheme - Channel State Information-capacity in fading and non-fading channels.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. T.S. Rappaport, “Wireless Communications: Principles and Practices”, Second Edition, Prentice Hall of India, 2014.
2. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2008.
3. John G. Proakis, “Digital Communication” McGraw Hill, Fourth Edition, 2008
4. Andreas.F. Molisch, “Wireless Communications”, John Wiley, India, 2006.
5. Kamil Feher , “Wireless Digital Communications”, First Edition, Pearson, 2006.
6. William C Lee,” Wireless and Cellular Communications”, Third Edition McGraw Hill, 2006.
7. Jochen Schiller,” Mobile Communication”, Second Edition, Addison-Wesley, 2003.

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L	T	P	J	C
3	0	2	0	4

U18ECI7203 **OPTICAL COMMUNICATION**

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the key elements and configurations of optical fiber systems.	K4
CO2	Apply techniques to determine signal distortion and dispersion in fibers.	K3
CO3	Evaluate the performance of various light sources for communication.	K5
CO4	Analyze the operation and performance of photodetectors and amplifiers in optical receivers.	K4
CO5	Apply networking concepts in designing optical communication systems.	K3
CO6	Apply experimental techniques to measure and analyze characteristics of optical communication components in laboratory settings.	K3

Pre-requisites: --

CO/PO Mapping:
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2				2							1
CO2	2	2	2				2							2
CO3	2	2	2				2							2
CO4	2	2	2				2							2
CO5	1	2	2				2							2
CO6	2	2	2				2							2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II (Theory Component) Assignment (Theory Component) Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) Model examination (Lab component) End Semester Examination (Theory and Lab component)
INDIRECT
Course-end survey

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THEORY COMPONENT CONTENT:

INTRODUCTION TO OPTICAL FIBERS **08 Hours**

Introduction to Optical Communication – key elements of an Optical Fiber system–Ray Optics–Optical Fiber Modes and Configurations–Overview of Modes–Power flow in Step index fibers- Single Mode Fibers - Graded Index fibers- Optical fiber fabrication techniques – Passive optical components – Optical couplers and isolators.

SIGNAL DEGRADATION IN OPTICAL FIBERS **11 Hours**

Attenuation –Core and Cladding losses, Signal Distortion in Optical Fibers-Information Capacity determination – Group Delay–Material Dispersion–Waveguide Dispersion– Signal distortion in Single Mode fibers – Polarization Mode dispersion, Design optimization of Single Mode fibers, special fibers.

FIBER OPTICAL SOURCES **10 Hours**

Direct and indirect Band gap materials -LED structures –Light source materials–Quantum efficiency and LED power– Modulation of LED, laser Diodes-Modes and Threshold condition–External modulation– Quantum-well laser, Laser sources for free space communication.

FIBER OPTICAL RECEIVERS AND AMPLIFIERS **08 Hours**

PIN– avalanche photodiode (*APD),* Photodetector noise–SNR, Avalanche Multiplication Noise — Fundamental Receiver Operation –digital receiver performance – probability of error- quantum limit, Receiver sensitivity, Optical amplifier -erbium-doped fiber amplifier (*EDFA).*

OPTICAL TRANSMISSION SYSTEM AND NETWORK **08 Hours**

Point-to-Point links- system considerations–Link Power budget – Rise time budget, Networking Concepts: SONET/SDH optical networks, WDM optical networks, layered optical network architecture.

REFERENCES:

1. Gerd Keiser, "Optical Fiber Communications" Tata McGraw–Hill education private Limited, New Delhi, fifth Edition, 2013.
2. Rajiv Ramaswami and Kumar. N. Sivarajan, "Optical networks: A practical perspective", Morgan Kaufmann, Third Edition, 2009.
3. J.Senior, "Optical Communication Principles and Practice", Prentice Hall of India, Third Edition, 2004.
4. J. Gower, "Optical Communication System", Prentice Hall of India, 2001.
5. Yarvi. A. "Quantum Electronics", John Wiley, 4th Edition, 1995.
6. Max Ming–Kang Liu, "Principles and applications of Optical communications", Tata McGraw Hill, 1996.

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LAB COMPONENT CONTENT:

LIST OF EXPERIMENTS

Measurement/ Simulation Analysis of

1. Numerical Aperture.
2. Attenuation coefficient and bending losses of optical fiber.
3. LED characteristics.
4. Pin Photo Diode characteristics.
5. APD characteristics.
6. Laser diode characteristics.
7. Analog communication link over Fiber optic cables.
8. Digital communication link over Fiber optic cables.
9. Loss characteristics of optical components using OTDR.
10. Single mode and multimode fibers.
11. Wavelength Division Multiplexing and De-multiplexing
12. Fiber optic link design – power and rise-time budget

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

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U18ECI7204 RF AND MICROWAVE ENGINEERING

L	T	P	J	C
3	0	2	0	4

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the principles of microwave frequency bands and their application in RF circuits.	K4
CO2	Evaluate the design and performance of impedance matching networks using lumped and distributed elements.	K5
CO3	Assess the functionality and characteristics of microwave components such as terminations, attenuators, and phase shifters.	K5
CO4	Demonstrate the operation and analyze the performance of microwave tubes including klystrons and traveling-wave tubes (TWTs).	K3
CO5	Apply measuring instruments to analyze RF systems and evaluate parameters like impedance, frequency, and power.	K3
CO6	Design and implement RF impedance matching networks and analyze their performance in the laboratory.	K6

Pre-requisites:

1. U18ECT4104- Transmission Lines and Waveguides

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2					2						1	
CO2	2		3				2						2	
CO3	2	2		2									2	
CO4	2			2	2									2
CO5	2			2	2									2
CO6			2	2	2									2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II (Theory Component) Assignment (Theory Component) Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) Model examination (lab component) End Semester Examination (Theory and lab component)
INDIRECT
Course-end survey

TWO PORT RF NETWORKS **09 Hours**

Microwave Frequency Bands, S Parameters -Formulation of S Parameters, Properties of S Parameters, Reciprocal and Lossless Network, RF behaviour of Resistors, Capacitors and Inductors, Chip Components and Circuit Board considerations

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RF IMPEDANCE MATCHING NETWORKS **09 Hours**

Importance of impedance matching, Components for matching, Design of Matching Networks - Matching network design using Lumped elements- RC, RL, RLC circuits, Design of Matching Networks using Distributed Elements- Transmission lines, Microstrip lines, Stubs.

PASSIVE AND ACTIVE MICROWAVE DEVICES **09 Hours**

Terminations, Attenuators, Phase Shifters, Directional Couplers, Microwave Hybrid Circuits, Power Dividers, Circulator, Isolator, PIN Diode Switch, Gunn Diode Oscillator, IMPATT-TRAPATT-BARITT Diodes, Varactor Diode-Introduction to Microwave Integrated Circuits.

MICROWAVE TUBES **09 Hours**

Klystrons- Re-entrant Cavities-Velocity Modulation Process– Bunching Process– Output Power and Beam Loading- Reflex Klystrons– Velocity Modulation– Power Output and Efficiency– Electronic Admittance, Helix Travelling–Wave Tubes (TWTs) –Microwave Crossed–Field Tubes – Cylindrical Magnetron.

MICROWAVE MEASUREMENTS **09 Hours**

Measuring Instruments: VSWR Meter, Power Meter, Spectrum Analyzer, Network Analyzer - Measurement of Impedance, Frequency, Power, VSWR.

REFERENCES:

1. Reinhold Ludwig And Gene Bogdanov, "RF Circuit Design: Theory and Applications", Pearson Education Inc., 2013.
2. Samuel Y.Liao, "Microwave Devices and Circuits", Prentice Hall of India, Third Edition, 2003.
3. Annapurna Das And Sisir K Das, "Microwave Engineering", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2009.
4. David M. Pozar, "Microwave Engineering", Wiley India (P) Ltd, New Delhi, 2008.
5. Thomas H Lee, "Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits", Cambridge University Press, 2004.
6. Mathew M Radmanesh, "RF And Microwave Electronics", Prentice Hall, 2000.

LAB COMPONENT:

LIST OF EXPERIMENTS

1. Design and Analysis of RF impedance matching network.
2. Microwave S-Parameter measurement using Network Analyser.
3. Reflex Klystron Characteristics.
4. Guide wavelength, source frequency and terminated impedance of a Microwave Device.
5. Gunn Diode Characteristics
6. Directional Coupler Characteristics
7. Magic Tee Characteristics
8. Radiation Pattern of Microwave Antenna.

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hours

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SEMESTER VIII

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U18ECP8701	PROJECT PHASE II	L	T	P	J	C
		0	0	0	24	12

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the fundamentals of project management to structure and plan the implementation of innovative solutions.	K3
CO2	Analyze the problem requirements to select suitable hardware and software tools for implementation.	K4
CO3	Evaluate the project's design and functionality of the proposed solution against project requirements.	K5
CO4	Develop a robust and functional prototype integrating hardware and software components effectively.	K6
CO5	Develop a comprehensive report and presentation to effectively communicate project outcomes.	K6

Pre-requisite

All the courses

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1		2	2	2	2		3	2	3	3
CO2	3	3	2	2		2	1	1	2		3	2	3	3
CO3	2	2	1	2	3	1	2	2	2		2	2	3	3
CO4	2	2	2	1	2		1		2		3	2	3	3
CO5									2	3	1	2	3	3

Course Assessment methods

Direct	Indirect
1. Project Review 2. End Semester Viva Voce Examination	1. Course-end survey 2. Programme Exit survey 3. Placement/Higher education record 4. Feedback (Students, Employers, Parents, and Alumni)

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PROFESSIONAL ELECTIVES

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COMMUNICATION SYSTEM

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U18ECE0001 **COGNITIVE RADIO**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply the foundational concepts of Software Defined Radio (SDR) to analyze its architecture evolution and technology tradeoffs.	K3
CO2	Analyze the essential functions and computational properties of functional components in SDR architecture.	K4
CO3	Evaluate the concepts and design considerations of enabling location and environment awareness in cognitive radios.	K5
CO4	Assess the primary functions, behaviors, and components of Cognitive Radio Architecture, and classify A-Priori Knowledge taxonomy.	K5
CO5	Create design solutions for Next Generation Wireless Networks, incorporating spectrum sensing, management, mobility, and sharing principles.	K6

Pre-requisites:

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2		2	2								2
CO2	2	2	2		2									2
CO3	2	2	2	2			2							
CO4	2		2	2			2							
CO5		2	2		2		2							2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION TO SOFTWARE DEFINED RADIO **09 Hours**
Definitions and potential benefits, software radio architecture evolution – foundations, technology tradeoffs and architecture implications.

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SDR ARCHITECTURE **09 Hours**

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

INTRODUCTION TO COGNITIVE RADIOS **09 Hours**

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

COGNITIVE RADIO ARCHITECTURE **09 Hours**

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

NEXT GENERATION WIRELESS NETWORKS **09 Hours**

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

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

1. Qusay. H. Mahmoud, "Cognitive Networks: Towards Self Aware Network", John Wiley & Sons Ltd. 2007.
2. Markus Dillinger, Kambiz Madani, Nancy Alonistioti, "Software Defined Radio", John Wiley, 2003.
3. Huseyin Arslan, "Cognitive Radio, SDR and Adaptive System", Springer, 2007.
4. Joseph Mitola, "Cognitive Radio Architecture", John Wiley & Sons, 2006.
5. Alexander M. Wyglinski, Maziarnekovee, Y. Thomas Hu, "Cognitive Radio Communication and Networks", Elsevier, 2010.
6. J. Mitola, "The Software Radio Architecture", IEEE Communications Magazine, 1995.
7. Joseph Mitola III and Gerald Q. Maquire, "Cognitive radio: making software radios more personal", IEEE Personal Communications, 1999.
8. J. Mitola, "Cognitive Radio: An Integrated Agent Architecture for software defined radio", Doctorof Technology thesis, Royal Inst. Technology, Sweden 2000.
9. Simon Haykin, "Cognitive Radio: Brain –empowered wireless communications", IEEE Journal on selected areas in communications, 2005.
10. Hasari Celebi, Huseyin Arslan, "Enabling location and environment awareness in cognitive radios", Elsevier Computer Communications, 2008.
11. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, "Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey" Elsevier Computer Networks, 2006.

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L	T	P	J	C
3	0	0	0	3

U18ECE0002 **SATELLITE COMMUNICATION**

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply Kepler's Laws and orbital parameters to analyze satellite orbits and their perturbations.	K3
CO2	Analyze spacecraft technology and communication subsystems to understand the operation of space and earth segments in satellite communication.	K4
CO3	Evaluate modulation techniques and multiple access methods to assess their suitability for satellite communication systems.	K5
CO4	Assess link power budgets and noise considerations to design efficient satellite communication links.	K5
CO5	Create solutions for various satellite applications such as satellite mobile services, GPS, and direct broadcast satellites considering their functionalities.	K6

Pre-requisites:

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2		2										
CO2	1	2				1								
CO3	1	1	1											1
CO4		1	1	1	1									
CO5			1	1			1							1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

SATELLITE ORBITS **09 Hours**

Introduction - Spectrum allocations for satellite systems -Kepler's Laws - orbital parameters - orbital perturbations - station keeping – Type of orbits - Geo stationary orbits – look angle determination- limits of visibility – eclipse -sub satellite point – sun transit outage - launching procedures - launch vehicles and propulsion.

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SPACE AND EARTH SEGMENT **09 Hours**

Spacecraft technology- structure- power supply- attitude and orbit control - thermal control and propulsion - communication subsystems - telemetry, tracking and command - Transponders-Antenna subsystem, Equipment reliability.

Earth station technology -Receive only home TV systems - MATV – CATV – Transmit Receive Earth Stations.

SATELLITE ACCESS **09 Hours**

Modulation and Multiplexing-Voice, Data, Video, Analog – digital transmission system-Digital video broadcast - multiple access: FDMA, TDMA, CDMA- assignment methods -spread spectrum communication -compression – encryption.

SATELLITE LINK DESIGN **09 Hours**

Introduction- Equivalent isotropic radiated power -Transmission Losses – Link power budget equation - System Noise, Carrier to Noise ratio – uplink – downlink – effects of rain – combined uplink and downlink C/N ratio – inter modulation noise - Interference between satellite circuits.

SATELLITE APPLICATIONS **09 Hours**

Satellite mobile services – VSAT- Radarsat- GPS- Orbcomm-iridium- Direct Broadcast satellites (DBS) - Direct to home Broadcast (DTH) -Digital audio broadcast (DAB) – World space services, Business TV (BTV) – GRAMSAT - Specialized services: E mail, Video conferencing, Internet- INTELSAT Series- INSAT – INMARSAT.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Dennis Roddy, 'Satellite Communication', McGraw Hill International, 4th Edition, 2006.
2. Timothy Pratt, Charles Bostian & Jeremy Allmuti, "Satellite Communications", John Wiley & Sons. Second Edition, 2008.
3. N.Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986.
4. Bruce R. Elbert, "The Satellite Communication Applications" Hand Book, Artech House Bostan London, Second Edition, 2004.
5. Tri T. Ha, "Digital Satellite Communication", Second Edition, 1990.
6. Emanuel Fthenakis, "Manual of Satellite Communications", McGraw Hill Book Co., 1984.
7. Robert G. Winch, "Telecommunication Transmission Systems", McGraw-Hill Book Co., Second Edition, 1998.

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L	T	P	J	C
3	0	0	0	3

U18ECE0003 **MIMO SYSTEMS**

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the principles of detection, diversity, and channel uncertainty in point-to-point communication systems.	K4
CO2	Apply spatial multiplexing techniques and channel modeling concepts to design MIMO communication systems.	K3
CO3	Evaluate multiplexing architectures: V-BLAST and D-BLAST for MIMO channels under different fading conditions.	K5
CO4	Identify space-time codes for optimal performance in MIMO systems.	K3
CO5	Analyze multiuser MIMO uplink and downlink configurations with multiple antennas.	K4

Pre-requisites:
1. U18EC T7002 - Wireless Communication

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	2		1							2
CO2	2	2	2	1	2		1							2
CO3	2	2	2	2	2		1							
CO4	2	2	2	1	1		1							2
CO5	2	2	2	2	1		1							2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

POINT-TO-POINT COMMUNICATION: **09 Hours**
DETECTION, DIVERSITY AND CHANNEL UNCERTAINTY

Detection in a Rayleigh Fading Channel - Time Diversity- Antenna Diversity - Frequency Diversity - Impact of Channel Uncertainty

SPATIAL MULTIPLEXING AND CHANNEL MODELING **09 Hours**
Multiplexing Capability of Deterministic MIMO Channels- Physical Modeling of MIMO Channels-Modeling of MIMO Fading Channels

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CAPACITY AND MULTIPLEXING ARCHITECTURES **09 Hours**

The V-BLAST Architecture- Fast Fading MIMO Channel- Receiver Architectures- Slow Fading MIMO Channel - D-BLAST: An Outage-Optimal Architecture.

DIVERSITY-MULTIPLEXING TRADEOFF AND UNIVERSAL SPACE-TIMECODES **09 Hours**

Diversity - Multiplexing Tradeoff - Universal Code Design for Optimal Diversity – Multiplexing Tradeoff

MULTIUSER COMMUNICATION **09 Hours**

Uplink with Multiple Receive Antennas - MIMO Uplink - Downlink with Multiple Transmit Antennas - MIMO Downlink

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2004.
2. A. Paulraj, Rohit Nabar, Dhananjay Gore., "Introduction to Space Time Wireless Communication Systems", Cambridge University Press, 2003.
3. Sergio Verdu "Multi User Detection", Cambridge University Press, 1998.

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L	T	P	J	C
3	0	0	0	3

U18ECE0004 **ADVANCED WIRELESS COMMUNICATION**

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze wireless channel models and their characteristics.	K3
CO2	Evaluate the performance of digital modulation techniques over wireless channels.	K5
CO3	Apply multicarrier modulation techniques such as OFDM and MC-CDMA in wireless communication systems.	K3
CO4	Assess cooperative communication strategies and green concepts in wireless networks.	K5
CO5	Examine the characteristics and standards of multi-gigabit millimeter-wave radios.	K4

Pre-requisites:

1.U18ECT7002 - Wireless Communication

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2		2			2							1
CO2	2	2	2											2
CO3	2	2	2				2							2
CO4				2			2							2
CO5	1	2	2				2							2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

WIRELESS CHANNEL MODELS **12 Hours**

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

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DIGITAL MODULATION AND DIVERSITY TECHNIQUES **09 Hours**

Performance of Digital Modulation over Wireless Channel-Fading– Outage Probability– Average Probability of Error — Combined Outage and Average Error Probability.

MULTICARRIER MODULATION **09 Hours**

Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Subchannels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset – OFDM, MC CDMA.

COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS **09 Hours**

Network architectures and research issues in cooperative cellular wireless networks - Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches - Fundamental trade- offs on the design of green radio networks, Green modulation and coding schemes, Cooperative techniques for energy efficiency

INTRODUCTION TO MULTI-GIGABIT **09 Hours**

60-GHz MILLIMETER WAVE RADIOS -Millimeter wave characteristics - Channel performance at 60 GHz, Gigabit wireless communication, Standards- Wi-Gig, IEEE 802.11ad, IEEE 802.15.3c- Millimeter wave applications.

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

REFERENCES:

1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005
2. Ekram Hossain, Dong In Kim, Vijay K. Bhargava, "Cooperative Cellular Wireless Networks", Cambridge University Press, 2011.
3. Kao-Cheng Huang, Zhaocheng Wang, "Millimeter wave communication systems", John Wiley & Sons, Hoboken, New Jersey, 2011
4. T.S. Rappaport, "Wireless Communications", Pearson Education, 2nd Edition, 2014.
5. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
6. Ekram Hossain, Vijay K. Bhargava (Editor), Gerhard P. Fettweis (Editor), "Green Radio Communication Networks", Cambridge University Press, 2012.

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L	T	P	J	C
3	0	0	0	3

U18ECE0005 RADAR AND NAVIGATIONAL AIDS

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the principles of Radar and navigational aids to solve real-world problems.	K3
CO2	Organize the concepts of MTI and Pulse Doppler Radar to analyze radar performance.	K4
CO3	Evaluate the detection of signals in Radar systems, considering propagation, receiver technology, and display techniques.	K5
CO4	Design and plan methods of navigation systems using radio direction finding and distance measuring equipment.	K6
CO5	Create solutions for distance measurement and navigation using DME, TACAN, and Doppler navigation systems.	K6

Pre-requisites:

1. U18EC I5201 - Communication Engineering I
2. U18EC T5005 - Antennas and Wave Propagation

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2				1			3				1
CO2	3	2	1								2			1
CO3				2		1					1	2		2
CO4					3		2				1			
CO5			1					1						2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION TO RADAR **09 Hours**

Radar Block Diagram- Radar Frequencies – Radar equation –Applications of Radar – Probabilities of Detection and False Alarm- Integration of Radar Pulses- Radar Cross Section of Targets- Radar cross Section Fluctuations- Transmitter Power- Pulse Repetition Frequency- Antenna Parameters - System losses.

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MTI AND PULSE DOPPLER RADAR **09 Hours**

Introduction to Doppler and Moving Target Indicator (MTI) Radar- Delay Line Cancellers - Staggered Pulse Repetition Frequencies – Digital MTI Processing - Moving Target Detector - Limitations to MTI Performance - MTI from a Moving Platform.

Pulse Doppler Radar – Tracking with Radar – Monopulse Tracking –Conical Scan and Sequential Lobing - Limitations to Tracking Accuracy – Low Angle Tracking - Tracking in Range - Other Tracking Radar Topics -Comparison of Trackers - Tracking with Surveillance Radars (ADT).

DETECTION OF SIGNAL **09 Hours**

Introduction – Automatic Detector - Constant False Alarm Rate Receivers - Radar operator - Propagation Radar Waves - Atmospheric Refraction -Standard propagation - Nonstandard Propagation - Radar Antenna - Reflector Antennas - Electronically Steered Phased Array Antennas - Phase Shifters – Frequency Scan Arrays. Radar Transmitters - Linear Beam Power Tubes - Solid State RF Power Sources - Magnetron Radar Receivers - Receiver noise Figure - Superheterodyne Receiver - Duplexers and Receiver Protectors- Radar Displays.

METHODS OF NAVIGATION **09 Hours**

Radio Direction Finding - Loop Antenna - Loop Input Circuits - Aural Null Direction Finder - Goniometer - Errors in Direction Finding - Adcock Direction Finders - Direction Finding at Very High Frequencies - Automatic Direction Finders - Commutated Aerial Direction Finder - Range and Accuracy of Direction Finders Radio Ranges - LF/MF Four course Radio Range - VHF Omni Directional Range (VOR) - VOR Receiving Equipment - Range and Accuracy of VOR - Hyperbolic Systems of Navigation (Loran and Decca) – Loran A Equipment - Range and precision of Standard Loran – Loran C - Decca Navigation System - Decca Receivers - Range and Accuracy of Decca - Omega System.

DME AND TACAN **09 Hours**

Distance Measuring Equipment - Operation of DME - TACAN - TACAN Equipment Approach and Landing - Instrument Landing System (ILS) - Ground Controlled Approach (GCA) System - Microwave Landing System (MLS) Doppler Navigation - Doppler Effect - Beam Configurations -Doppler Frequency Equations - Track Stabilization - Doppler Spectrum - Components of the Doppler Navigation System - Doppler range Equation - Accuracy of Doppler Navigation Systems.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Merrill I. Skolnik, “Introduction to Radar Systems”, Tata McGraw-Hill, 3rd Edition, 2003.
2. N.S.Nagaraja, “Elements of Electronic Navigation Systems”, Tata McGraw-Hill, 2nd Edition, 2000.
3. Myron Kyton and W.R.Fried, “Avionics Navigation systems”, John Wiley & Sons, 2nd Edition, 1997.
4. Albert D. Helfrick, “Principles of Avionics, Avionics communications Inc, 7th Edition, 2012.
5. Peyton Z. Peebles, "Radar Principles", John Wiley, 2004.
6. J.C. Toomay, “Principles of Radar”, Prentice Hall India, 2nd Edition, 2004.

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U18ECE0006 RADAR SYSTEM DESIGN

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the fundamentals of radar systems and their importance in various applications.	K4
CO2	Evaluate radar system components including transmitters, receivers, antennas, and signal processing techniques.	K5
CO3	Analyze radar signal processing techniques such as pulse compression, Doppler processing, and clutter rejection.	K4
CO4	Evaluate radar system design considerations including requirements, architecture, and performance factors.	K5
CO5	Create advanced radar system configurations and assess their effectiveness in electronic warfare scenarios.	K6

Pre-requisites:

1. U18ECI5201 - Communication Engineering I
2. U18ECT5005 - Antennas and Wave Propagation

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2				1			3				1
CO2	3	2	1								2			1
CO3	1			2		1					1	2		2
CO4	1				3		2				1			1
CO5	1		1					1						2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

Fundamentals of Radar Systems **09 Hours**

Introduction to radar systems, Importance and applications of radar, Basic principles of radar operation.

Radar System Components **09 Hours**

Radar transmitters and receivers, Antenna systems, Signal processing, Display and control systems.

Radar Signal Processing Techniques **09 Hours**

Pulse compression, Doppler processing, Clutter rejection, Target tracking algorithms.

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Radar System Design Considerations **09 Hours**

Requirements and architecture, Design trade-offs, Factors influencing performance.

Radar System Performance Analysis and Advanced Concepts **09 Hours**

Range and Doppler resolution, Signal-to-noise ratio, Monostatic and bistatic radar configurations, phased array systems, and electronic warfare.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. M.I. Skolnik, “Introduction to Radar Systems”, Tata McGraw Hill, 2001.

2. B.R. Mahafza, “Radar Systems Analysis and Design using MATLAB”, CRC Press, 2013.

3. S.M. Sherman and D.K. Barton, “Monopulse Principles and Techniques”, Artech House, 2011.

4. M.A. Richards, “Fundamentals of Radar Signal Processing”, Tata McGraw Hill, 2005.

5. Harry M. Jol (Editor), “Ground Penetrating Radar: Theory and Applications”, Elsevier, 2008.

6. K.K. Sharma, “Radar, Sonar and Navigation Engineering", S. K. Kataria & Sons, 2019.

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L	T	P	J	C
3	0	0	0	3

U18ECE0007 AVIONIC SYSTEM DESIGN

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the fundamentals of avionics systems and their integration in different aircraft.	K4
CO2	Evaluate various airborne and onboard communication technologies used in aviation.	K5
CO3	Analyze the avionics system development lifecycle and the role of standards and regulations in design.	K4
CO4	Evaluate software development processes and testing techniques specific to avionics systems.	K5
CO5	Create comprehensive avionics system testing methodologies compliant with industry standards.	K6

Pre-requisites:

1. U18ECI5201 - Communication Engineering I
2. U18ECT5005 - Antennas and Wave Propagation

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2				1			2				1
CO2	2	2	1								2			1
CO3	1			2		1					1	1		1
CO4	1				2		2				1			1
CO5	1		1					1						2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION TO AVIONICS **09 Hours**

Avionics for Civil Aviation, Tactical Avionics, Typical Aircraft Avionics Systems, Avionics System Requirements, Avionics Systems Integration, Digital computers and their electronics, Architecture of Microprocessors.

AIRBORNE AND ONBOARD COMMUNICATIONS **09 Hours**

Basics of communication, Frequency Band for Aviation, Radio signals, Modulation, VHF communication, HF communication, SATCOM, ATC communications, SELCAL, Databuses: MIL-STD-1553B, ARINC 429 and 629, Ethernet.

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AVIONICS SYSTEM DEVELOPMENT LIFECYCLE **09 Hours**

Overview of the avionics development process, including requirements generation, design, integration, testing, and certification Understanding the role of standards and regulatory requirements in avionics system design.

SOFTWARE DEVELOPMENT FOR AVIONICS **09 Hours**

Understanding the role of real-time embedded software in avionics - Overview of software testing, verification, and validation techniques.

AVIONICS SYSTEM TESTING **09 Hours**

Overview of avionics system testing methodologies - Understanding the role of simulation, modeling, and hardware-in-the-loop testing - Overview of certification testing and compliance with industry standards and regulations.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Albert Helfrick, "Principles of Avionics", Avionics Communications Inc., Ninth Edition, 2015.

2. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishers, Sixth Edition, 2013.

3. R. P. G. Collinson, "Introduction to Avionics Systems", Springer Science, Third Edition, 2011.

4. Myron Kayton and Walter R. Fried, "Avionics Navigation Systems", John Wiley and Sons, Second Edition, 1997.

5. Cary R. Spitzer (Ed.), Uma Ferrell (Ed.) and Thomas Ferrell (Ed.), "Digital Avionics Handbook", CRC Press, Third Edition, 2014.

6. Cary R. Spitzer, "Digital Avionics Systems: Principles and Practice", The Blackburn Press, Second Edition, 2001.

7. Ian Moir, Allan Seabridge and Malcolm Jukes, "Civil Avionics Systems", Wiley, Second Edition, 2013.

8. John H. Blakelock, "Automatic Control of Aircraft and Missiles", John Wiley and Sons, Second Edition, 1991.

9. Mike Tooly and David Wyatt, "Aircraft Communications and Navigation Systems: Principles, Maintenance and Operation", Butterworth-Heinemann's Series, 2007.

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U18ECE0008 **ELECTRONIC WARFARE AND ECM/ECCM TECHNOLOGIES**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the principles of electronic attack (EA) systems and ECM system architecture.	K4
CO2	Evaluate various jamming types and recommend appropriate countermeasures based on scenario analysis.	K5
CO3	Analyze the functionality of Infrared Countermeasures (IRCM) and Electro-Optic Counter Measure (EOCM) systems.	K4
CO4	Evaluate the effectiveness of Airborne Tactical Jamming System and Shipboard Self-Defense System against EA threats.	K5
CO5	Create innovative Electronics Counter-Countermeasures (ECCM) strategies and evaluate their effectiveness.	K6

Pre-requisites:

1. U18ECI5201 - Communication Engineering I

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2				1			1				1
CO2	2	2	1								2			1
CO3	1			2		1					1	1		1
CO4	1				2		2				1			1
CO5	1		1					1						1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **09 Hours**

Principals of Electronic Attack (EA), ECM System architecture, OnBoard ECM Systems, Off-Board ECM Systems.

JAMMING AND ITS TYPES **09 Hours**

Fundamental jamming relationship - Jamming-to-Signal Ratio, Jamming Types BurnThrough, Cover Jamming, Range Deceptive Jamming, Inverse Gain Jamming, Stand-Off Jamming, Escort Jamming, Self-Protection Jamming, Repeater Jamming, Noise Jamming, Side lobe Jamming, Main lobe Jamming.

COUNTERMEASURES AND ITS TYPES **09 Hours**

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Infrared Countermeasures (IRCM), Communications Countermeasures (COM-ECM), Electro-Optic Counter Measure (EOCM) Systems.

DEFENSE SYSTEMS **09 Hours**

Airborne Tactical Jamming System, Shipboard Self-Defense System, EA/Susceptibility against Weapon Systems. Search Radar Counter-Countermeasures, Tracking Radar.

COUNTER-COUNTERMEASURES **09 Hours**

Electronics Counter-Countermeasures (ECCM), Infrared Counter-Countermeasures (IRCCM), Communications Counter-Countermeasures.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Bahman Zohuri, "Electronic Countermeasure and Electronic Counter-Countermeasure", In book: Radar Energy Warfare and the Challenges of Stealth Technology (pp.111-145).

2. S.A. Vakin, L.N. Shustov and R.H. Dunwell, "Fundamentals of Electronic Warfare 2001", 2001.

3. Adrian Graham, "Communications, Radar and Electronic Warfare", John Wiley & Sons, 2010.

4. "Electronic Warfare & Radar Systems Engineering Handbook", Naval Air Warfare Center Weapons Division, 2013.

5. David Adamy, "EW 101: A First Course in Electronic Warfare (Artech House Radar Library)", 1st Edition, Artech House, 2001.

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SIGNAL PROCESSING

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U18ECE0011 **DIGITAL IMAGE PROCESSING**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the elements of visual perception and their role in digital image processing.	K4
CO2	Evaluate different image transforms and their properties in representing digital images.	K5
CO3	Compare and contrast spatial domain and frequency domain methods for image enhancement.	K4
CO4	Assess various techniques for image restoration and their applications in restoring degraded images.	K5
CO5	Evaluate various image compression methods.	K5

Pre-requisites:
1. U18EC I4201 - Digital Signal Processing

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3												1
CO2	2		2											2
CO3		2			2									2
CO4	2			3										2
CO5			2		2									1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment Group Presentation End Semester Examination
INDIRECT
Course-end survey

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DIGITAL IMAGE FUNDAMENTALS **09 Hours**

Elements of visual perception – Image sensing and acquisition – Image Formation Model, Image Sampling and Quantization, Representation of Digital Images, Spatial and Gray level Resolution, Zooming and Shrinking of Digital Images, Basic relationship between pixels – Basic gray level transformations. Color images – Color models - Chromaticity diagram.

IMAGE TRANSFORMS **09 Hours**

1D and 2D image transforms - Separable Transforms - One dimensional Fourier Transform - DFT – Two dimensional Fourier Transform - Discrete Cosine Transform - Walsh–Hadamard Transform – Wavelet transform –discrete and continuous- Haar transform – Properties.

IMAGE ENHANCEMENT AND RESTORATION **09 Hours**

Image Enhancement: Spatial Domain Methods. Image subtraction– Image averaging– Spatial filtering - Smoothing, Sharpening filters–First and Second Derivatives– Histogram –Histogram –Equalization Frequency Domain Methods – Filtering - Smoothing and Sharpening–Butterworth filter

Image Restoration: Model of Image Degradation/ Restoration process – Linear, position–invariant degradation – Estimating the degradation function – Inverse filtering- Weiner filtering–Unconstrained restoration

IMAGE SEGMENTATION AND REPRESENTATION **09 Hours**

Detection of discontinuities - Point, Line and Edge detection – Gradient operators - Edge linking – Graph theoretic technique - Thresholding – global and adaptive –Region-based segmentation.

Boundary representation – chain codes - Polygonal approximation–Signatures– skeletons – Boundary segments– Boundary descriptors: Shape numbers-Fourier descriptors-Regional descriptors–topological descriptors

IMAGE COMPRESSION **09 Hours**

Introduction to image compression– Lossy and Lossless compression – Sequential and Progressive Compression – Rate/Distortion optimization - compression metrics- Huffman coding – Run Length Coding – Predictive coding – DPCM - Transform coding – Vector quantization-Image compression standards.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. R. C. Gonzalez, R. E. Woods, "Digital Image Processing", Pearson Education, 4th Edition, 2017.
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson Education, 1st Edition, 2015.
3. David Salomon, "Data Compression", Springer Verlag, New York, Inc., 4th Edition, 2006.
4. S. Jayaraman, S. Esakkirajan and T. Veerakumar, "Digital Image Processing", Tata McGraw-Hill, 2nd Edition, 2020.
5. William K. Pratt, "Digital Image Processing", John Wiley and Sons, 4th Edition, 2007.
6. S.Sridhar, "Digital Image Processing", Oxford University Press, 2nd Edition, 2016.

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U18ECE0012 MULTIMEDIA AND COMPRESSION

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the features of multimedia data and evaluate the need for compression.	K4
CO2	Apply various text compression techniques.	K3
CO3	Assess audio compression techniques such as PCM, DPCM, and sub-band coding.	K5
CO4	Evaluate various techniques for image compression.	K4
CO5	Compare various video compression standards.	K4

Pre-requisites:
1. U18EC I4201 - Digital Signal Processing

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2			2									1
CO2	2	2			2									2
CO3	2	2			2									2
CO4	2	2			2									2
CO5	2	2			2									1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment Group Presentation End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **09 Hours**

Multimedia data - Features — Storage requirements for multimedia - Need for Compression - Taxonomy of compression – Metrics – Quantitative and Qualitative techniques - Overview of source coding – Vector quantization.

TEXT COMPRESSION **09 Hours**

Characteristics of text data – Run Length Encoding - Huffmann coding – Adaptive Huffmann Coding – Arithmetic coding — Dictionary techniques – LZW algorithm - GIF, TIF.

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AUDIO AND SPEECH COMPRESSION **09 Hours**

Fundamental concepts of speech and audio - Audio compression techniques – μ Law and A- Law companding - PCM, DPCM, DM, ADM - sub-band coding – G.722 – MPEG audio – MP3, MP4 - LPC – CELP, RELP coders.

IMAGE COMPRESSION **09 Hours**

Image data representation – Transform Coding – DCT - JPEG Standard – Fundamentals of Wavelets – Properties –DWT – Sub-band coding – QMF Filters –JPEG 2000 standard.

VIDEO COMPRESSION **09 Hours**

Fundamental concepts of video - Video signal representation - Motion estimation and compensation Techniques – MPEG Video Compression standards: MPEG – 1, 2 and 4 — H.264 Standard.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Khalid Sayood, **"**Introduction to Data Compression**",** Morgan Kauffman, 5th Edition, 2017.
2. David Salomon, "Data Compression – The Complete Reference", Springer Verlag New York Inc., 4th Edition, 2006.
3. Mark S. Drew, Ze-Nian Li, Jiangchuan Liu, "Fundamentals of Multimedia", Prentice Hall of India, 1stEdition, 2014.
4. Yun Q. Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms and Standards", CRC press, 2003.
5. Peter Symes, "Digital Video Compression", McGraw Hill, 2004.

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U18ECE0013 BIOMEDICAL SIGNAL PROCESSING

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Examine and categorize the properties and behavior of different types of biomedical signals.	K4
CO2	Apply signal averaging methods for artifact removal and noise reduction in biosignal analysis.	K3
CO3	Assess frequency domain analysis and adaptive filtering for noise reduction in biosignals.	K5
CO4	Analyze biomedical signals using time-series techniques.	K4
CO5	Critically analyze biosignal classification techniques using statistical and neural network-based methods.	K4

Pre-requisites:

1.U18EC I4201 - Digital Signal Processing

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2				1					1		1
CO2	2	2	2				1					1		2
CO3	2	2	2				1					1		2
CO4	2	2	2				1					1		2
CO5	2	2	2				1					1		1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment Group Presentation End Semester Examination
INDIRECT
Course-end survey

BIOSIGNALS AND THEIR CHARACTERISTICS **09 Hours**

Source of Bioelectric potential, Resting and action potential, Propagation of action potentials in nerves, Characteristics of biomedical signals, The nature of biomedical signals signal analysis, Biomedical signal acquisition and processing, Difficulties in biomedical signal acquisition and analysis, computer aided diagnosis

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SIGNAL AVERAGING **09 Hours**

Basics of signal averaging, signal averaging as a digital filter, limitations of signal averaging. Removal of artifacts by averaging. Filtering for removal of artifacts**:** Introduction, Random noise, structured noise and physiological interference, stationary versus non stationary process. Finite time averaging: Introduction, finite time estimation of mean value, estimation of variance, correlation, synchronous averaging.

FREQUENCY DOMAIN ANALYSIS AND ADAPTIVE FILTERING **09 Hours**

Frequency domain analysis Introduction, Spectral analysis, linear filtering, Removal of high frequency noise (power line interference). Adaptive filtering– LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in FECG.

TIME SERIES ANALYSIS **09 Hours**

Time series analysis – linear prediction models, process order estimation, lattice representation, non stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator.

BIOSIGNAL CLASSIFICATION AND RECOGNITION **09 Hours**

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network-based classification. Application in Normal versus Ectopic ECG beats.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Arnon Cohen, "Bio-Medical Signal Processing", CRC Press, 2nd Edition, 2000.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach", 2nd Edition, Wiley, 2015.
3. D.C.Reddy**, "**Biomedical Signal Processing- principles and techniques", Tata McGraw-Hill, 2005.

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L	T	P	J	C
3	0	0	0	3

U18ECE0014 **MACHINE LEARNING**

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the feasibility of different types of learning methods.	K4
CO2	Apply various neural network models and algorithms to solve real-world problems effectively.	K3
CO3	Evaluate the performance of linear models in both regression and classification tasks.	K5
CO4	Analyze the effectiveness of clustering and dimensionality reduction techniques.	K4
CO5	Apply various graphical models in both regression and classification tasks.	K3

Pre-requisites: --

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2												
CO2		2			2									
CO3	2			2										
CO4		2		2										
CO5			2		2									

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment Group Presentation End Semester Examination
INDIRECT
Course-end survey

FUNDAMENTALS OF MACHINE LEARNING **09 Hours**

Learning - types of learning: supervised, unsupervised and reinforcement learning– feasibility of learning – Vapnik-Chervonenkis Bound (VC Bound), error and noise –training versus testing–theory of generalization –generalization bound– approximation- generalization tradeoff –bias and variance decomposition –learning curve.

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NEURAL NETWORK **09 Hours**

Brain and neuron -Models of a neuron –Perceptron- feed-forward neural networks, learning Boolean function –Network training- Error Propagation, Multi-layer Perceptron, back propagation algorithm - network pruning, limitations and convergence of back- propagation learning, Generalized radial-basis function networks

LINEAR MODEL **09 Hours**

Linear models, Linear models for regression: linear basis function models, Bayesian linear regression. Linear models for classification: discriminant functions –Least squares for classification, Fisher's linear discriminant - two classes and multiple classes.

Probabilistic Generative Models: Maximum margin classifiers - support vector machine.

CLUSTERING **05 Hours**

Probability and learning - Gaussian Mixture model, K-means clustering, Vector Quantization, Self-Organizedfeature map.

DIMENSIONALITY REDUCTION **04 Hours**

Dimensionality reduction, Factor analysis, Linear Discriminant analysis, Principal Component Analysis, Independent Component Analysis.

GRAPHICAL MODEL **09 Hours**

Directed graphical models - Bayesian network, Undirected graphical models -Markov Random fields-inferencein graphical models - Markov model - Hidden Markov Models (HMMs).

Decision trees – Classification and regression tree.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Tom. M. Mitchell, “Machine Learning”, McGraw Hill, 1st Edition, 2013.
2. Stephen Marsland, “Machine Learning - An Algorithmic Perspective”, Chapman and Hall CRC Machine Learning and Pattern Recognition Series, 2nd Edition, 2014.
3. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, 3rd Edition, 2014.
4. K. P. Murpthy, “Machine Learning: A probabilistic perspectivel”, MIT Press, 2012.
5. Laurene Fauseett, “Fundamentals of Neural Networks”, Prentice Hall India, New Delhi, 2004.
6. Bishop, Christopher, Pattern Recognition and Machine Learning, Springer, 2007
7. D. Barber, “Bayesian Reasoning and Machine Learning”, Cambridge University Press, 2012.
8. Simon Haykin, “Neural Networks - a comprehensive foundation”, Pearson Education, 2nd Edition, 2008.
9. M. Mohri, A. Rostamizadeh and A. Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.

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U18ECE0015 STASTISTICAL SIGNAL PROCESSING

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the properties of random signals and random processes.	K4
CO2	Analyze various methods of power spectrum estimation and evaluate their bias and consistency.	K4
CO3	Apply different filtering techniques for linear prediction and estimation.	K3
CO4	Implement adaptive filters for signal processing applications.	K5
CO5	Apply wavelet transforms for signal analysis.	K3

Pre-requisites:
1.U18EC I4201 - Digital Signal Processing

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2			1						1	
CO2	2	2		2									1	
CO3	2	2	2	2										1
CO4	1	2	2	2										1
CO5	2	2		2										1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment Group Presentation End Semester Examination
INDIRECT
Course-end survey

DISCRETE-TIME RANDOM SIGNALS **09 Hours**

Discrete random process – Ensemble averages, Stationary and ergodic processes, Autocorrelation and Autocovariance properties and matrices, White noise, Power Spectral Density, Spectral Factorization, Filtering random processes.

SPECTRUM ESTIMATION **09 Hours**

Introduction to power spectrum estimation - Parameter estimation - Bias and consistency – Non parametric methods - Periodogram - Modified Periodogram – Bartlett Method - Welch Method – Blackman Tukey method - ARMA, AR, MA processes- Yule-Walker equations – Parametric methods for spectral estimation.

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LINEAR PREDICTION AND ESTIMATION **09 Hours**

Forward and backward linear prediction – Lattice filter realization - Optimum Filtering – FIR Weiner filter – Filtering and Linear prediction – Non-causal and causal IIR Weiner filters.

ADAPTIVE FILTERS **09 Hours**

Principles of adaptive filters – FIR adaptive filters– Newton's steepest descent adaptive filter–LMS adaptation algorithms–RLS algorithm, Applications - Noise cancellation – channel equalization– echo cancellers.

WAVELET TRANSFORM **09 Hours**

Fourier Transform and its limitations – Short Time Fourier Transform – Continuous Wavelet Transform – Multi resolution analysis - Discrete Wavelet Transform - Haar Wavelet – Daubechies Wavelet – Implementation of wavelet transform with sub band coding.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", Wiley Eastern, 2009.
2. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", PHI, 3rd Edition, 2014.
3. Sanjit K. Mitra, "Digital Signal Processing: A Computer Based Approach", 2nd Edition, Tata McGraw-Hill, 2001.
4. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Artech House, 2005.
5. C. Sidney Burrus, Ramesh A. Gopinath, Haitao Guo, "Introduction to Wavelets and Wavelet Transforms: A Primer", Prentice Hall, 1998.

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COMMUNICATION NETWORKS

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L	T	P	J	C
3	0	0	0	3

U18ECE0021 ADHOC WIRELESS NETWORKS

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the fundamentals of wireless communication technologies in mobile ad hoc and sensor networks.	K3
CO2	Analyze the design challenges and protocols of MAC layer in ad hoc wireless networks.	K4
CO3	Evaluate various routing protocols in ad hoc wireless networks.	K5
CO4	Analyze transport layer protocols for ad hoc wireless networks.	K4
CO5	Design secure communication frameworks for ad hoc wireless networks by exploring security challenges.	K6

Pre-requisites:

1. U18EC I5203 - Communication Networks

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2			2	2								1
CO2		2		2					2	2				1
CO3		2	2			2				2				1
CO4	2			2	2			2						1
CO5			3			2	2				2			1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **09 Hours**

Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum – Radio propagation Mechanisms – Characteristics of the Wireless Channel -mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs): concepts and architectures. Applications of Ad Hoc and Sensor networks. Design Challenges in Ad hoc and Sensor Networks.

MAC PROTOCOLS FOR AD HOC WIRELESS NETWORKS **09 Hours**

Issues in designing a MAC Protocol- Classification of MAC Protocols- Contention based protocols, Contention based protocols with Reservation Mechanisms- Contention based protocols with Scheduling Mechanisms – Multi channel MAC-IEEE 802.11

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ROUTING PROTOCOLS IN ADHOC WIRELESS NETWORKS **09 Hours**

Issues in designing a routing for Ad hoc networks- proactive routing, reactive routing (on-demand), hybrid routing- Table Driven Routing Protocols: DSDV, WRP, CGSR SLE: STAR protocol On-Demand Routing Protocols: Dynamic source Routing Protocol DSR, AODV, TORA, LAR, ABR, and FORP.

TRANSPORT LAYER PROTOCOLS IN ADHOC WIRELESS NETWORKS **09 Hours**

Transport Layer Protocols for Ad-hoc wireless Networks: Introduction, Issues in Designing a Transport Layer Protocol for Ad-hoc wireless Networks, Design Goals of a Transport Layer Protocol for Ad hoc wireless Networks, Classification of Transport Layer Solutions, TCP over Ad-hoc wireless Networks: Feedback-Based TCP, TCP with Explicit Failure Notification, TCP-BUS, Ad-hoc TCP, Split TCP.

SECURITY IN ADHOC WIRELESS NETWORKS **09 Hours**

Security in wireless Ad hoc wireless Networks, Network security requirements, Issues &Challenges in Security Provisioning, Network security Attacks, Key Management: Symmetric and Asymmetric key Algorithms, Key management in Ad-hoc Wireless Networks: Secure routing in Ad hoc wireless Networks: Requirements, SAR protocol, Security-Aware AODV protocol

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall Professional Technical Reference, 2008.
2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, "Ad Hoc and Sensor Networks: Theory and Applications World Scientific Publishing, 2nd Edition, 2011.
3. C.K.Toh, "Ad Hoc Mobile Wireless Networks", Pearson Education, 2002.
4. Erdal Çayırcı, Chunming Rong, "Security in Wireless Ad Hoc and Sensor Networks", John Wiley and Sons, 2009.
5. Ozan K. Tonguz and Gianguigi Ferrari, "Ad hoc Wireless Networking", John Wiley, 2006.
6. Xiuzhen Cheng, Xiao Hung, Ding-Zhu Du, "Ad hoc Wireless Networking", Kluwer Academic Publishers, 2004.

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U18ECE0022 **HIGH SPEED NETWORKS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the principles of Frame Relay Networks and ATM Protocol Architecture to analyze network efficiency.	K3
CO2	Analyze queuing models and congestion control techniques to differentiate their impacts on network performance.	K4
CO3	Evaluate Integrated Services Architecture and Queuing Discipline to assess Quality of Service in IP networks.	K5
CO4	Examine IP forwarding architectures and MPLS to recommend effective network architecture solutions.	K5
CO5	Design a Bluetooth protocol stack to develop efficient wireless communication systems.	K6

Pre-requisites:

1. U18EC I5203 - Communication Networks

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2			2									1
CO2		2		2										1
CO3			2		2									1
CO4			2			2	2							1
CO5					2									2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

HIGH SPEED NETWORKS **09 Hours**

Frame Relay Networks - Asynchronous transfer mode - ATM Protocol Architecture, ATM logical Connection, ATM Cell - ATM Service Categories - AAL. High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel - Wireless LAN's, WiFi and WiMax Networks applications, requirements – Architecture of 802.11.

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CONGESTION AND TRAFFIC MANAGEMENT **09 Hours**

Queuing Analysis – Queuing Models – Single Server Queues – Effects of Congestion – Congestion Control –Traffic Management – Congestion Control in Packet Switching networks – Frame Relay Congestion Control- Need for Flow and error Control

QUALITY OF SERVICE IN IP NETWORKS **09 Hours**

Integrated Services Architecture - Approach, Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ - Random Early Detection, Differentiated Services

ADVANCED NETWORK ARCHITECTURE **09 Hours**

IP forwarding architectures overlay model – Multi Protocol Label Switching (MPLS) – integrated services inthe Internet – Resource Reservation Protocol (RSVP) – Differentiated services

BLUE TOOTH TECHNOLOGY **09 Hours**

The Blue tooth module – Protocol stack Part I: Antennas – Radio interface – Base band – The Link controller – The Link Manager – The Host controller interface The Blue tooth module – Protocol stack Part II: Logical link control and adaptation protocol – RFCOMM – Service discovery protocol – Wirelessaccess protocol.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. William Stallings, "High-speed Networks and Internets", 2nd Edition, Pearson Education Asia, 2003.
2. Jean Walrand and Pravinvaraiya, "High Performance Communication networks", 2nd Edition, Harcourt and Morgan Kauffman, London, 2000.
3. Sumit Kasera and Pankaj Sethi, "ATM Networks", Tata McGraw-Hill, New Delhi, 2000.
4. Jennifer Bray, Charles Sturman, "Bluetooth: Connect Without Cables", Prentice Hall, 2001, Digitized 7 Dec 2007.
5. Jennifer Bray and Charles F.Sturman, "Blue Tooth", Pearson Education Asia, 2001.
6. Leon Gracia and Widjaja, "Communication networks", Tata McGraw-Hill, New Delhi, 2000.

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L	T	P	J	C
3	0	0	0	3

U18ECE0023 **NETWORK SECURITY**

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze symmetrical ciphers to understand cryptographic Mechanisms	K4
CO2	Employ cryptographic protocols using asymmetric key techniques	K2
CO3	Understand and evaluate the role of hash algorithms and authentication mechanisms in ensuring data integrity	K2
CO4	Apply digital signature concepts and their application in secure authentication	K3
CO5	Assess the design and implementation of network security and system level security mechanisms	K3

Pre-requisites:

1. U18EC I5203 - Communication Networks

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2			2									1
CO2	2	2		2										1
CO3	2		2		2									1
CO4	1		2							2				1
CO5		2				2	2							2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

CRYPTOGRAPHY AND SYMMETRIC KEY TECHNIQUES **10 Hours**

Modern cryptography, Historical ciphers and cryptanalysis, Security attacks, services and mechanisms, OSI security architecture. SYMMETRIC TECHNIQUES - Substitution ciphers, Transposition ciphers, Characteristics of good ciphers Data Encryption Standard (DES), Advanced Encryption Standard (AES), Blowfish, Block cipher modes of operation, Stream cipher: RC5.

ASYMMETRIC KEY TECHNIQUES **10 Hours**

Basics of number theory, Principles of public key cryptosystems, RSA Algorithm, Key management, D Hellman key exchange algorithm, Elliptic Curve Cryptography (ECC), Case study: eCash, PAKE proto.

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HASH FUNCTIONS AND MESSAGE AUTHENTICATION CODES **10 Hours**

Hash Functions: Introduction, Applications, Requirements and security, Secure Hash Algorithm (SHA), RACE Integrity Primitives Evaluation Message Digest (RIPEMD-160).

Message Authentication: Authentication requirements, Authentication functions, Message Authentication Codes (MAC), Hash-based Message Authentication Code (HMAC).

DIGITAL SIGNATURES **07 Hours**

Digital Signatures, Authentication Protocols, Digital Signature Standard (DSS), Elgamal, Schnorr, Applications.

NETWORK SECURITY AND SYSTEM LEVEL SECURITY **08 Hours**

Authentication Applications: Kerberos – X.509 Authentication Service– Electronic Mail Security– PGP– S/MIME–IP Security–Secure Electronic Transaction Intrusion detection – password management – Viruses and related Threats –Virus Counter measures– Firewall Design Principles.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Behrouz A Foruouzan, “Cryptography and Network Security”, Tata McGraw Hill, 2007.
2. William Stallings, “Cryptography and Network Security – Principles and Practice”, Pearson Education, 2013.
3. Josef Pieprzyk, Thomas Hardjono and Jennifer Sebery, “Fundamentals of Computer Security”, Springer, 2002.
4. Bruce Schneier, “Applied Cryptography”, John Wiley, 2008.
5. Charles P. Pfleeger and Shari Pfleeger, “Security in Computing”, Pearson Education, 2009.

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U18ECE0024 **WIRELESS SYSTEM AND STANDARDS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the principles of Frame Relay Networks and ATM Protocol Architecture to analyze network efficiency.	K3
CO2	Analyze queuing models and congestion control techniques to differentiate their impacts on network performance.	K4
CO3	Evaluate Integrated Services Architecture and Queuing Discipline to assess Quality of Service in IP networks.	K5
CO4	Examine IP forwarding architectures and MPLS to recommend effective network architecture solutions.	K5
CO5	Design a Bluetooth protocol stack to develop efficient wireless communication systems.	K6

Pre-requisites:

1.U18EC T7002 - Wireless Communication
2.U18EC I5203 - Communication Networks

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2			2									3
CO2		3		2								2		3
CO3			3		2						2			3
CO4				2			2			2				2
CO5						2		2				2		3

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

FUNDAMENTALS OF WIRELESS COMMUNICATIONS **09 Hours**

Theory of Radio Communication Channels-Radio Signal Propagation-Fading Channel Models-Narrowband and Frequency-Domain Characteristics-Wideband and Time-Domain Characteristics- Spread Spectrum Techniques-Direct-Sequence Spread Spectrum Techniques-Frequency Hopping Spread Spectrum Techniques-Time Hopping Spread Spectrum and Ultra-Wideband Techniques.

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MULTIPLE ACCESS TECHNOLOGIES **09 Hours**

Frequency Division Multiple Access-Time Division Multiple Access-Code Division Multiple Access- Random Multiple Access Technologies-Multiple User Signal Processing-Multiuser Joint Detection against MAI-Pilot-Aided CDMA Signal Detection-Beam-Forming against Co-Channel Interference- OSI Reference Model-Switching Techniques-Circuit Switching Networks-Packet Switching Networks-IP-Based Networking.

3G MOBILE CELLULAR TECHNOLOGIES **09 Hours**

CDMA2000-Operational Advantages-General Architecture-Air link Design-Data Throughput-Turbo Coding -Forward Link-Scheduling-Reverse Link-CDMA2000 1xEV Signaling-Handoffs-Summary of CDMA2000 1x-EV-CDMA2000 1xEV-DO-CDMA2000 1xEV-DV-WCDMA-History of UMTS WCDMA-ETSI UMTS versus ARIB WCDMA -UMTS Cell and Network Structure-UMTS Radio Interface-UMTS Protocol Stack-UTRA Channels-UTRA Multiplexing and Frame Structure- Spreading and Carrier Modulations-Packet Data-Power Control-Handovers-TD-SCDMA.

STANDARDS FOR WIRELESS NETWORKS **09 Hours**

Fundamentals of IEEE 802.11 Standards-Architecture and Functionality of a MAC Sublayer-IEEE 802.11 Frequency Hopping Spread Spectrum-IEEE 802.11 Direct-Sequence Spread Spectrum- Infrared Specifications-IEEE 802.11b Supplement to 802.11 Standards-IEEE 802.11g Standard-IEEE 802.11a Supplement to 802.11 Standards-IEEE 802.11 Security-Authentication- WEP-IEEE 802.15 WPAN Standards-IEEE 802.15.3a Standard-IEEE 802.15.4 Standard-IEEE 802.16 WMAN Standards-ETSI HIPERLAN and ETSI HIPERLAN/2 Standards-MMAC by Japan.

HISTORY OF WIRELESS STANDARDS **09 Hours**

Cellular Phone Standards-First Generation Analog Systems-Second Generation Digital Systems- Evolution of 2G Systems-Third Generation Systems- Wireless Local Area Networks- Wireless Short- Distance Networking Standards.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Hsiao-Hwa Chen, Taiwan Mohsen Guizani, “Next Generation Wireless Systems and Networks”, John Willey Publications, 2006.
2. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2008.
3. T.S. Rappaport, “Wireless Communications”, Pearson Education, 2nd Edition, 2014.

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U18ECE0025 GRAPH THEORY AND ITS APPLICATIONS

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply the concepts of graph types and properties to analyze various graph structures and solve related problems.	K3
CO2	Analyze the properties of trees, spanning trees, and cut sets to demonstrate their application in network theory.	K4
CO3	Evaluate planar and dual graphs using matrix representations to determine graph planarity and perform network analysis.	K5
CO4	Analyze vertex coloring algorithms to optimize solutions for scheduling and frequency assignment problems.	K4
CO5	Create electrical network models using graph theory principles to perform circuit analysis and solve practical problems.	K6

Pre-requisites:

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2			2								1	
CO2		3	2	2									1	
CO3	2	2		2	2								1	
CO4		2	2		2					2			1	
CO5			2		2	2							1	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **09 Hours**

Introduction and Applications of Graphs – Types of Graphs – Isomorphism – Sub graphs – Walks, Paths and Circuits – Connected Graphs, Disconnected Graphs and Components – Euler graphs – Hamiltonian Graph – Traveling Salesman Problem.

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TREES **09 Hours**

Trees – Properties of Trees – Distance and Centres – Types – Rooted and Binary Trees – On Counting Trees – Spanning Trees – Fundamental Circuits – Cut Sets – Properties of a Cut-Sets – Fundamental Circuit and Cut-Sets – Connectivity and separability.

GRAPHS AND MATRICES **12 Hours**

Planar Graphs – Various Representation of Planar graphs – Detection of Planarity – Dual Graph – Geometric and Combinatorial – Digraphs – Types – Dual Digraph – Euler Digraph.
Incidence matrix – Circuit matrix –Application to a Switching Network – Cut-set matrix – Path Matrix –Adjacency Matrix.

COLOURING, COVERING AND PARTITIONING **09 Hours**

Vertex-coloring - chromatic number, vertex coloring algorithms – sequential vertex coloring, largest degree first algorithm, applications - scheduling problem, assignment of radio frequencies, fast register allocation for computer programming.
Chromatic Partitioning – Chromatic Polynomial – Matchings – Coverings

ELECTRICAL NETWORK ANALYSIS BYGRAPH THEORY **06 Hours**

Electrical Network – Kirchhoff's current and voltage laws – Loop currents and Node Voltages – RLC Networks with Independent sources: Nodal Analysis – RLC Networks with Independent sources: Loop Analysis – General lumped, linear and fixed networks.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. L.R.Foulds , "Graph Theory Applications", Springer, 2016.
2. J.A. Bondy, and U.S.R. Murty, "Graph Theory with Applications", North Holland, Publication, 2008.
3. R. Diestel, "Graph Theory", Springer, 3rd Edition, 2006.
4. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw Hill, 7th Edition, 2011.

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RF and ANTENNA

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U18ECE0031 **RF MEMS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply the principles of wireless transceiver architectures to demonstrate understanding of MEMS-based wireless appliances.	K3
CO2	Analyze the properties of RF/Microwave substrates to compare different RF MEMS-enabled circuit elements.	K4
CO3	Evaluate reconfigurable circuit elements to recommend suitable designs for resonant MEMS switches.	K5
CO4	Examine tunable antennas and phase shifters to assess their performance in various applications.	K5
CO5	Design advanced RF MEMS filters and oscillators to create efficient communication systems.	K6

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	2							2		1
CO2	3	3	2	2	2							1		1
CO3	2	2	2	2	1							1		1
CO4	2	2	2	2	1							1		1
CO5	3	-	2	2	2							1		1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **09 Hours**

Conceptual wireless systems – Wireless transceiver architectures – MEMS based wireless appliances enable ubiquitous connectivity – Physical aspects of RF circuit design – Transmission lines on thin substrates – Self-resonance frequency –Quality factor – Packaging – Practical aspects of RF circuit design – DC biasing – Impedance mismatch effects in RF MEMS.

RF MEMS ENABLED CIRCUIT ELEMENTS **14 Hours**

RF/Microwave substrate properties – Micromachined enhanced elements – Capacitors – Inductors – Varactors – MEM switches – Shunt MEM switch – Push-pull series switch – Folded beam springs suspension series switch – Transmission line planar resonators – Cavity resonators – micromechanical resonators – Film bulk acoustic wave resonators – MEMS modeling – Mechanical modeling – Electromagnetic modeling.

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RECONFIGURABLE CIRCUITS **09 Hours**

Reconfigurable circuit elements – The resonant MEMS switch – Capacitors – Inductors – Tunable CPW resonator – MEMS microswitch arrays – Double – Stub tuner – Filters – Resonator tuning system – Massively parallel switchable RF front ends

ANTENNAS AND PHASE SHIFTERS **05 Hours**

Tunable dipole antennas – Tunable microstrip patch – Array antenna – Phase shifters – Concepts – True time Delay digital phase shifters.

FILTERS & OSCILLATORS **08 Hours**

Film bulk acoustic wave filters – FBAR filter fundamentals – FBAR filter for PCS applications – RF MEMS filters – A Ka-Band millimeter – Wave Micromachined tunable filter – RF MEMS Oscillators – Concepts.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Hector J. De Los Santos, "RF MEMS Circuit Design for Wireless Communications", Artech House, 2002.
2. Vijay K. Varadan, K.J. Vinoy and K.A. Jose, "RF MEMS and their Applications", Wiley India Pvt. Ltd, 2011.
3. Gabriel M. Rebeiz, "RF MEMS Theory, Design & Technology", Wiley India Pvt. Ltd, 2010.

WEB REFERENCE

1. http://nptel.ac.in/courses/117105082/

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U18ECE0032 **RF SYSTEM DESIGN**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply transmission line theory to demonstrate understanding of impedance mismatches and SWR.	K3
CO2	Analyze the importance of RF design to compare the behavior of high-frequency passive components.	K4
CO3	Evaluate various RF filter designs to recommend suitable filter configurations for different applications.	K5
CO4	Distinguish different impedance matching networks to assess their effectiveness in RF circuits.	K4
CO5	Design RF amplifiers, oscillators, and mixers to create efficient high-frequency circuits.	K6

Pre-requisites:

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2				1							1
CO2	2		2				1			1				2
CO3	2		1	1										1
CO4	1		2	1										1
CO5	2		2		2									2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

TRANSMISSION LINE THEORY **09 Hours**

Review of Transmission Line Theory: Lumped Element Model, Field Analysis of Transmission Lines, Terminated Lossless Lines, SWR, and Impedance Mismatches. Planar Transmission-Lines: Stripline, Microstrip, Coplanar-Line.

Smith Chart: Reflection Coefficient, Load Impedance, Impedance Transformation, Admittance Transformation, Parallel and Series Connection. Revision of S-Parameters.

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INTRODUCTION TO RF DESIGN **09 Hours**

Importance of RF design, Electromagnetic Spectrum, RF behavior of passive Components, -High frequency resistors- high frequency capacitors- high frequency inductors, Chip components-chip resistors –chip capacitors and Circuit Board considerations, Scattering Parameters

RF FILTER DESIGN **09 Hours**

Overview, Basic Resonator and Filter Configuration, Special Filter Realizations, Filter Implementations, Coupled Filter.

IMPEDANCE MATCHING NETWORKS **09 Hours**

Impedance Matching using Discrete Components, Microstrip line Matching Networks, Single Stub Matching Network, Double Stub Matching Network. Quarter-Wave Transformers, Multi-Section and Tapered Transformers.

RF AMPLIFIERS, OSCILLATORS AND MIXERS **09 Hours**

Characteristics; Amplifier Power Relations, Stability Considerations, Constant Gain Circles, Noise Figure Circles, Constant VSWR Circles, Low Noise Circuits; Broadband, High Power and Multistage Amplifiers. Basic Oscillator Model, High Frequency Oscillator Configurations, Basic Characteristics of Mixers.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Reinhold Ludwig and Powel Bretchko, “RF Circuit Design – Theory and Applications”, Pearson Education Asia, 1st Edition, 2004.
2. David M. Pozzar, “Microwave Engineering”, 3rd Edition, Wiley India, 2007.
3. Mathew M. Radmanesh, “Radio Frequency and Microwave Electronics”, 2nd Edition, Pearson Education Asia, 2006.
4. Mathew M. Radmanesh, “Advanced RF and Microwave Circuit Design-The Ultimate Guide to System Design”, Pearson Education Asia, 2009.
5. Joseph J. Carr, “Secrets of RF Circuit Design”, McGraw Hill Publishers, 3rd Edition, 2000.

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U18ECE0033 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the concepts of EMI and EMC to demonstrate understanding of their sources and effects.	K3
CO2	Analyze the principles of EMI measurements to compare different measuring instruments and techniques.	K4
CO3	Evaluate various EMC standards and regulations to recommend appropriate compliance strategies.	K5
CO4	Distinguish different EMI control methods to assess their effectiveness in minimizing interference.	K4
CO5	Design strategies to control radiation noise in digital circuits to create more efficient and compliant electronic systems.	K6

Pre-requisites:

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	PROGRAMME OUTCOMES													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2		2							2		1
CO2		2		2	2									2
CO3	2		2	2			2							2
CO4	2		2											2
CO5	2		2	2	2									1

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

BASIC CONCEPT **09 Hours**

EMI and EMC concepts and definitions with examples, Intra and Inter system EMI, Sources of EMI, Classification of EMI/EMC - CE, RE, CS, RS, Units of Measurement Parameters, EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression, EMC Testing Categories, EMC Engineering Application.

EMI MEASUREMENTS **09 Hours**

Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed throughcapacitor, current probe, open area test site, shielded anechoic chamber, TEM cell.

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EMC STANDARD AND REGULATIONS **09 Hours**

National and Intentional standardizing organizations- FCC, CISPR, ANSI, DOD, IEC, CENEEC, FCC CE and REstandards, CISPR, CE and RE Standards, IEC/EN, CS standards, Frequency assignment - spectrum conversation.

EMI CONTROL METHODS **09 Hours**

Shielding, Grounding-safety grounds, signal grounds, single - point ground systems, multipoint ground systems, hybridgrounds, Bonding, Filtering, EMI gasket, Isolation transformer, opto isolator, PCB Traces Cross Talk.

DIGITAL CIRCUIT RADIATION NOISE **09 Hours**

DM radiation, Controlling DM radiation, CM radiation, Controlling CM radiation, Frequency versus Time Domain, Analog versus Digital Circuits, Digital logic noise, Internal noise sources, Digital Circuit Ground noise, and Power distribution

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. R Prasad Kodali.V, "Engineering Electromagnetic Compatibility", S. Chand & Co, New Delhi, 2000.
2. Henry W. Ott, "Noise Reduction Techniques in Electronic System", Wiley Inter science, 2nd Edition, 1988.
3. Bem hard Keiser, "Principles of Electromagnetic Compatibility", Artech House, 3rd Edition, 1994.
4. Don R.J. White Consultant Incorporate, "Handbook of EMI / EMC", Vol I –V, 1988.
5. C.R.Paul, "Introduction to Electromagnetic Compatibility", John Wiley and Sons, 1992.

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U18ECE0034 COMPUTATIONAL ELECTROMAGNETICS

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the principles of electromagnetic theory to demonstrate understanding of classification and theorems.	K3
CO2	Analyze finite difference methods to compare their application to different types of partial differential equations.	K4
CO3	Evaluate variational methods to assess their effectiveness in solving PDEs using functionals.	K5
CO4	Analyze the method of moments to examine its applications in quasi-static, scattering, and radiation problems.	K4
CO5	Create finite element and Monte Carlo solutions to develop effective models for electromagnetic problems.	K6

Pre-requisites: -

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2	2	2									2
CO2		2		2	2									2
CO3	2		2	2			2							2
CO4	2		2	2										2
CO5	2	2	2		2									2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **06 Hours**

Review of Electromagnetic Theory, Classification of EM Problems, Theorems, Separation of Variables.

FINITE DIFFERENCE METHODS AND BOUNDARY CONDITIONS **08 Hours**

Finite Difference Schemes - Finite Differencing of Parabolic PDEs, Hyperbolic PDEs and Elliptic PDEs, Accuracy and Stability of FD Solutions, Absorbing Boundary Conditions for FDTD.

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VARIATIONAL METHODS **07 Hours**

Construction of Functionals from PDEs, Rayleigh–Ritz Method, Weighted Residual Method.

METHOD OF MOMENTS **09 Hours**

Integral Equations, Green's Functions, Applications: Quasi-Static Problems, Scattering Problems, RadiationProblems, EM Absorption in the Human Body.

FINITE ELEMENT METHOD **08 Hours**

Solution of Laplace's Equation, Solution of Poisson's Equation, Solution of the Wave Equation, BandwidthReduction, Finite-Element Time-Domain Method.

MONTE CARLO METHODS **07 Hours**

Generation of Random Numbers and Variables, Evaluation of Error, Numerical Integration, Solution of PotentialProblems, Regional Monte Carlo Methods. Case Study: Attenuation Due to Raindrops.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. M.N.O. Sadiku, "Numerical Techniques in Electromagnetics", CRC Press, 2000.
2. D.B. Davidson, "Computational Electromagnetics for RF and Microwave Engineering", Cambridge University Press, 2005.
3. K.J.Binns, P.J.Lawrenson and C.W Trowbridge, "The analytical and numerical solution of Electric andmagnetic fields", John Wiley & Sons, 1993.
4. Nathan Ida and Joao P.A.Bastos , "Electromagnetics and calculation of fields", Springer Verlag, 1992.
5. Karl E. Lonngren, Sava V. Savov and Randy J. Jost, "Fundamentals of Electromagnetics with MATLAB", Second Edition, SciTech Publishing, 2007.
6. D.M. Sullivan, Electromagnetic Simulation using the FDTD Method, IEEE Computer Society Press, 2000.

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VLSI

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U18ECE0041 **VLSI TESTING AND TESTABILITY**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Demonstrate an understanding of fault modeling and simulation techniques in digital circuits.	K3
CO2	Analyze test generation algorithms and methods for single stuck-at faults in combinational and sequential circuits.	K4
CO3	Evaluate delay test methodologies and strategies to address delay issues in VLSI circuits.	K5
CO4	Analyze design techniques and standards for enhancing testability in VLSI circuits.	K4
CO5	Examine fault diagnosis strategies and approaches for system-level diagnosis in VLSI systems.	K4

Pre-requisites:

1. U18ECI5202 VLSI and HDL Programming

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2		2		1					2	2	
CO2	2	2	1		2		1						1	
CO3	2	2	2		2		1						1	
CO4	2		2		2		1						1	
CO5	2	2	2		2		1						1	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

FAULT MODELLING AND SIMULATION **09 Hours**

Introduction to Testing - Faults in digital circuits - Modeling of faults - Logical Fault Models - Fault detection - Fault location - Fault dominance – Single stuck fault model and multiple stuck fault model - Logic Simulation - Types of simulation - Delay models - Gate level Event-driven simulation- Fault Simulation Techniques- Serial , Parallel and Deductive

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TESTING FOR SINGLE STUCK AT FAULTS **09 Hours**

Test Generation algorithms for combinational circuits – Fault oriented ATG – D Algorithm-Examples – PODEM - Fault independent ATG - Random Test generation - ATGs for SSFs in sequential circuits – TG usingiterative array models- Random Test Generation.

DELAY TEST **09 Hours**

Delay test problem – Path delay test – Test generation for Combinational circuits, Number of paths in a circuit-Transition faults – Delay test methodologies-Slow clock combinational test, Enhanced scan test, normal scan sequential test, Variable- clock Non-scan sequential test, Rated- clock Non-scan sequential test.

DESIGN FOR TESTABILITY **09 Hours**

Testability- Controllability and observability, Ad-hoc design for testability Techniques – Controllability and observability by means of scan registers- Storage cells for scan design- Level sensitive scan design (LSSD)-Partial scan using I-Paths – Boundary scan standards.

FAULT DIAGNOSIS **09 Hours**

Logical Level Diagnosis – Diagnosis by UUT reduction – Fault Diagnosis for Combinational Circuits – Self-checking design – System Level Diagnosis.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Abramovici, M., Brever, A., and Friedman, D., "Digital Systems Testing and Testable Design", Jaico Publishing House, 2002.
2. Michael L. Bushnell and Vishwani D Agarwal, “Essentials of Electronic Testing for Digital, Memory and Mixed Signal Circuits”, Springer, Verlag, 2000.
3. Stanley L. Hurst, “VLSI Testing: Digital and Mixed Analogue Digital Techniques”, Institute of Electrical Engineers,1998.
4. Xiaoqing Wen, Cheng Wen Wu and Laung Terng Wang, “VLSI Test Principles and Architectures: Design for Testability”, Cambridge University Press, 2000.
5. Parag K. Lala, “Fault Tolerant and Fault Testable Hardware Design”, BS Publications, 2002.

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L	T	P	J	C
3	0	0	0	3

U18ECE0042 **SYSTEM DESIGN WITH FPGA**

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply FPGA programming technologies and methods to implement designs using SRAM, Anti-Fuse, and Flash configurations.	K3
CO2	Analyze and compare fine, medium, and coarse-grained FPGA architectures to identify the most suitable for given applications.	K4
CO3	Evaluate and justify the use of different FPGA coding styles and design practices to optimize performance and resource usage.	K5
CO4	Apply comprehensive FPGA system architectures to incorporate various design flows, including HDL, DSP, and embedded processors.	K3
CO5	Examine simulation, synthesis and verification algorithms to ensure proper verification and timing analysis of FPGA designs.	K4

Pre-requisites:
1. U18ECI5202 - VLSI and HDL Programming

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		3		2								3	
CO2	2	2	2										3	
CO3	2	2	2		2								2	
CO4	2		3		2								3	
CO5				2	2								3	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

FPGA ARCHITECTURES **09 Hours**

Introduction, Programming Technologies – SRAM, Anti Fuse, E^2PROM/Flash Hybrid Flash-SRAM. Fine, medium and Coarse Grained Architectures, Logic Blocks – MUX based, LUT Based. Comparison of LUT, Distributed RAM and SRAM based Logic blocks. Logic Elements, CLBS, LABs, Distributed RAMs and shift registers. Dedicated specialized components in FPGAs, Clock –Clock tree, clock Manager, IO Block – Gigabit Transceivers.

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FPGA PROGRAMMING **09 Hours**

Anti fuse based FPGAs, SRAM based FPGAS, Using Configuration port, Using JTAG, Using Embedded processor.

FPGA DESIGN **09 Hours**

Coding Styles, pipelining and levels of Logic, Asynchronous design practices, clock considerations, Register and Latch consideration, Resource sharing, State Machine encoding, Testing Methodologies.

SYSTEM DESIGN FLOW **09 Hours**

Schematic based Design Flow, HDL Based Design Flow, DSP Based Design Flow, Embedded Processor based Design Flow.

SIMULATION, SYNTHESIS AND VERIFICATION **09 Hours**

Cycle based and event driven simulation-Logic / HDL synthesis technology- static, statistical and dynamic timing analysis- Verification- formal verification.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Clive Maxfield, "FPGAs: Instant Access", Newnes, 2008.
2. Charles H. Roth, Jr, Lizy Kurian John, "Principles of Digital system Design using VHDL", Cengage Learning India Private Limited, 2009.
3. Wayne Wolf, "FPGA Based System Design", Prentice Hall, 2004.
4. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", Pearson, 2011.
5. Ian Grout, "Digital Systems Design with FPGAs and CPLDs", Elsevier, 2012.
6. Robert Dueck, "Digital design with CPLD applications and VHDL", Thomson, 2004.
7. Bob Zeidman, "Designing with CPLDs and FPGAs", CRC Press, 2002.

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L	T	P	J	C
3	0	0	0	3

U18ECE0043 **SYSTEM ON CHIP**

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply principles of system architecture to describe and evaluate the components and interconnections of a system.	K3
CO2	Analyze different processor architectures and their impact on system performance and design considerations.	K4
CO3	Evaluate various system-level interconnection strategies and their effectiveness in different application scenarios.	K5
CO4	Develop a system-level co-design approach that combines hardware and software for maximum energy efficiency.	K3
CO5	Choose a comprehensive testing and implementation plan for SOC design using specific standards	K3

Pre-requisites:

1. U18ECI5202 - VLSI and HDL Programming

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		2				2						1	
CO2	2											2	1	
CO3	1		2										2	
CO4	1		2										2	
CO5	1		2		2								1	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

SYSTEM ARCHITECTURE **06 Hours**

Introduction to system Architecture, Components of a system, Hardware and Software: Programmability Versus Performance, Processor Architectures, Memory and Addressing, System-Level Interconnection, An Approach for SOC Design, System Architecture and Complexity.

SYSTEM-LEVEL DESIGN **12 Hours**

Processor selection-Concepts in Processor Architecture: Instruction set architecture (ISA), elements in Instruction Handing-Robust processors: Vector processor, VLIW, Superscalar, CISC, RISC—Processor evolution: Soft and Firm processors, Custom-Designed processors-IP based design - on - chip memory.

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SYSTEM-LEVEL INTERCONNECTION **09 Hours**

Overview: Interconnect Architecture, On-chip Buses: basic architecture, Bus standards: AMBA, Core Connect, Wishbone, Avalon-Network-on-chip – Architecture – topologies - switching strategies - routing algorithms - flow control, quality-of-service - Reconfigurability in communication architectures.

CO-DESIGN CONCEPTS **09 Hours**

Nature of hardware & software- quest for energy efficiency- driving factors for hardware-software co-design- Co-design space-Dualism of Hardware design and Software design - Modeling Abstraction Level- Concurrency and Parallelism- Hardware Software tradeoffs- Introducing Dataflow modeling.

SOC IMPLEMENTATION AND TESTING **09 Hours**

Study of Microblaze RISC processor - Real-time operating system (RTOS), peripheral interface and components, High-density FPGAs-Introduction to tools used for SOC design: Xilinx SOC based development kit. Manufacturing test of SOC: Core layer, system layer, application layer-P1500 Wrapper Standardization-SOC Test Automation (STAT).

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Michael J.Flynn, Wayne Luk, "Computer system Design: System-on-Chip", Wiley-India, 2012.
2. Patrick Schaumont, "A Practical Introduction to Hardware/Software Co-design", 2nd Edition, Springer, 2012.
3. Lin, Y-L.S. (ed.), "Essential issues in SOC design: designing complex systems-on- chip", Springer, 2006.
4. Sudeep Pasricha, Nikil Dutt, "On Chip Communication Architectures: System on Chip Interconnect", Morghan Kaufmann Publishers, 2008.
5. W.H. Wolf, "Computers as Components: Principles of Embedded Computing System Design", Elsevier, 2008.

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U18ECE0044 **NANO ELECTRONICS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply principles of nanoelectronics scaling to analyze scaling limits	K3
CO2	Analyze physical properties of nanoscale structures using transmission probability calculations	K4
CO3	Evaluate single electron, SESO, and CNT devices for their applicability in memory technologies	K5
CO4	Assess spintronics and molecular nanodevices for their potential in optoelectronic devices	K5
CO5	Create fabrication techniques for nanostructures to enable advanced device fabrication	K6

Pre-requisites: -

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						2						2	
CO2	2			2			2						2	
CO3	1		2				2						2	
CO4	3		2				2						2	
CO5	1		2				2						3	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

NANOELECTRONICS AND SCALING **09 Hours**

Introduction to Nanoelectronics – Classical and quantum systems – Current CMOS device technology- International Technology Roadmap for Semiconductor projections – Scaling principles – General scaling, Characteristic scale length – Limits to scaling – Quantum mechanics, Atomistic effects, Thermodynamic Effects, Practical considerations – Power constrained scaling limits.

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PHYSICAL PROPERTIES OF NANOSCALE STRUCTURES **09 Hours**

Energy subbands and Density of States in nanoscale structures – Electron transport in a Two Dimensional electron gas – Resistance of a ballistic semiconductor – Landauer formula – Transmission probability calculation – Resonant tunnelling effect – Coulomb blockade – Quantization of thermal conductance in ballistic nanostructures.

SINGLE ELECTRON, SESO AND CNT DEVICES **09 Hours**

Introduction – Quantum Dot transistor – structure and fabrication – Single Electron and Single Hole Quantum Dot transistor – Artificial atom – Single Electron MOS Memory – structure and fabrication - SESO Transistor – SESO Memory – CNT transistor – CNT based Field Emission devices – CNT based Microwave devices.

SPINTRONICS AND MOLECULAR NANODEVICES **09 Hours**

Introduction – Spin filters – Spin diodes – Spin transistors – Spin based optoelectronic devices – Electrical conduction of molecules – Manipulation of single molecules – Molecular motors – Molecular nanoactuators – Molecular electronic devices – Molecular based optic devices.

FABRICATION TECHNIQUES **09 Hours**

Optical lithography – Electron beam lithography – X –Ray lithography - Focused Ion beam lithography – Nanoimprint lithography – Pulsed laser deposition – Sputter deposition – Chemical Vapour Deposition – Wet and dry etching techniques – Chemical Mechanical Polishing.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Mircea Dragoman and Daniela Dragoman, “Nanoelectronics Principles and Devices”, Artechhouse, Boston, 2006.
2. Shunri Oda and David Ferry, “Silicon Nanoelectronics”, Taylor & Francis, USA, 2006.
3. W.R. Fahrner, “Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques”, Springer (India), New Delhi, 2011.

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U18ECE0045 **LOW POWER VLSI**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the need for low power design in CMOS and evaluate the hierarchy of limits and sources of power consumption.	K4
CO2	Evaluate different voltage scaling approaches and their impact on supply voltage management and power efficiency.	K5
CO3	Create strategies for minimizing switched capacitance using architectural level optimization techniques and glitch power reduction methods.	K6
CO4	Design and implement leakage power minimization techniques, including multiple threshold voltages and dynamic scaling approaches.	K6
CO5	Analyze power estimation techniques and assess their effectiveness in predicting power consumption for CMOS circuits.	K5

Pre-requisites:
1. U18ECI5202 - VLSI and HDL Programming

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	1									2	
CO2	3	2	2	1									2	
CO3	2	2	2	2									1	
CO4	3	2	2	2									2	
CO5	2	2	2	2									2	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment End Semester Examination
INDIRECT
Course-end survey

POWER DISSIPATION IN CMOS **08 Hours**

Need for low power design, Hierarchy of limits of power – Sources of power consumption – Basic principleof low power design, Degree of freedom.

SUPPLY VOLTAGE SCALING **10 Hours**

Challenges in supply voltage scaling, Voltage scaling approaches, Static voltage scaling approaches- Device feature size scaling, Architectural level approaches - Parallelism, Pipelining, voltage scaling through optimal transistor sizing, voltage scaling using high level transformations, multi level voltage scaling, Dynamic voltagescaling, Adaptive voltage scaling.

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SWITCHED CAPACITANCE MINIMIZATION **12 Hours**

Hardware Software Trade-off, Bus Encoding, Use of number system, Architectural level Optimization Techniques, Glitch power, Clock Gating, State encoding, Logic styles, Low power techniques for SRAM and DRAM. Special topics - Adiabatic Switching Circuits Battery-aware Synthesis Variation tolerant design CAD tools for low power synthesis.

LEAKAGE POWER MINIMIZATION **10 Hours**

Standby leakage reduction- Fabrication of multiple threshold voltages, Transistor stacking, Variable-threshold-voltage CMOS (VTCMOS), Multi-threshold-voltage CMOS (MTCMOS), Power gating, Run time leakage reduction- V_{DD} scaling, combining power gating with Dynamic voltage and frequency scaling, multi level V_{DD} scaling, Dual-Vt assignment approach (DTCMOS), dynamic V_{th} scaling.

POWER ESTIMATION **05 Hours**

Power estimation techniques – Logic level power estimation – Simulation power analysis–Probabilistic power analysis.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. K.Roy and S.C. Prasad , “Low Power CMOS VLSI circuit design”, Wiley, 2000.
2. Gary Yeap, “Practical low power digital VLSI design”, Kluwer, 2001.
3. Dimitrios Soudris, Chirstian Pignet, Costas Goutis, “Designing CMOS Circuits for Low Power”, Kluwer, 2002.
4. J.B. Kuo and J.H Lou, “Low voltage CMOS VLSI Circuits”, Wiley, 1999.
5. A.P. Chandrakasan and R.W. Broadersen, “Low power digital CMOS design”, Kluwer, 1995.
6. Abdellatif Bellaouar, Mohamed I. Elmasry, “Low power digital VLSI Design”, Kluwer, 1995.
7. James B. Kuo, Shin-chia Lin, “Low voltage SOI CMOS VLSI Devices and Circuits”, John Wiley and sons, 2001.
8. Ajit Pal, “Low-Power VLSI Circuits and Systems”, Springer India, 2015.

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EMBEDDED SYSTEM

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U18ECE0051 **INDUSTRIAL ROBOTICS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the classification and anatomy of industrial robots with their degrees of freedom and applications.	K4
CO2	Evaluate kinematic solutions for industrial robots, including forward and inverse kinematics, and identify singularities and their implications.	K5
CO3	Apply principles of manipulator design on workspace optimization, end effector selection, and motor control techniques.	K3
CO4	Analyze motion control strategies and trajectory planning methods for industrial robots.	K4
CO5	Create robot programs using various programming methods such as on-line programming, teach-dependent programming, and Robot Operating System (ROS) integration.	K6

Pre-requisites: --

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3					2					2		
CO2	3	3	3									2		1
CO3			3	3	2									3
CO4				3	3				2					2
CO5					3				2	2				2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end Survey

INTRODUCTION **03 Hours**

Introduction to industrial robotics - classification of robots, Laws of robotics, robot anatomy, degrees of freedom, links, joints, robot applications, ethics of robots, Introduction to robot programming.

KINEMATICS OF ROBOTS **09 Hours**

Rotation matrices, Different coordinates- Cartesian, cylindrical, spherical, articulated, RPY, Euler angles, Denavit-Hartenberg notation, solving simple forward kinematics problem.

Inverse kinematics- inverse orientation, inverse locations, Singularities, Jacobian. .

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DESIGN OF INDUSTRIAL MANIPULATORS **12 Hours**

Different configuration of manipulators, workspace design, end effectors and different types of gripper, typesand classification of motors, Electronic drives and control, sensors and feedback systems.

MOTION CONTROL AND TRAJECTORY PLANNING **12 Hours**

Open loop vs closed loop control, PID Control, Differential motion, force, torque, electronic control using microprocessor and micro controllers, errors in motion control.

Basics of trajectory planning, Cartesian space trajectories, graph based planning - grassfire algorithm, Djikstra's algorithm, artificial potential field, sampling methods.

ROBOT PROGRAMMING **09 Hours**

Robot programming: Introduction; On-line programming: Manual input, lead through programming, Teach dependent programming.

Introduction to Robot Operating System, reinforcement learning for robotic manipulators, Simple robotic simulations in gazebo simulator.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Saeed B. Niku, "Introduction to Robotics", Prentice Hall of India, 2nd Edition, 2010.
2. Mikell P. Groover, "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
3. Deb. S.R., "Robotics Technology and flexible Automation", John Wiley, USA, 1992.

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U18ECE0052 **INDUSTRIAL AUTOMATION**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the evolution of automation strategies in industries and the role of fluid power systems and automation tools.	K4
CO2	Evaluate the components and operation of fluid power systems, including pumps, valves, actuators, and sensors, in industrial automation.	K5
CO3	Apply programming techniques for industrial automation hardware modules.	K3
CO4	Analyze industrial communication protocols and standards, such as Modbus, HART, Profibus, and Ethernet, in the context of Industry 4.0 and Industrial IoT.	K4
CO5	Create SCADA systems and Distributed Control Systems (DCS) for industrial automation.	K6

Pre-requisites: -

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2				2	2							2
CO2	2	2			2		1						2	
CO3			2	2	2								2	
CO4			2	2		2				2				2
CO5			2	2	2				2					2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

THEORY COMPONENT CONTENTS

INTRODUCTION **05 Hours**

The need for automation in industries, evolution of automation strategy, Introduction to fluid power, Types of fluid power systems, application and advantages, Introduction to automation tools - PLC, Sensors, switches and timer modules, DCS, SCADA, Introduction to IEC 61131.

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FLUID POWER SYSTEMS **09 Hours**

Pumps and compressor - Types and working principles, types of valves - direction control valve, pressure valve, servo valve - flow control valve - accumulators, types of actuators, Electro Hydraulic circuits, electro pneumatic circuits, sensors - proximity sensor, magnetic reed switch, flow measurement, velocity and position sensors, light sensors, strain sensors, temperature sensors, Relays and latches.

AUTOMATION HARDWARE MODULES AND PROGRAMMING **11 Hours**

PLC Hardware - input and output modules, CPU - design, memory design and types, Human machine interfaces, PLC wiring, PLC Programming - types of PLC programming, addressing, ladder logic programming - program control instructions, arithmetic instruction, timers and counters programming.

Embedded systems in industrial automation - SoC substitutes for PLC, Challenges and limitation of implementation, OOP in automation, need for packaging and standards.

INDUSTRIAL COMMUNICATION **11 Hours**

Definition of protocol, Introduction to Open System Interconnection (OSI) model, Communication standard (RS232, RS485), Modbus (ASCII/RTU), HART Protocol, Foundation Field bus H1, Comparison of HART, Foundation Field bus, Device net, Profibus, Control net, Industrial Ethernet.

Introduction to Industry 4.0, Industrial IoT- block diagram, application, simple case studies.

SCADA AND DISTRIBUTED CONTROL SYSTEMS **09 Hours**

SCADA Concept of SCADA systems, Programming techniques for: Creation of pages, Sequencing of pages, Creating graphics & animation, Dynamos programming with variables, Trending, Historical data storage & Reporting, Alarm management, reporting of events and parameters, Comparison of different SCADA packages. DCS introduction, Various function Blocks, DCS components/block diagram, DCS Architecture of different makes, comparison of these architectures with automation pyramid, DCS specification, latest trend and developments.

Large scale data handling - basics of big data analysis, introduction to classification techniques, simple data analysis using weka/ MATLAB software.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Frank D. Petruzella, "Programmable Logic Controllers", McGraw-Hill Companies, 3rd Edition, March 2013.
2. Lukas, "Distributed Control systems", Van Nostrand Reinfold Company, 1995.
3. Anthony Esposito, "Fluid Power with Applications", Pearson Education Inc., 7th Edition, 2009.
4. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw-Hill, 2009.
5. James A. Sullivan, "Fluid Power: Theory and Applications", C.H.I.P.S, 4th edition, 2007.

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U18ECE0053 **VIRTUAL INSTRUMENTATION**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the principles and concepts of virtual instrumentation, including data acquisition, signal processing, and interfacing techniques.	K4
CO2	Evaluate the suitability of different sensors, transducers, and measurement techniques for virtual instrumentation applications.	K5
CO3	Apply programming skills to develop custom virtual instruments using software platforms like LabVIEW or MATLAB/Simulink.	K3
CO4	Analyze and optimize virtual instrumentation systems for real-time data acquisition, processing, and control in various engineering domains.	K4
CO5	Evaluate the performance and reliability of virtual instrumentation systems through testing, validation, and calibration procedures.	K5

Pre-requisites: -

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2										
CO2	2	2	2		2									
CO3	2	2	2	2										
CO4	2	2	2	2										
CO5			2	2	2									

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **9 Hours**

Virtual Instrumentation- Comparison with Traditional Instrumentation – Definition and Flexibility - Architecture - software for Virtual Instrumentation - Modular Programming, Loop and Charts, Arrays, Clusters and Graphs, Case and Sequence Structures, Formula nodes, String and File Input / Output.

DATA ACQUISITION **9 Hours**

A/D and D/A converters, Plug-in Analog Input / Output cards – Digital Input and Output Cards, Organization– Performing analog input and analog output – Scanning multiple analog channels – Issues involved in selection of Data acquisition cards – Data acquisition modules with serial communication – Design of digital voltmeter with transducer input –Timers and Counters.

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IMAQ VISION **9 Hours**

Vision basics- Image processing and analysis, particle analysis – Machine vision, Hardware modules, Building machine vision system - Image processing tools, Acquisition and implementation using NI- Driver software- Applications.

REAL TIME CONTROL **9 Hours**

Designs using VI Software – ON/OFF controller – Proportional controller – Modeling and basic control of level andreactor processes – Case studies on development of HMI, SCADA in VI.

HARWARE & OPERATING SYSTEM OVERVIEW **9 Hours**

PC architecture, operating system requirements, PC based instrumentation, analog and digital interfaces- PXI and SCXI main frame - modular instruments-Real time I/O and compact RIO-Introduction to NI-ELVIS – Transducers power, speed and timing considerations.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Jovitha Jerome, "Virtual Instrumentation using LABVIEW", PHI Learning, New Delhi, 2010.
2. Gary W. Johnson and Richard Jennings, "LabVIEW Graphical Programming", McGraw-Hill, 4th Edition, 2011.
3. Barry Paton, "Sensor, transducers and Lab view", Prentice Hall of India, 2000.
4. Buchanan, W., "Computer buses", CRC Press, 2000.
5. Lisa K Wells, "Lab view for Everyone", Prentice Hall of India, 1996.

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U18ECE0054 **REAL TIME EMBEDDED SYSTEMS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the architecture and hardware units of embedded systems.	K4
CO2	Evaluate various communication protocols used in embedded systems.	K5
CO3	Apply embedded programming techniques using C and C++.	K3
CO4	Assess real-time operating system concepts and their applications.	K5
CO5	Construct integrated hardware/software solutions for embedded systems.	K4

Pre-requisites:

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2		2							2	2	
CO2		2	2									2	2	
CO3	2		2		2							2	2	
CO4		2		2	2		1						2	
CO5		2	2				2					2	2	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

ARCHITECTURE OF EMBEDDED SYSTEMS **9 Hours**

Definition and classification- Overview of processors-Hardware units in an Embedded systems-Software embedded into a system- Exemplary Embedded systems- Embedded systems on a chip-The use of VLSI designed circuits.

DEVICES AND BUSES FOR DEVICES NETWORK **9 Hours**

I/O Devices– Types and Examples–Synchronous, Iso-synchronous and Asynchronous Communications from Serial Devices – Examples of Internal Serial-Communication Devices UART and HDLC–Parallel Device Ports – Sophisticated interfacing features in Devices Ports-Timer and Counting Devices – Serial bus communication protocols: I^2C,'USB','CAN'andAdvanced I/O serial high speed buses– Parallel bus device protocols : ISA, PCI,PCI/X , ARM bus and Advanced parallel high speed buses.

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EMBEDDED PROGRAMMING IN C, C++ **9 Hours**

C Program Elements, Macros and functions - Use of Pointers - NULL Pointers - Use of Function Calls - Multiple function calls in a Cyclic Order in the Main Function Pointers - Function Queues and Interrupt Service Routines Queues Pointers - Concepts of EMBEDDED PROGRAMMING in C++ - Objected Oriented Programming - Embedded Programming in C++ - C Program compilers - Optimization of memory codes.

REAL-TIME OPERATING SYSTEM CONCEPTS **9 Hours**

Architecture of the Kernel–task and task scheduler–Interrupt Service Routines–Semaphores–Mutex– Mailboxes–Message Queues–Event Registers–Pipes–Signals–Timers–Memory Management – Priority Inversion Problem-Study of µC/OS-II RTOS.

HARDWARE/SOFTWARE INTEGRATION **9 Hours**

Compiler - Cross compiler -. Emulator, Simulators - Host and target machines - Linkers/locators for embedded software - Getting embedded software into the target system and testing on host machine.
Case study of Embedded systems like Digital camera, Smart card, Flight simulation and control.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Raj Kamal, "Embedded Systems Architecture Programming and Design", 2nd Edition, TMH, 2008
2. David E. Simon, "An Embedded Software Primer", Pearson Education, 4th Reprint, 2007.
3. Steve Heath, "Embedded Systems Design", 2nd Edition., Elsevier Publications, 2006.
4. Wayne Wolf, "Computers as Components; Principles of Embedded Computing System Design", Harcourt India, Morgan Kaufman Publishers, First Indian Reprint, 2005.
5. Frank Vahid and Tony Gwasrgie, "Embedded system Design", John Wiley and Sons, 2002.
6. Daniel. W Lewis, "Fundamentals of Embedded Software", Pearson Education, 2001.
7. Wayne Wolf, "Computers as Components; Principles of Embedded Computing System Design", Harcourt India, Morgan Kaufman Publishers, First Indian Reprint, 2005.

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U18ECE0055 **AUTOMOTIVE ELECTRONICS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Understand the fundamental principles and operation of key automotive mechanical systems, including the power train, transmission, braking, and steering systems.	K2
CO2	Analyze the role of electronic systems in improving vehicle performance parameters such as speed, power, torque, fuel economy, emissions. and safety.	K3
CO3	Apply the fundamental concepts of an Integrated Development Environment (IDE) and its role in software and hardware development within automotive systems.	K3
CO4	Implement embedded system concepts in automotive applications with a focus on engine management, electronic transmission control, and vehicle safety.	K3
CO5	Apply embedded communication protocols in automotive based on data transfer speed, reliability, and application suitability.	K3

Pre-requisites: -

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3										2			2
CO2	3	2		2									2	
CO3		3			2		2						2	
CO4	3	2											2	
CO5	3													3

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

AUTOMOTIVE MECHANICAL SYSTEMS: VEHICLE SYSTEMS **09 Hours**

Power Train System (Air System, Fuel System (Carburettor & Diesel Fuel Injection, Ignition System, Exhaust System and other Auxiliary Systems (Cooling, Lubrications & Electrical Systems)), Transmission System (Front, Rear & 4 wheel Drive, Manual, Automatic Transmission, Differential). Braking System (Drum, Disc, Hydraulic, Pneumatic), Steering System (Rack and Pinion, Power Steering).

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ELECTRONICS IN AUTOMOTIVE SYSTEMS **09 Hours**

Need for Electronics in Automotive Systems: Performance (Speed, Power, and Torque), Control (Emission, Fuel Economy, Drivability, and Safety) & Legislation (Environmental legislation for pollution & Safety Norms). Overview of Vehicle Electronic Systems: Basic electrical components and their operation in an automobile: Power train subsystem (Starting systems, Charging systems - Ignition systems – Electronic fuel control), Chassis subsystem (ABS, TCS, & ESP) – Comfort and safety subsystems (Night Vision, Airbags, Seatbelt Tensioners, Cruise Control-Lane-departure-warning, Parking).

INTEGRATED DEVELOPMENT ENVIRONMENT **09 Hours**

Introduction to Integrated development environment (IDE) – Getting started, HW / SW configuration (boot service, Host – target interaction) – Booting reconfiguration – Managing IDE – Target servers, agents, Cross development, debugging – Introduction to an IDE for lab board – RTOS, PC based debugger.

EMBEDDED SYSTEM IN AUTOMOTIVE APPLICATIONS **09 Hours**

Engine management systems – Gasoline / Diesel systems, various sensors used in system – Electronic transmission control - Vehicle safety system – Electronic control of braking and traction – Body electronics – Infotainment systems – Navigation systems – System level tests – Software calibration using engine and vehicle dynamometers – Environmental tests for Electronic Control Unit - Application of Control elements and control methodology in Automotive System.

EMBEDDED SYSTEM COMMUNICATION PROTOCOLS **09 Hours**

Introduction to control networking – Communication protocols in embedded systems – SPI, I2C, USB – Vehicle communication protocols – Introduction to CAN, LIN, FLEXRAY, MOST, KWP2000.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Joerg Schaeuffele and Thomas Zurawka, "Automotive Software Engineering Principles, Processes, Methods and Tools", SAE International, 2005.
2. BOSCH Automotive Handbook, 6th Edition, 2014.
3. Jean J.Labrosse, "µC/OS-II Real Time Kernel, CMP Books", 2nd Edition, 2002.
4. Raj Kamal, "Embedded systems Architecture, programming and design", McGraw Hill Education, 3rd Edition, 2017.
5. Denton. T, "Automobile Electrical and Electronic Systems", 4th Edition, 2012.
6. William B. Ribbens, "Understanding Automotive Electronics", Butterworth–Heinemann publication,5th Edition, 1998.
7. Ronald K. Jurgen, "Automotive Electronics Handbook", McGraw Hill Publications, 1999.
8. Nicholas Navit, "Automotive Embedded System Handbook", CRC Press, Taylor and Francis Group, 2009.
9. Fu K.S. Gonzaleaz R.C. and Lee C.S.G., "Robotics Control Sensing, Vision and Intelligence", McGraw Hill International Editions, 1987.

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U18ECE0056 **MULTICORE ARCHITECTURE AND PROGRAMMING FOR EMBEDDED SYSTEMS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply the fundamentals of multicore architectures, including the drivers, limits of single-core computing, and the evolution towards MPSoCs.	K3
CO2	Analyze Multicore hardware architectures, distinguishing between heterogeneous and homogeneous designs and their communication mechanisms.	K4
CO3	Evaluate scheduling concepts and operating system aspects in the context of multicore systems, comparing scheduling algorithms and their implications.	K5
CO4	Analyze the concepts of concurrency and parallelism, identifying dependencies and synchronization primitives, and resolving synchronization-related issues.	K4
CO5	Create strategies for advanced multicore topics such as timing analysis, WCET analysis, schedulability analysis, and deterministic behavior evaluation.	K6

Pre-requisites:
1. U18ECI5206 - Embedded Processor Architecture
2. U18ECI6203 - VLSI and HDL Programming

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2		2								2	
CO2	2	3	2		2								2	
CO3			2		2								2	
CO4	2			2	2								2	
CO5		1	1		1							2	2	

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION TO MULTICORE **4 Hours**

Drivers for Multicore Architectures: Low power, Performance/Throughput and need for memory bandwidth – Limits of single core computing – Moore's law - Limits to Instruction Level Parallelism (ILP) – Power and heat dissipation issue – Increased amount of data to process – Evolution from traditional System-On-Chip (SoC) to MPSoCs (Multi processor System-On-Chips) - Need for Multicore controllers.

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MULTICORE ARCHITECTURE **12 Hours**

Dependent Multicore software and hardware architectures – Multicore hardware architecture overview: Heterogeneous and Homogenous Multicore hardware – Communication between hardware processing elements: Point-to-point connections, Shared buses, On-chip cross bar, Network-On-Chip (NoC) - Memory access in Multicore architectures: Symmetric Multi-Processing (SMP), Asymmetric Multiprocessing (NUMA) – Multicore architecture specific to applications - Example Multicore hardware used in Automotive – Infineon Tricore series, ST devices.

SCHEDULING CONCEPTS AND OS ASPECTS **12 Hours**

Scheduling – Static and Dynamic Scheduling - Scheduling algorithms: Rate Monotonic Scheduling (RMS), Fixed priority pre-emptive scheduling, Round robin scheduling, Earliest deadline first, First come First serve – Process and threads – Need of pre-emption - Types of Multicore Scheduling: Global, Semi-partitioned and Partitioned – OS for General purpose and Real time systems - Scheduling in Single core vs Scheduling in Multicore – Timing Jitter.

CONCURRENCY AND PARALLELISM **12 Hours**

Amdahl's law – Need for Parallelism – Concurrency Fundamentals – Data parallelism, Functional Parallelism, loop Parallelism – Dependencies – Producer consumer — Need for Synchronization, Loop dependencies–Shared resources – Caching aspects - Problems with no synchronization - Synchronization primitives – Semaphore, Mutex, spinlocks, Test and Set, Compare and swap–Synchronization related issues and how to avoid them: Data races, Livelocks, Deadlock, Non-atomic operations.

ADVANCED MULTICORE TOPICS **5 Hours**

Multicore timing analysis - Timing simulation: WCET (Worst Case Execution Time) analysis – Schedulability analysis – Additional challenges in Multicore - Tools used in automotive: Timing architect, ChronSIM, Sym TA/S- Deterministic behavior – Logical Execution Time (LET).

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Bryon Moyer, "Real world Multicore embedded systems", 1st Edition, Newnes, 2013.
2. Michael Barr, "Programming Embedded Systems: With C and GNU Development Tools", 2nd Edition, O'Reilly Media, 2006.

References on the internet for Multicore timing analysis:

3. Why is timing analysis important? http://embedded.cs.unisaarland.de/publications/EnablingCompositionalityRTNS2016.pdf

Multicore timing simulation solutions:

4. https://www.vector.com/int/en/events/global-de-en/webinars/2020/timing-analysis-formulticore-ecus/
5. https://www.rapitasystems.com/multicore-timing
6. https://www.inchron.com/tool-suite/chronsim/
7. https://www.absint.com/ait/symtas.htm
8. https://www.danlawinc.com/wp-content/uploads/MC-BR-006-Multicore-Timing-Analysis-Solution-For-Aerospace-v3.pdf

Logical Execution Time (LET)

9. https://ieeexplore.ieee.org/document/5577967

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U18ECE0057 **INTRODUCTION TO HMI**

L	T	P	J	C
3	0	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO1	Analyze the use cases and functionalities of HMI in various domains such as Automotive, Industrial, Consumer Electronics, Medical, and Aero.	K4
CO2	Evaluate different communication protocols used for Electronic Control Units (ECUs) in automotive systems.	K5
CO3	Apply HMI architecture and concepts to design hardware and software platforms using Intel, Qualcomm, and i.MX6 for automotive applications.	K3
CO4	Analyze the components and frameworks of HMI applications using platforms like Qt, Android SDK, CGISTUDIO, and IAR SYSTEMS.	K4
CO5	Evaluate advanced HMI technologies in automotive and other domains.	K5

Pre-requisite: -

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2				2					2		2
CO2	2	2	2									2		2
CO3	2		2		2							2		2
CO4	2	2			2		1							2
CO5		2	2				2					2		2

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II	Course end survey
2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable)	
3. End Semester Examination	

INTRODUCTION TO HMI AND AUTOMOTIVE ELECTRONICS **9 Hours**

HMI use cases for Automotive, Industrial, Consumer Electronics, Medical and Aero - ECUs within cars and their functionalities. Communication protocols for ECUs. (CAN, LIN, Most, FlexRay, Ethernet).

CAR MULTIMEDIA **6 Hours**

Instrument Cluster, In Vehicle Infotainment, Professional Systems, Rear Seat Entertainment - Evolution of car multimedia, Overview, H/W, S/W and mechanics.

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AUTOMOTIVE HMI **10 Hours**

HMI Architecture & Concepts, H/W Platform (Intel, Qualcomm, i.MX6), S/W Platform (OS, Graphics libraries and Connectivity), Services (Navigation, map Engine, Alexa), Application Framework (Qt, Android sdk,) HMI domain specific applications - HMI application components (Radio, HVAC, Navigation, Telematics, ADAS, Park assist) Widgets, Framework, Framework model and state machine, Qt state chart for state machine along with Qt tool.

UX AND UI **10 Hours**

Introduction to UX design - stages, theory, Design thinking, UX Case Studies, Comparison of UX and UI, Interaction concepts, Graphic design with introduction to tools Figma (know different formats and import and export of UX), Asset Design - Overview only, Guidelines and norms, Blender tool-Overview on the topic, 2D/3D rendering.

TRENDS AND ADVANCED TOPICS **10 Hours**

Voice, Gesture, Vision, sensor based UI controls, Haptics, New technologies (eyegaze, gesture, dual display), SPI - android auto, car play, Smart City and Public Transport, ride sharing, personal, Virtual Reality, Augmented Reality and Mixed Reality, UI Analytics (Usage patterns), Debugging, Performance Profiling.

Theory: 45 Hours **Total Hours: 45**

REFERENCES:

1. Shuo Gao, Shuo Yan, Hang Zhao, Arokia Nathan, "Touch-Based Human-Machine Interaction: Principles and Applications", Springer Nature, 1st Edition, 2021.
2. Robert Wells, "Unity 2020 By Example: A project-based guide to building 2D, 3D, augmented reality, and virtual reality games from scratch", Packt Publishing Limited, 3rd Edition, 2020.
3. Ryan Cohen, Tao Wang, "GUI Design for Android Apps", Apress, Berkeley, CA, 2014.

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U18ECE0058 **Advanced HMI**

L	T	P	J	C
2	0	2	0	3

Course Outcomes:

CO1	Analyze the architecture and concepts of HMI and its subcomponents.	K4
CO2	Apply advanced 3D development techniques using Unity 3D, including scripting and real-time rendering.	K3
CO3	Evaluate the significance of QT in HMI development and its application across different platforms.	K5
CO4	Demonstrate proficiency in Android and web app development for HMI interfaces.	K3
CO5	Organize HMI testing methods and automation strategies to address verification and validation challenges.	K3
CO6	Create functional HMI prototypes using Raspberry Pi with capacitive touch screens.	K6

Pre-requisite:

1. U18ECE0057 – Introduction to HMI

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3			2									2
CO2			3		3									2
CO3	1			2	1									1
CO4	1		2		3									2
CO5		2		3	2									1
CO6	2		3		3									1

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II	Course end survey
2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable)	
3. End Semester Examination	

INTRODUCTION **2 Hours**

HMI Architecture & Concepts, HMI Subcomponents

GAMING ADVANCED 3D DEVELOPMENT **9 Hours**

Introduction to game development and advanced 3D development, Game Engine, Unity 3D – installation -code editor – camera - game objects and transform – Renderer – lighting – UI – Scripting, Realtime 3D in Automotive world, HMI Development.

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QT **8 Hours**

History of QT, Why QT? Supported Platforms, QT Installation, QT Creator, QT Modules, Signals and slots, Event Processing. HMI Application framework in QT, Creating and Testing of HMI application in QT.

ANDROID AND WEB APP DEVELOPENT **8 Hours**

Introduction to Android, Android application life cycle, Application development using Android framework and Testing.

HMI TESTING AND AUTOMATION **3 Hours**

Introduction, elements of HMI, Challenges of HMI Testing, Verification and Validation

Theory: 30 Hours **Practical: 30 Hours** **Total Hours: 60**

REFERENCES:

1. Shuo Gao, Shuo Yan, Hang Zhao, Arokia Nathan, "Touch-Based Human-Machine Interaction: Principles and Applications", Springer Nature Switzerland AG; 1st Edition, 2021.
2. Robert Wells, "Unity 2020 By Example: A project-based guide to building 2D, 3D, augmented reality, and virtual reality games from scratch", Packt Publishing Limited, 2020.
3. Lee Zhi Eng, "Qt5 C++ GUI Programming Cookbook: Practical recipes for building cross-platform GUI applications, widgets, and animations with Qt 5, 2nd Edition, Packt Publishing Limited, 2019.
4. Karim Yaghmour, "Embedded Android: Porting, Extending, and Customizing", First Edition, Shroff/O'Reilly, 2013.
5. Louis J.Williams, "Basic Programming Android for beginners Handbook", IT Campus Academy, March 2016.
6. Julie C. Meloni, "Sams Teach Yourself HTML, CSS, and JavaScript All in One", Pearson Education, 2011.
7. Arnon Axelrod, "Complete Guide to Test Automation by Arnon Axelrod", Apress, September 2018.
8. Dean Alan Hume, "Progressive Web Apps", Manning Publisher, December 2017.

LABORATORY COMPONENT:

LIST OF EXPERIMENTS:

1. Setting up of Raspberry Pi with capacitive touch screen
2. Setting up the Unity environment
3. Working with UI controls of Unity
4. QT Installation, Configuration, Application Development and Testing
5. Creating Dialogs and Main windows using QT programming and Application Development and Testing.

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MANAGEMENT STUDIES

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U18ECE0061 PRODUCT DESIGN AND DEVELOPMENT

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Analyze the key challenges in product development and apply methods to optimize the development process.	K4
CO2	Examine customer needs and establish clear product specifications based on gathered data.	K4
CO3	Evaluate different product concepts and justify the best approach through systematic concept selection.	K5
CO4	Assess the implications of product architecture and design products considering industrial design and manufacturability.	K5
CO5	Create prototypes and develop economic models to effectively manage product development projects.	K6

Pre-requisites: --

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		2		2					1				
CO2			2											
CO3	2		2											
CO4			3			1				2	2			
CO5			3		2	2								

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION – DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING 9 Hours

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development.

A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process identify opportunities.

Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

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IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS 9 Hours

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into ahierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING 9 Hours

The activities of concept generation clarify the problem search externally, search internally, explore systematically,reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE – INDUSTRIAL DESIGN - DESIGN FOR MANUFACTURING 9 Hours

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Definition, estimation of manufacturing cost,reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING – PRODUCT DEVELOPMENT ECONOMICS – MANAGING PROJECTS 9 Hours

Prototyping basics, principles of prototyping, technologies, planning for prototypes, Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on projectsuccess, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Karl Ulrich,T, Steven Eppinger, D, “Product Design and Development”, McGraw Hill, 2015.
2. Chitale, AK, Gupta, RC, “Product Design and Manufacturing”, PHI, 2013.
3. Timjones, “New Product Development: An Introduction to a multifunctional process”, Butterworth-Heinemann, 1997.
4. Geoffery Boothroyd, Peter Dewhurst and Winston Knight A, “Product Design for Manufactureand Assembly”, CRC Press, 2011.

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U18ECE0062 **TOTAL QUALITY MANAGEMENT**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the concepts of quality and apply the principles of TQM to real-world scenarios.	K4
CO2	Evaluate customer satisfaction and implement continuous process improvement strategies to enhance service quality.	K5
CO3	Apply statistical tools to monitor process control and solve issues related to quality variations.	K3
CO4	Assess the effectiveness of TQM tools and recommend best practices for quality management.	K5
CO5	Design and develop quality systems adhering to ISO standards for efficient documentation and auditing processes.	K6

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2		2							2			
CO2		2		2							2			
CO3		2		2							2			
CO4					3						2			
CO5		2			3						2			

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

INTRODUCTION **9 Hours**

Definition of Quality, Dimensions of Quality, Quality Costs, Top Management Commitment, Quality Council, Quality Statements, Barriers to TQM Implementation, Contributions of Deming, Juran and Crosby, Team Balancing.

TQM PRINCIPLES **9 Hours**

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Continuous Process Improvement,5S, Kaizen, Just-In-Time and TPS.

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STATISTICAL PROCESS CONTROL **9 Hours**

The seven tools of quality, New seven Management tools, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Concept of six sigma.

TQM TOOLS **9 Hours**

Quality Policy Deployment (QPD), Quality Function Deployment (QFD), Benchmarking, Taguchi Quality Loss Function, Total Productive Maintenance (TPM), FMEA

QUALITY SYSTEMS **9 Hours**

Need for ISO 9000 and Other Quality Systems, ISO 9001:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 14001:2004

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Dale H. Besterfield, "Total Quality Management", Pearson Education, 5th Edition, 2020.
2. James R.Evans and William M.Lindsay, "The Management and Control of Quality", South-Western (Thomson Learning), 2008.
3. Oakland.J.S., "Total Quality Management", Butterworth – Hcinemann Ltd., Oxford, 2003.
4. Bhaskar S., "Total Quality Management", Anuradha Agencies, Chennai, 2007.
5. Narayana V. and Sreenivasan, N.S., "Quality Management – Concepts and Tasks", New Age International, 2007.
6. Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.
7. Feigenbaum A.V, "Total Quality Management", McGraw Hill Publishers, 1991.

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U18ECE0063 **OPERATIONS RESEARCH**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Analyze the formation and solution methods of linear programming models and apply these techniques to optimize real-world scenarios.	K4
CO2	Evaluate transportation and assignment problems using optimization techniques and recommend the best allocation strategies.	K5
CO3	Apply project management principles to schedule and manage resources effectively using PERT and CPM techniques.	K3
CO4	Analyze replacement and sequencing models to determine the most efficient strategies for resource management.	K4
CO5	Design and develop inventory and queuing models to optimize operations and improve system efficiency.	K6

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2					1							
CO2	3	3					1							
CO3			2								2			
CO4	2	2					2							
CO5			2				2						1	2

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

LINEAR MODEL **9 Hours**

The phases of OR study, formation of an L.P model, graphical solution, simplex algorithm, artificial variables technique (Big M method, two phase method), duality in simplex.

TRANSPORTATION AND ASSIGNMENT PROBLEM **9 Hours**

Transportation model, Initial solution by North West corner method, least Cost method, VAM. Optimality test, MODI method and stepping stone method. Assignment model, formulation, balanced and unbalanced assignment problems

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PROJECT MANAGEMENT BY PERT & CPM **9 Hours**

Basic terminologies, Constructing a project network, Scheduling computations – PERT – CPM, Resource smoothening, Resource leveling, PERT Cost

REPLACEMENT AND SEQUENCING MODELS **9 Hours**

Replacement policies, Replacement of items that deteriorate with time (value of money not changing with time), Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies).

Sequencing models- n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem

INVENTORY AND QUEUING THEORY **9 Hours**

Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management.

Queuing system and its structure, Kendall‘s notation , Common queuing models - M/M/1: FCFS/∞/∞ - M/M/1: FCFS/n/∞ - M/M/C: FCFS/∞/∞ - M/M/1: FCFS/n/m

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Taha H.A., “Operation Research”, Pearson Education, 2016.
2. Hira and Gupta, “Introduction to Operations Research”, S Chand and Co, 2002.
3. Hira and Gupta, “Problems in Operations Research”, S. Chand and Co, 2008.
4. Wagner, “Operations Research”, Prentice Hall of India, 2000.
5. S.Bhaskar, “Operations Research”, Anuradha Agencies, Second Edition, 2004.

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U18ECE0064 **PROFESSIONAL ETHICS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Apply ethical theories and moral reasoning to identify and solve moral issues in engineering scenarios.	K3
CO2	Analyze the impact of engineering practices as social experimentation and assess ethical codes and legal aspects involved.	K4
CO3	Evaluate safety and risk management practices through case studies and assess their effectiveness in real-world scenarios.	K5
CO4	Analyze the responsibilities and rights of engineers, including issues related to professional ethics and intellectual property.	K4
CO5	Create a comprehensive plan for addressing global issues in engineering, integrating ethical considerations and managerial roles.	K6

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2					1								
CO2	2	2		2										
CO3			2				2							
CO4	1			1				2						
CO5						2					2			

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

ENGINEERING ETHICS AND THEORIES **9 Hours**

Definition, Moral issues, Types of inquiry, Morality and issues of morality, Kohlberg and Gilligan's theories, consensus and controversy, Professional and professionalism, moral reasoning and ethical theories, virtues, professional responsibility, integrity, self respect, duty ethics, ethical rights, self interest, egos, moral obligations.

SOCIAL ETHICS AND ENGINEERING AS SOCIAL EXPERIMENTATION **9 Hours**

Engineering as social experimentation, codes of ethics, Legal aspects of social ethics, the challenger case study, Engineers duty to society and environment.

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SAFETY **9 Hours**

Safety and risk – assessment of safety and risk – risk benefit analysis and reducing risk – the Three Mile Island and Chernobyl case studies. Bhopal gas tragedy.

RESPONSIBILITIES AND RIGHTS OF ENGINEERS **9 Hours**

Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – Intellectual Property Rights (IPR) – discrimination.

GLOBAL ISSUES AND ENGINEERS AS MANAGERS, CONSULTANTS AND LEADERS **9 Hours**

Multinational Corporations – Environmental ethics – computer ethics – weapons development – engineers as managers – consulting engineers – engineers as expert witnesses and advisors – moral leadership – Engineers as trend setters for global values.

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

REFERENCES:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering". (2005) McGraw-Hill, NewYork.
2. John R. Boatright, "Ethics and the Conduct of Business", (2003) Pearson Education, New Delhi.
3. Bhaskar S. "Professional Ethics and Human Values", (2005) Anuradha Agencies, Chennai.
4. Charles D. Fleddermann, "Engineering Ethics", 2004 (Indian Reprint) Pearson Education /Prentice Hall, New Jersey.
5. Charles E. Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics – Conceptsand cases", 2000 (Indian Reprint now available) Wadsworth Thompson Learning, United States.

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U18ECE0065 **ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Apply the fundamental concepts of economic theories and demand analysis to forecast demand and determine supply requirements.	K3
CO2	Analyze different market structures and firm practices to evaluate their impact on diversification and integration strategies.	K4
CO3	Evaluate national income concepts and the effects of inflation and deflation to recommend policies for economic stabilization.	K5
CO4	Create a financial management plan by applying methods of appraising project profitability and managing working capital effectively.	K6
CO5	Analyze and interpret financial statements using ratio analysis to assess the financial health and performance of an organization.	K4

Pre-requisites: --

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2				2					2			
CO2				2		2					2			
CO3						2					2			
CO4				2							3			
CO5											3			
CO6		2		2							3			

Course Assessment Methods

DIRECT
Continuous Assessment Test I, II Assignment (Theory Component) End Semester Examination
INDIRECT
Course-end survey

ECONOMICS, COST AND PRICING CONCEPTS **9 Hours**

Economic theories – Demand analysis – Determinants of demand – Demand forecasting – Supply – Actual Cost and opportunity Cost – Incremental Cost and sunk Cost – Fixed and variable Cost – Marginal Costing– Total Cost – Elements of Cost – Cost curves – Breakeven point and breakeven chart – Limitations of break- even chart – Interpretation of break-even chart– Contribution – P/V-ratio, profit-volume ratio or relationship– Price fixation – Pricing policies – Pricing methods.

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CONCEPTS ON FIRMS AND MANUFACTURING PRACTICES **9 Hours**

Firm – Industry – Market – Market structure – Diversification – Vertical integration – Merger – Horizontal integration.

NATIONAL INCOME, MONEY AND BANKING, ECONOMIC ENVIRONMENT **9 Hours**

National income concepts – GNP – NNP – Methods of measuring national income – Inflation – Deflation – Kinds of money – Value of money – Functions of bank – Types of bank – Economic liberalization – Privatization – Globalization.

CONCEPTS OF FINANCIAL MANAGEMENT **9 Hours**

Financial management – Scope – Objectives – Time value of money – Methods of appraising project profitability – Sources of finance – Working capital and management of working capital.

ACCOUNTING SYSTEM, STATEMENT AND FINANCIAL ANALYSIS **9 Hours**

Accounting system – Systems of book-keeping – Journal – Ledger – Trail balance – Financial statements – Ratio analysis – Types of ratios – Significance – Limitations.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Prasanna Chandra, "Financial Management: Theory & Practice", TMH, 2019.
2. Weston, J. Fred (John Fred), "Essentials of Managerial Finance", Fort Worth: Dryden Press, 1992.
3. Pandey, I. M., "Financial Management", Vikas Publishing House, 11th Edition, 2015.
4. James C. Van Horne, "Fundamentals of Financial Management", Pearson Education, 13th Edition, 2015.
5. Bhaskar S., "Engineering Economics and Financial Accounting", Anuradha Agencies,Chennai, 2003.
6. James C. Van Horne, "Financial Management and Policy", Prentice-Hall (Canada), 1993.
7. M. Y. Khan and P. K. Jain, "Management Accounting & Financial Management", Tata McGraw Hill publishers, 2004.
8. P. Saravanavel, "Management Accounting: Principles & Practice", Progressive Corporation, 1981.
9. A. Ramachandra Aryasri and V.V. Ramana Murthy, "Engineering Economics & Financial Accounting", Tata McGraw Hill, New Delhi, 2006.
10. R.L. Varshney and K.L. Maheswari, "Managerial Economics", Sultan Chand & Sons, 2001.
11. Samvelson and Nordhaus, "Economics", Tata McGraw Hill, New Delhi, 2002.

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OPEN ELECTIVE COURSES

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U18ECO0001 **VIRTUAL INSTRUMENTATION**

L	T	P	J	C
3	0	0	0	3

Description

This course is intended to motivate undergraduate students to enable them to translate their experience into productive code using Virtual Instrumentation. Working with NI LABVIEW instrumentation is flexible, indispensable, time saving package without all the frustrating aspects of ordinary programming language. It aims the concept of VI by using NI LABVIEW as the application development environment. Students will be trained to develop programming using NI LABVIEW and articulate the emerging importance of software in instrumentation systems.

Objectives

- To visualize and explore the concepts used in NI
- To design using NI LABVIEW software
- To know about hardware and operating systems for virtual Instrumentation

Expected Outcomes

Students will be able,

- To construct basic instruments using NI LABVIEW
- To select data acquisition cards for all types of data
- To design real time control systems using NI LABVIEW
- To describe the PC hardware and operating system for virtual instrumentation

Expected Audience

The course will be offered to students from the following Departments

- Mechanical Engineering / Mechatronics
- Automobile Engineering
- Aeronautical Engineering
- Computer Science and Engineering
- Information Technology

Teaching methodology

The course will have a combination of the pedagogical techniques for delivery of the course:

- Classroom teaching / Hands-on Training
- Demonstration videos
- Guest lectures by experts / Field Trip

Module-1: VIRTUAL INSTRUMENTATION **10 Hours**

Comparison with Traditional Instrumentation - Definition and Flexibility - Architecture - software for Virtual Instrumentation - Modular Programming, Loop and Charts, Arrays, Clusters and Graphs, Case and Sequence Structures, Formula nodes, String and File Input / Output

Module-2: DATA ACQUISITION **10 Hours**

A/D and D/A converters, Plug-in Analog Input / Output cards – Digital Input and Output Cards, Organization– Performing analog input and analog output – Scanning multiple analog channels – Issues involved in selection of Data acquisition cards – Data acquisition modules with serial communication – Design of digital voltmeter with transducer input –Timers and Counters.

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Module-3: IMAQ VISION AND REAL TIME CONTROL **15 Hours**

IMAQ Vision - Vision basics- Image processing and analysis, particle analysis - Machine vision, Hardware modules - Building machine vision system - Image processing tools, Acquisition and implementation using NI-Driver Software - Applications.

Real-Time Control - Designs using VI Software – ON/OFF controller – Proportional controller – Modeling and basic control of level and reactor processes.

Module-4: INTERFACING EXTERNAL DAQ BOARDS **10 Hours**

Interface procedures to Arduino boards, Raspberry Pi boards, Beagle bone Black. Introduction to PXI and SCXI main frame - modular instruments-Real time I/O and compact RIO-Introduction to NI-ELVIS.

Grading Policy

Pattern I - Two Assessment Component (Each Carries 50 Marks)		
Assignment – 1 (Tasks in Labview)	**Assignment – 2 (Project Practical Exam)**	**Total**
50	**50**	**100**

Textbooks

1. Jovitha Jerome, "Virtual Instrumentation using LABVIEW," PHI Learning, New Delhi, 2010.

2. Gary W. Johnson and Richard Jennings, "Lab VIEW Graphical Programming," 4th Edition, McGraw-Hill Professional Publishing, 2011.

Reference books

1. Barry Paton, "Sensor, transducers and Lab view," Prentice Hall of India, 2000.

2. Lisa K Wells, "Lab view for Everyone," Prentice Hall of India, 1996.

3. Jeffrey Travis, Jim Kring, "LabVIEW for Everyone: Graphical Programming Made Easy and Fun," 3rd Edition, Prentice Hall of India, 2007.

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U18ECO0002 AUTOTRONICS – AN INTRODUCTION TO SMART VEHICLES

L	T	P	J	C
3	0	0	0	3

Description

Automotive industry no longer will be only for mechanical/automobile domain. Electrical & Electronics plays a predominant role in automotives. Current and future automotive technology relies on smart & self-driving cars which intern employs smart sensors, processors, actuators. etc. This course prepares students for entry-level positions or advanced training in automotive electrical and electronics systems. Students apply principles of electronics to automotive technology and develop diagnostic skills. The syllabus for this course is originally given by The Robert Bosch Engineering & Business solutions and it is modified as per our requirement and resources.

Objectives

- To understand the basics of automotive mechanical systems.
- To understand the concepts of Automotive Electronics, its evolution and trends
- To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software.
- To understand the Engine Management system and safety systems.
- To develop entrepreneurship skills in the automotive industry.

Expected Outcomes

- Describe various mechanical systems in an automobile.
- Illustrate different types of electronic systems in an automobile.
- Explain the various embedded systems used in automotive applications.
- Work with Infineon DEMS DK.

Expected Audience

The course will primarily benefit students with interests as below:

- Those who are interested in Automobiles.
- Students aspire to work with leading automobile industry
- Technology Enthusiasts.

Teaching methodology

The course will have a combination of the following pedagogical techniques for delivery of the course:

- Classroom teaching.
- Lab (Bosch Center) session for working with DEMS,
- Demonstration videos
- Guest lectures by industrial experts.
- Company visit

Module-1: AUTOMOTIVE MECHANICAL SYSTEMS: VEHICLE SYSTEMS 10 Hours

Power Train System - Transmission System - Braking System - Steering System.

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Module-2: ELECTRONICS IN AUTOMOTIVE SYSTEMS **10 Hours**

Need for Electronics in Automotive Systems - Performance - Control & Legislation - Overview of Vehicle Electronic Systems - Basic electrical components and their operation in an automobile - Power train subsystem - Chassis subsystem – Comfort and safety subsystems

Module-3: EMBEDDED SYSTEM IN AUTOMOTIVE APPLICATIONS **10 Hours**

Engine management systems – Gasoline / Diesel systems, various sensors used in system – Electronic transmission control - Vehicle safety system – Electronic control of braking and traction – Body electronics – Infotainment systems – Navigation systems – System level tests – Software calibration using engine and vehicle dynamometers – Environmental tests for Electronic Control Unit - Application of Control elements and control methodology in Automotive System

Module-4: INTRODUCTION TO DIESEL ENGINE MANAGEMENT SYSTEM (DEMS) **15 Hours**

Introduction to Diesel Engine Management System – Architecture of Aurix TC27x 32-Bit Single-Chip Microcontroller – Working with Infineon DEMS kit – Case study on applications of DEMS.

Textbooks

1. Joerg Schaeuffele, Thomas Zurawka, "Automotive Software Engineering Principles, Processes, Methods and Tools", SAE International, 2nd Edition, 2016.

2. BOSCH Automotive Handbook, 9th Edition, 2014.

3. Infineon Aurix, TC27x C-Step Handbook, V2.2, 2014.

Reference books

1. Denton. T, "Automobile Electrical and Electronic Systems",4th Edition, 2012.

2. Nicholas Navit, "Automotive Embedded System Handbook", CRC Press, Taylor and Francis Group, 2009.

3. Ronald K. Jurgen, "Automotive Electronics Handbook", McGraw Hill Publications, 1999.

Grading Policy

Pattern I - Two Assessment Component (Each Carries 50 Marks)		
Assignment – 1	**Assignment – 2**	**Total**
50	**50**	**100**

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U18ECO0003 Advance Mobile technology: NFV, LTE & 5G

L	T	P	J	C
3	0	0	0	3

Description

This course aims to give insight into emerging mobile technology. Beginning with LTE and its protocols, this will introduce 5G core with the opportunities it brings in and the associated challenges. This will also cover the NFV concepts and how they are being practiced in industry.

Objectives

- To understand the working of LTE call flows
- To visualize the standards evolution in mobile communication field
- To understand the basics of 5G technology
- To study cloud computing platform to achieve NFV

Expected Outcomes

- Protocol level understanding of LTE
- Know-how of 5G
- Visualize next generation communication techniques
- Understand how cloud computing enables NFV in telecom

Expected Audience

Students from Communication background and Computer science & IT

Teaching methodology

- Classroom teaching/Board with chalk piece
- Power Point Presentation/ Demonstration videos
- Guest lectures by experts / Field Trip (optional)

Modules covered	Title	Hours
Module / Unit -1	Mobile communication basics (2G & 3G)	9
Module / Unit - 2	LTE: interfaces & protocols	9
Module / Unit - 3	VoLTE	9
Module / Unit - 4	5G core basics	9
Module / Unit - 5	VNF & cloud computing basics	9

Textbooks

1. Dahlman, E., Parkvall, S., & Skold, J., "4G: LTE/LTE-advanced for mobile broadband," Academic Press, 2013.
2. Dahlman, E., Parkvall, S., & Skold, J., "5G NR: The next generation wireless access technology, Academic Press, 2020.

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Online References

1. https://www.3gpp.org/specifications
2. https://www.openstack.org/

Grading Policy

Pattern I - Two Assessment Component (Each Carries 50 Marks)		
Assignment – 1	**Assignment – 2**	**Total**
50	**50**	**100**

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U18ECO0004 **CCNA-CICCO Certified Network Associate**

L	T	P	J	C
2	0	2	0	3

Description
To explore Hardware and Software parts of networking elements. To play along with IoT and IoE.

Objectives
This course is designed to impart knowledge about detailed knowledge of Computer Networks, various protocols used in Communication, Managing and configuring Cisco Switches and Routers and various WAN technologies.

Expected Outcomes
After completion of the course the student will be able to manage Network for an Organization

Expected Audience
- Students across all branches
- Students would be able to access remote devices by assigning individual virtual addresses to them.

Teaching methodology
- Power Point Presentation
- Hands-on Session - 100% Practical session using Cisco Packet Tracer Software and Switch and Router Hardware.

Modules covered	Title	Hours
Module / Unit -1	Introduction to Networks	10
Module / Unit - 2	Routing & Switching Essentials	11
Module / Unit - 3	Scaling Networks	12
Module / Unit - 4	Connecting Networks	12

Textbooks
1. CCNA Routing & Switching, CISCO Press, 2000.

Online Reference
1. https://www.netacad.com/

Grading Policy

Pattern I - Four Assessment Component				
Assignment – 1	**Assignment – 2**	**Assignment – 3**	**Assignment – 4**	**Total**
25	**25**	**25**	**25**	**100**

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U18ECO0005 Introduction to Neural Networks and Deep Learning

L	T	P	J	C
3	0	0	0	3

Description

This course will provide some basic introduction about Neural Networks and Deep Learning Architectures. Also introduce some tools for the implementation of these architectures for various applications.

Objectives

1.To study the basic introduction for Neural Network Architectures.
2. To study the basics of Deep Learning and convolutional networks
3. To learn the tools for the implementation of Neural Networks and Deep Learning Architectures

Expected Outcomes

At the end of this course, the students will be able to
1. Build a Neural Network model for any applications.
2. Demonstrate the basics of convolutional neural Networks and apply for some applications.
3. Write a technical paper on applications related to Neural Networks and Deep Learning Techniques.

Expected Audience

Students having knowledge in basic mathematics and linear algebra.

Teaching methodology

- Lecturing
- Hands-on sessions
- Simulation projects

Module - 1 **10 Hours**

Introduction - What Are Neural Networks: Artificial and biological neural networks, Artificial intelligence and neural networks, Neurons and Neural Networks: Biological neurons, Models of single neurons, Different neural network models.
Introduction to Python concepts and programming. Introduction to Google Colab and Jupiter notebook.

Module - 2 **7 Hours**

Perceptron - Single Layer Perceptrons - Least mean square algorithm. The XOR problem, Multilayer Perceptrons, Hidden Layers, Activation Functions, Model, Loss Function, Training.

Module – 3 8 **Hours**

Implementation of Multilayer Perceptrons - Back-propagation algorithm, Heuristic for improving the back-propagation algorithm, Training Error and Generalization Error, Implementation of Multilayer Perceptrons from Scratch.

Module – 4 **10 Hours**

Layers and Blocks: A Custom Block, The Sequential Block, Executing Code in the Forward Propagation Function, Efficiency, Parameter Management, Custom Layers: Layers without Parameters, Layers with Parameters, Computing Devices: Tensors and GPUs, Neural Networks and GPUs.

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Module – 5 **10 Hours**

Deep Neural Networks: Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG).

Textbooks

1. Laurene Fausett, "Fundamentals of Neural Networks", Prentice Hall India, New Delhi, 2006.

2. Simon Haykin, "Neural Networks", 2nd Edition, Pearson Education, 2008.

Online References and Book

1. https://www.python.org/about/gettingstarted/

2. https://colab.research.google.com/notebooks/intro.ipynb

3. https://www.deeplearningbook.org/

4. Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J. (2023). Dive into deep learning. Cambridge University Press.

Grading Policy

Pattern III- Five Assessment Components (Each Carries 20 Marks)					
Quiz	**Case study presentation**	**Assignment**	**Simulation Project**	**Presentation (Reverse Engg.)**	**Total**
20	**20**	**20**	**20**	**20**	**100**

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U18ECO0006 **CYBER SECURITY**

L	T	P	J	C
2	0	2	0	3

Description

In recent times, the importance of Cyber Security has been tremendously increased due to 'n' no of new & very Harmful Attack Vectors & Malwares. Engineers are professional innovators who work in the realm of attack vectors & threat management and are often the first involved in creating the Protection measures to safeguard our Valuable Data & Assets. The course introduces all aspects of Cyber Security Measures. It also includes case studies & Real time Exposure to fight against Cyber Threats which Threatening Many Valuable IT Resources.

Objectives

- Graduates are prepared to be employed in the field of cyber security and IT industries by providing expected domain knowledge in Cyber Security and Digital Forensic Science.
- Provided with practical training, hands-on and project experience to meet the needs in the field of Digital and Cyber Security
- To understand the importance of protecting their assets and to make protection against the Cyber Threats.
- Achieve advanced knowledge in field of Cyber and Digital Forensic Science to excel professionally in the industry with effective communication to work in a team
- Produce graduates who demonstrate ethical backgrounds and who can articulate the ethical and professional standards of the discipline.

Expected Outcomes

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

- Investigate professionally with ethical responsibility as an individual as well as in multifaceted teams with positive attitude
- Adapt to sustain in emerging era in the field of digital forensic science and constantly upgrade skills towards independent and lifelong learning.
- Develop oral and written communication skills through the sequence of courses, with particular attention to development of the ability to present technical information without bias, at a variety of levels in criminal justice system.
- Design, develop models and provide solutions to cater the needs and to develop the skills to take up research and higher studies in the field of digital forensic science.
- Inculcate skills to excel in the fields of digital forensic science and IT enabled services, Criminology sectors, teaching and Research & Explore new avenues in their career pursuit.

Expected Audience

- Students who want to become security Analyst / Architect
- Students who have innovative ideas and creative knowledge
- Those who are passionate in Learning & Mitigating Cyber Threats.
- Students interested to know about the Latest Malwares & Protection Mechanism.
- Students who are contemplating research and sensitized the importance of SOC (Incident) management in the Nation Securing in the global scenario.

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Teaching methodology

- Class Lecture method
- Power Point Presentation
- Screening Videos
- Guest lecture by experts
- Case studies presentation
- Group discussion and debate
- Quiz program

Module-1: Introduction to Cyber Crime

Introduction - Cyber Crime - Who are Cyber criminals? -Classification of Cyber Crimes - Social Engineering – Cyber stalking – Cyber cafe and cybercrimes – Botnets- Attack vector Security challenges posed by mobile devices - Tools and Methods used in Cyber Crime: Introduction - Proxy servers and Anonymizers - Phishing - Password Cracking-Key loggers and Spywares - Virus and Worms - Trojan Horse and Backdoors – Steganography.

Module-2: Ethical Hacking & Network Security

Overview of Networking & Ethical Hacking: Overview of OSI Model and TCP/IP Protocol. IP Addressing and NAT. Routers and Routing Protocols. Important Terminologies - Asset, Vulnerability, Threat, Risk. Introduction to Hacking, Phases involved in Hacking. Basic Cryptography Concepts. Web based Attacks & web Security – Firewalls, IDS, IPS and IDPS. Malware Terminology: Root kits, Trapdoors, Botnets, Key loggers. Active and Passive Security Attacks. Teardrop, DoS, DDoS, XSS, SQL injection, MITM Attack.

Module-3: Cyber Forensic & Forensic Audio Video Analysis

PGP - S/MIME - Roles of Firewalls – Firewall related terminology- Types of Firewalls - SET for E-Commerce Transactions. Types of CF techniques - Preparation for IR: Creating response tool kit and IR team - Forensics Technology and Systems - Understanding Computer Investigation – Data Acquisition. Processing Crime and Incident. Current Computer Forensics Tools: Software/ Hardware Tools. Validating Forensics Data – Data Hiding Techniques – Image Forensics – CCTV forensics.

Module-4: VAPT & Mobile Device Security

Mobile Devices: Security implications for organizations - Organizational measures for handling mobile - Organizational security policies and measure in mobile computing era – Phishing and Identity Theft: Phishing –Methods – Techniques – Spear phishing – Types of phishing scams – Phishing Toolkits and spy phishing – Phishing counter measures. Identity Theft: Personally identifiable information – Types - Techniques – countermeasures – How to efface your online identity.

Module-5: Incident Response & Security Operations Center (Practical's)

Incident Response – Analyzing Threat vectors – Reporting Generation – Setting up of SOC - Working with SPLUNK – JIIRA Service Ticketing Tool – Malware Analysis – Virus total – Ultimate Windows Security – CVE NVD Exposures. Automated Assessment Tools – Incident Response Planning for disaster and recovery - Evidence Handling – Requirements of Regulated Industries – Intrusion Detection Systems. Network Forensics – Email Investigations – Cell Phone and Mobile Devices Forensics.

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Textbooks

1. Sunit, B., & Nina, G., "Cyber Security: Understanding Cybercrimes, computer forensics and Legal Perspectives," Wiley India, 2011.
2. EC-Council, "Ethical Hacking and Countermeasures: Attack Phases," Cengage Learning, 2016.
3. Nelson, Phillips, Enfinger, Steuart, "Computer Forensics and Investigations", Cengage Learning, India Edition, 2008.

Reference books

1. CEH v10: Certified Ethical Hacker - Version 10 Study - 14 May 2018 and CEH v12.
2. Britz. M., "Computer forensics and cybercrime: An introduction," 2nd Edition, Pearson Education India, 2009.
3. Sean-Philip, O., & Michael, G., "Hacker Techniques, Tools, and Incident Handling, 2010.

Grading Policy

Pattern I - Two Assessment Component (Each Carries 50 Marks)		
Assignment – 1	**Assignment – 2**	**Total**
50	**50**	**100**

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ONE CREDIT COURSES

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U18ECC0001 **ADVANCE SYSTEM DESIGN USING 16BIT ULTRA LOW POWER MICROCONTROLLERS**

L	T	P	J	C
1	0	0	0	1

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Demonstrate the functions of various architectural components of microcontroller from Texas Instruments MSP430 16-bit energy efficient microcontrollers.	K2
CO2	Build the interfacing of the display and memory card to microcontrollers.	K3
CO3	Design the microcontroller based systems by interfacing various sensors and actuators to microcontrollers and work with various applications.	K6

Pre-requisites:

1. U18ECI5206 – Embedded Processor Architecture
2. U18ECI6204 – Microcontroller and its Applications

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												2	
CO2			3	2	3							3	2	
CO3			3	2	3		3					3	3	

Course Assessment methods:

Direct	Indirect
1. Internal Tests 2. Assignment	Course end survey

OVERVIEW **3 Hours**

Review of 16Bit Ultra Low Power Microcontrollers, Introduction to Advanced architecture of 16Bit Ultra Low Power Microcontrollers, clock module configuration, various frequency settings, Introduction to IDE, compiler and linker file configuration, interfacing the IDE and HW development board.

DISPLAY INTERFACE **3 Hours**

Types of LCD Display, Advantages of LCD Display, and Introduction to Dot matrix display, Character Formation, Pixel density, Implementation for 102x64 dot-matrixes LCD Interface.

SENSOR **3 Hours**

Introduction to sensors, Types of Sensors, Need for Integration of sensors, Analog Front end Introduction, Introduction to Temperature Sensor, Implementation of Temperature Sensors, Introduction to Capacitive Touch Sense, Advantages of using capacitive touch sensors. Interfacing with 16Bit Ultra Low Power Microcontrollers.

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MEMORY **3 Hours**

Introduction to memory, various types of memory, Introduction to SD Card, Advantages of using SD card, Types of SD Cards, Interfacing SD Card with 16bit ultra low power controller

SERIAL INTERFACE **3 Hours**

Types of Serial Interface, Advantages of using serial interface, Comparisons between various serial communication standards, Introduction to USB, Types of USB Interfacing Standards, Modes of Interfacing.

Theory: 15	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 15 Hours**

REFERENCES:

1. John H. Davies, MSP430 Microcontroller Basics, 2013.
2. Chris Nagy, Embedded Systems Design Using the TI MSP430 Series, 2013.
3. MSP430 Teach ROM CD.
4. Datasheet, Technical Documents and Application Notes: http://www.ti.com/product/msp430F5529.

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U18ECC0002

ADVANCED MOTOR CONTROL APPLICATION USING 32 BIT REAL TIME CONTROLLERS

L	T	P	J	C
1	0	0	0	1

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Demonstrate the function of various architectural components of TI C2000 Real time controller	K3
CO2	Build the interfacing circuits to interface various sensors and actuators to real time microcontrollers and work with various Digital signal controller's applications	K6
CO3	Design the efficient motor driver circuits and algorithm in digital signal processing domain	K6

Pre-requisites:
1. U18ECI5206 – Embedded Processor Architecture
2. U18ECI6204 – Microcontroller and its Applications

Course Assessment methods:

Direct	Indirect
1. Internal Tests 2. Assignment	Course end survey

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		3											2	
CO2			3	2								2	3	
CO3			3	2		3	2					3	3	

OVERVIEW **3 Hours**

Overview of INSTASPIN, Advantages of using INTASPIN, Architecture of INSTASPIN, Introduction to MotorWare, Types of MotorWare, Advantages of using MotorWare, Implementation of INSTASPIN in Microcontrollers, overview of INSTASPIN based microcontrollers

BLDC MOTOR **4 Hours**

Introduction to Motors, Various Types of Motors, Introduction to BLDC Motors, Commutation of BLDC motors, Sensor less BLDC Motors, Control of BLDC motors.

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MOTORCONTROLDRIVER **3 Hours**

Introduction to motor drivers, Types of Motor Drivers, Advantages of using Motor Drivers, Implementation of Motor Drives, Design consideration for motor drivers usage of Digital Signal Controllers in motor control.

REAL TIME IMPLEMENTATION **5 Hours**

Design Consideration for implementing Motor Control Application, Hardware Flow, Software Flow, and Implementation of INSTASPIN in software, Coding Standards, Real time control of BLDC Motors

Theory: 15	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 15 Hours**

REFERENCES:

1. Hamid Toliyat and Steven Campbell, "DSP based Electromechanical Motion Control", CRC Press, 2003.
2. Sen M. Kuo and Woon-Seng Gan, "Digital Signal Processors – Architectures, Implementations and Applications, Prentice Hall, 2005.
3. Chang-liang Xia, Permanent Magnet Brushless DC Motor Drives and Controls, Wiley Publications, 1995.
4. C2000 Teaching ROM CD.
5. Datasheet, Technical Documents and Application Notes: http://www.ti.com/product/tms320f28335.
6. User Guide and Software Codes: http://www.ti.com/tool/tmdsprex28335.
7. Code Composer Studio v6: http://processors.wiki.ti.com/index.php/Category:Code_Composer_Studio_v6.

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U18ECC0003

ENERGY EFFICIENT MICROCONTROLLERS AND ITS APPLICATIONS

L	T	P	J	C
1	0	0	0	1

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Illustrate the function of various architectural components of microcontroller from Texas Instruments MSP 430 16-bit energy efficient microcontrollers.	K3
CO2	Build interfacing circuits to interface various Digital modules and Timers for a given application.	K6
CO3	Design microcontroller based system by interfacing various sensors and actuators and work with various applications.	K6

Pre-requisites:

1. U18ECI5206 – Embedded Processor Architecture
2. U18ECI6204 – Microcontroller and its Applications

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											3	
CO2			3	2									3	
CO3			3	2			3					3	3	

Course Assessment methods:

Direct	Indirect
1. Internal Tests 2. Assignment	Course end survey

OVERVIEW **3 Hours**

Introduction to CPU Architecture, Basic Block Diagram, Clock Module Overview, clock module configuration, various frequency settings, Introduction to IDE, compiler and linker file configuration, Interfacing the IDE and HW development board.

DIGITAL PERIPHERALS **3 Hours**

Introduction to digital peripherals, Introduction to Input / Output Ports, Modes of operation, Configuration of Digital ports as Input and Output, Introduction to Low Power Modes. Advantages of using Low Power modes, Various Low power mode of operations and settings.

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TIMERS **5 Hours**

Introduction to Timers, Various types of timers in Microcontrollers, Advantages of using timers in Embedded systems, Introduction to Watchdog timer, configuration of watch dog timer and implementation, General Purpose Timer Module introduction, Application and settings and implementation of timers.

ANALOG MODULES **4 Hours**

Introduction to ADC, Need for ADC, Various ADC Modes Of operations, Timing for data conversion, ADC Conversion calculation, Configuration of ADC, DMA Transfer for results.

Theory: 15	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 15 Hours**

REFERENCES:

1. John H. Davies, MSP430 Microcontroller Basics, 2013.
2. Chris Nagy, Embedded Systems Design Using the TI MSP430 Series, 2013.
3. MSP430 Teach ROM CD.
4. Datasheet, Technical Documents and Application Notes: http://www.ti.com/product/msp430g2553.

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L	T	P	J	C
1	0	0	0	1

U18ECC0004 **INTERNET OF THINGS (IoT) USING CC3200**

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Illustrate the architectural blocks in 32-bit microcontrollers and deploy them as suitable solution.	K3
CO2	Demonstrate available embedded networking mechanisms and work with IoT (Internet of Things).	K2
CO3	Illustrate cloud computing and handle the data to stream to the cloud.	K3

Pre-requisites:
1. U18ECI5206 – Embedded Processor Architecture
2. U18ECI6204 – Microcontroller and its Applications

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		3	2										3	3
CO2		3	2			2						3	3	3
CO3		3	2			2						3	3	3

Course Assessment methods:

Direct	Indirect
1. Internal Tests 2. Assignment	Course end survey

OVERVIEW **3 Hours**

Introduction to Internet of Things (IoT). Review of CC3200 core and its architecture, Introduction to advanced ARM Cortex M4 architecture, Peripherals overview, User API, Power challenges with IoT, CC3200 Simple link applications, Starting with Code Composer Studio V6.

SIMPLELINK WI-FI CPU **2 Hours**

Introduction to CC3200 Simple link Wi-Fi MCU, hardware Functional Block Diagram, Embedded Software Overview, TI-RTOS support for CC3200 Simple link, TI-RTOS configuration for CC3200 Simple link, Simple link Wi-Fi certification, Power Modes.

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WLAN CONNECTION **2 Hours**

Introduction to WLAN, WLAN parameters, AP/STATION modes and its Security types, Socket connection, Typical commends and event flow, WLAN AP and WLAN STATION configuration settings.

SOFTWARES **2 Hours**

Introduction to Pin-Mux Tool, Configuration with Pin-Mux Tools, Introduction to Uniflash, Debugging with Uniflash Tools, HTML page Download.

HANDS-ON WITH CC3200 **6 Hours**

Brief introduction to CC3200 Peripherals, OUT OF BOX demo, Home and Industrial automation and control, Creating project0, programming with ADC, Programming with GPIO, enabling interrupt, Introduction to serial interface, Overview of sensor interface with CC3200, TI RTOS configuration in CCS workspace, Client severer model basics, Simple Email application, Emailing an sensor (ADC) value.

Theory: 15	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 15 Hours**

REFERENCES:

1. Jonathan W Valvano, Introduction to ARM(r) Cortex -M Microcontrollers, 2012.
2. Andrew Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide, 2004.
3. Datasheet, Technical Documents and Application Notes http://www.ti.com/product/CC3200

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U18ECC0005 **AUTOMOTIVE COMMUNICATION SYSTEMS**

L	T	P	J	C
1	0	0	0	1

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Illustrate OSEK communication structures.	K3
CO2	Demonstrate CAN BUS protocols	K3
CO3	Illustrate on-vehicle and off-vehicle communications	K3

Pre-requisites:
1. U18ECI5203- Communication Networks

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3		2						3					2
CO2	3		2						3					2
CO3	3		2						3					2

Course Assessment methods:

Direct	Indirect
1. Internal Tests 2. Assignment	Course end survey

BASICS AUTOMOTIVE ELECTRONICS **6 Hours**

Automotive Embedded System, Sensors, Actuators, Power train Management System (Gasoline, Diesel, Hybrid), Active Safety System -- Electronic Stability Program (Antilock Braking System, Antislip Regulation), Passive Safety Systems - Air Bags, Seatbelt Tensioners, Steering System, Night vision, Park Assistance, Cruise Control, Speed Limiter & System Testing. Vehicle Network Architecture

OSEK – COMMUNICATION STRUCTURE **3 Hours**

Introduction – Message Transmission, Message Reception, Deadline Monitoring, Notification, Communication System Management, Functional Model of the interaction Layer, Network Management (Direct and Indirect). Impacts upon OS, COM and the data link layer

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CAN BASICS **3 Hours**

CAN BUS: Overview, CAN Bus Overview, The Development of CAN, CAN BUS and the OSI Model, CANBUS Physical Layer, Message Oriented Transmission Protocol, Message Format, Bus Arbitration, Basic Bit Encoding and CAN Frames.

ON VEHICLE AND OFF VEHICLE **3 Hours**

Introduction to On Vehicle Communication and Off Vehicle Communications, Need for Services, Introduction to Universal Diagnostic Services, in depth understanding of Diagnostic Services.

Theory: 15	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 15 Hours**

REFERENCES:

1. Wolfhard Lawrenz, "CAN System Engineering-From Theory to Practical Applications", Second Edition, Springer-Verlag London, 2013.

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U18ECC0006

URBAN MINING AND ELECTRONIC RESOURCE FROM E-WASTE

L	T	P	J	C
1	0	0	0	1

Course Outcomes (COs):

After successful completion of this course, the students will be able to

CO1	Demonstrate the effect of E-waste on people's health and environment	K2
CO2	Illustrate the value in e-waste and the ways to extract them to support local economy	K2
CO3	Develop sustainable e-waste recovery and recycling business models	K3

Pre-requisites: --

CO/PO Mapping

(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1						3	3	3						
CO2						3	3	3						
CO3						3	3	3						

Course Assessment methods:

Direct	Indirect
1. Internal Tests 2. Assignment	Course end survey

OVERVIEW **2 Hours**

Introduction on E-waste management – Circular Economy-Ideology-Recycling of E-waste.

E-WASTE/WEEE - EXPOSURE PATHWAY OF POLLUTANTS **3 Hours**

Types of E-waste - Composition of E-waste –Challenges- Pathway of pollutants from E-waste- Informal and formal processing of E-waste.

LEGISLATION AND POLICY ON E-WASTE MANAGEMENT **3 Hours**

E-waste management rules 2011, 2016 – Amendments of E-waste rules 2017 and 2018 – Implementation of rules- Casestudies - Stakeholders– Basel convention, Rotterdam, and Stockholm Conventions

VULNERABILITY OF E-WASTE **3 Hours**

Life cycle analysis- IT asset management - Importance of data processing - Recycling techniques and disposal methods.

GREEN BUSINESS **4 Hours**

Current trends on global and Indian market – Key aspects on flow of e-waste - Opportunities on E-waste- Unique initiatives around the world– Circular economy.

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REFERENCES:

1. Joon, V, Shahrawat, R, Kapahi, M., "The Emerging Environmental and Public Health Problem of Electronic Waste in India", Journal of Health and Pollution 2017, 7 (15), 1-7.

2. Ghosh, B, Ghosh, M, Parhi, P, Mukherjee, P, Mishra, B., "Waste printed circuit boards recycling: an extensive assessment of current status", Journal of Cleaner Production 2015, 94, 5-19.

3. Mary, J. S, Meenambal, T, "Inventorisation of E-Waste and Developing a Policy–Bulk Consumer Perspective", Procedia Environmental Sciences 2016, 35, 643-655.

4. Amit Jain et al., 2006, e-waste assessment methodology and validation in India.

5. Anwesha Borthakur et al., 2013, Generation of electronic waste in India: Current scenario, dilemmas and Stakeholders.

6. Dharna Tiwari et al.,2014, International Journal of Environmental Research and Development, India

7. DIT, 2003, Environmental management for Information Technology industry in India, Dept. of Information Technology, Govt. of India.

8. E-waste management rules 2016, E- Waste (Management) Amendment Rules 2017 and 2018 E-waste (management and handling) rules 2011.

Theory: 15	Tutorial: 0	Practical: 0	Project: 0	Total: 15 Hours

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U18ECC0506 **HANDS-ON COURSE IN DIGITAL SYSTEM DESIGN USING HDL**

L	T	P	J	C
0	0	2	0	1

Course Outcomes (COs):
After successful completion of this course, the students will be able to

CO1	Demonstrate the steps involved in the VLSI design flow	K3
CO2	Design advanced digital systems	K6
CO3	Design and implement HDL in FPGA kits	K6

Pre-requisites:

1. U18CSI1202 - Problem Solving and Programming using C
2. U18ECI4202 - Analog Electronics and Integrated Circuits
3. U18ECI 3203 - Digital System Design

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PROGRAMME OUTCOMES													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1			3	2	3								3	
CO2			3	2	3	3	3					3	3	
CO3			3	2	3	2						3	3	

Course Assessment methods:

Direct	Indirect
1. Internal Tests 2. Assignment	Course end survey

LAB EXPERIMENTS

DESIGN AND IMPLEMENTATION OF

1. **LED & LCD.**
   FPGA pin configuration using Plan ahead
   Industrial standard HDL Coding development
   Gate Level Simulation
   Implementation in FPGA kit
   Output analyzed with testing and verification

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2. **7 Segment Display.**
   FPGA pin configuration using Plan ahead
   Industrial standard HDL Coding development
   Gate Level Simulation
   Implementation in FPGA kit
   Output analyzed with testing and verification

3. **Analog to Digital Converter.**
   FPGA pin configuration using Plan ahead
   Industrial standard HDL Coding development
   Gate Level Simulation
   Implementation in FPGA kit
   Output analyzed with testing and verification

4. **Communication protocol Intellectual Properties (SPI, I2C, UART).**
   FPGA pin configuration using Plan ahead
   Industrial standard HDL Coding development
   Gate Level Simulation
   Implementation in FPGA kit
   Output analyzed with testing and verification

5. **Communication Devices (Bluetooth, IR, RFID, Zig Bee, GSM, GPS).**
   FPGA pin configuration using Plan ahead
   Industrial standard HDL Coding development
   Gate Level Simulation
   Implementation in FPGA kit
   Output analyzed with testing and verification

6. **Timer & PWM.**
   FPGA pin configuration using Plan ahead
   Industrial standard HDL Coding development
   Gate Level Simulation
   Implementation in FPGA kit
   Output analyzed with testing and verification

Theory: 0	**Tutorial: 0**	**Practical: 60**	**Project: 0**	**Total: 60 Hours**

REFERENCES:

1. Douglas A. Pucknell, K. Eshragian, “Basic VLSI Design”, Third edition, PHI, 2009.
2. Neil.H.E. Weste, Kamaran Eshraghian, “Principles of CMOS VLSI Design”, Second Edition, Addison Wesley Publications, 2002.
3. Samir Palnitkar, “Verilog HDL–Guide to Digital design and synthesis”, Second Edition Pearson Education, 2009.
4. Wayne Wolf, “Modern VLSI Design”, Pearson Education, 2003.

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Signature of BOS Chairperson, ECE