B.TECH. ELECTRONICS & COMMUNICATION ENGINEERING

COURSE STRUCTURE

Approved in Academic Council held on 25.10.2018

Department of Electronics & Communication Engineering

PROGRAM OUTCOMES

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Approved in Academic Council held on 25.10.2018

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 1st SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS111	English and Technical Communication	2	0	0	2	2
2	HSS	18B17HS171	English and Technical Communication Lab	0	0	2	1	2
3	Basic Sciences	18B11MA111	Engineering Mathematics-I	3	1	0	4	4
4	Basic Sciences	18B11PH111	Engineering Physics-I	3	1	0	4	4
5	Basic Sciences	18B17PH171	Engineering Physics Lab-I	0	0	2	1	2
6	Engg Science	19B11CI111	Programming for Problem Solving-II	2	0	0	2	2
7	Engg Science	18B17GE173	Engineering Graphics **OR**	0	0	3	1.5	3
		18B17GE171	Workshop Practices					
8	Engg Science	19B17CI171	Programming for Problem Solving Lab-II	0	0	4	2	4
9		18B17GE172	Mandatory Induction Program	-	-	-	-	-
							17.5	23

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 2nd SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Basic Sciences	18B11MA211	Engineering Mathematics-II	3	1	0	4	4
2	Basic Sciences	18B11PH211	Engineering Physics-II	3	0	0	3	3
3	Basic Sciences	18B11PH271	Engineering Physics Lab-II	0	0	2	1	2
4	Engg Science	18B11EC211	Electrical Science	3	1	0	4	4
5	Engg Science	18B17EC271	Electrical Science Lab	0	0	2	1	2
6	Engg Science	18B17GE171	Workshop Practices **OR**	0	0	3	1.5	3
		18B17GE173	Engineering Graphics					
7	Engg Science	18B17CI211	Data Structures and Algorithms	3	1	0	4	4
8	Engg Science	18B17CI271	Data Structures and Algorithms Lab	0	0	4	2	4
							20.5	26

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 3rd SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS311	Interpersonal Dynamics, Values and Ethics	3	0	0	3	3
2	Basic Sciences	18B11MA314	Probability Theory and Random Processes	3	1	0	4	4
3	Engg Science	18B11EC313	Electronic Devices & Circuits	3	1	0	4	4
4	Engg Science	18B17EC373	Electronic Devices & Circuits Lab	0	0	2	1	2
5	Professional Core	18B11EC311	Automatic Control Systems	3	0	0	3	3
6	Professional Core	18B17EC371	Automatic Control Systems Lab	0	0	2	1	2
7	Professional Core	18B11EC312	Digital Electronics & Logic Design	3	1	0	4	4
8	Professional Core	18B17EC372	Digital Electronics & Logic Design Lab	0	0	2	1	2
							21	24

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 4th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS411	Finance and Accounts	3	0	0	3	3
2	Basic Sciences	18B11MA413	Discrete Mathematics	3	0	0	3	3
3	Engg Science	18B17EC474	Python Lab	0	0	2	1	2
4	Professional Core	18B11EC411	Analog Integrated Circuits	3	0	0	3	3
5	Professional Core	18B17EC471	Analog Integrated Circuits Lab	0	0	2	1	2
6	Professional Core	18B11EC412	Fundamentals of Signals & Systems	3	1	0	4	4
7	Professional Core	18B17EC472	Fundamentals of Signals & Systems Lab	0	0	2	1	2
8	Professional Core	18B11EC413	Modern Analog and Digital Communication	3	1	0	4	4
9	Professional Core	18B17EC473	Modern Analog and Digital Communication Lab	0	0	2	1	2
10			Environmental Studies	2	0	0	0	2
							21	27

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 5th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS511	Project Management and Entrepreneurship	3	0	0	3	3
2	Professional Core	18B11EC511	Principles of Digital Signal Processing	3	1	0	4	4
3	Professional Core	18B17EC571	Principles of Digital Signal Processing Lab	0	0	2	1	2
4	Professional Core	18B11EC512	Microprocessor and Interfacing	3	0	0	3	3
5	Professional Core	18B17EC572	Microprocessor and Interfacing Lab	0	0	2	1	2
6	Professional Core	18B11EC513	Electromagnetic Waves	3	1	0	4	4
7	Engg. Science		Science Elective	3	0	0	3	3
8	Professional Elective		Professional Elective-I	3	0	0	3	3
							22	24

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 6th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11EC611	Wireless and Data Communication	3	0	0	3	3
2	Professional Core	18B11EC612	VLSI Technology	3	1	0	4	4
3	Professional Core	18B11EC671	Mini Project	0	0	2	1	2
4	Professional Core	18B17EC672	VLSI Technology Lab	0	0	2	1	2
5	Professional Core	18B17EC673	Advance Communication Lab	0	0	2	1	2
6	Open Elective		Open Elective-I/MOOCs (**HSS Elective**)	3	0	0	3	3
7	Open Elective		Open Elective-II / MOOCs	3	0	0	3	3
8	Open Elective		Open Elective-III / MOOCs	3	0	0	3	3
9	Professional Elective		Professional Elective-II	3	0	0	3	3
10			Industrial Training				0	0
							22	25

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 7th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Project	18B19EC791	Project Part-I				7	7
2	HSS		Indian Constitution	1	0	0	0	1
3	Open Elective		Open Elective-IV/ MOOCs	3	0	0	3	3
4	Professional Elective		Professional Elective-III	3	0	0	3	3
5	Professional Elective		Professional Elective-IV	3	0	0	3	3
							16	17

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 8th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective		Open Elective V/ MOOCs	3	0	0	3	3
2	Professional Elective		Professional Elective-V	3	0	0	3	3
3	Professional Elective		Professional Elective-VI	3	0	0	3	3
4	Professional Elective		Professional Elective-VII	3	0	0	3	3
5	Project	18B19EC891	Project Part-II				8	8
							20	20

TOTAL CREDITS	160
TOTAL HOURS	186
HSS	12
Basic Science	24
Engg. Science	27
Professional Core	46
Professional Elective	21
Open Elective	15
Project	15

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-I

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC534	Network Analysis and Synthesis	3	0	0	3	3
2	Professional Elective	18B1WEC535	Communication Engineering	3	0	0	3	3
3	Professional Elective	18B1WEC536	Fundamentals of Digital Image Processing	3	0	0	3	3
4	Professional Elective	20B1WEC534	AVR Based Embedded System Design	2	0	0	2	2
5	Professional Elective	20B1WEC571	AVR Based Embedded System Design Lab	0	0	2	1	2

PROFESSIONAL ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC631	Digital Filter Design and Applications	3	0	0	3	3
2	Professional Elective	18B1WEC632	Intelligent Control Systems	3	0	0	3	3
3	Professional Elective	18B1WEC633	Optical Communication Systems	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-III

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC746	Microwave Theory and Techniques	3	0	0	3	3
2	Professional Elective	18B1WEC745	Next Generation Communication Systems	3	0	0	3	3
3	Professional Elective	18B1WEC744	FPGA based Instrumentation System Design	3	0	0	3	3
4	Professional Elective	18B1WEC743	Optimum Array Processing	3	0	0	3	3
						Total	3	3

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-IV

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC742	Antenna and Wave Propagation	3	0	0	3	3
2	Professional Elective	18B1WEC736	OFDM and Applications	3	0	0	3	3
3	Professional Elective	18B1WEC737	Robotic Systems and Control	3	0	0	3	3
4	Professional Elective	18B1WEC738	Time Frequency Analysis and Applications	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-V

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC852	Design of Modern Antennas	3	0	0	3	3
2	Professional Elective	18B1WEC851	Soft Computing Techniques	3	0	0	3	3
3	Professional Elective	18B1WEC850	Fault Tolerant Communication Systems	3	0	0	3	3
4	Professional Elective	18B1WEC849	Cognitive Radio Networks	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-VI

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC848	RF Engineering	0	0	3	3	3
2	Professional Elective	18B1WEC847	Medical Image Processing	3	0	0	3	3
3	Professional Elective	18B1WEC846	Design of Dependable Systems	3	0	0	3	3
4	Professional Elective	18B1WEC838	Artificial Intelligence Techniques	3	0	0	3	3
						Total	3	3

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-VII

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC839	Radar Principles and Applications	3	0	0	3	3
2	Professional Elective	18B1WEC840	Industrial Automation and Control	3	0	0	3	3
3	Professional Elective	18B1WEC841	Bio Electronic Sensors	3	0	0	3	3
4	Professional Elective	18B1WEC842	Optical Networks	0	0	3	3	3
						Total	3	3

OPEN ELECTIVE-I (HSS)

OPEN ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC635	Principles of Communication Systems	2	0	0	2	2
2	Open Elective	18B1WEC672	Principles of Communication Systems Lab	0	0	2	1	2
3	Open Elective	18B1WEC636	Fundamentals of Digital Signal Processing and Applications	2	0	0	2	2
4	Open Elective	18B1WEC673	Fundamentals of Digital Signal Processing Lab	0	0	2	1	2
5	Open Elective	20B1WEC731	Automation and Robotics	3	0	0	3	3
6	Open Elective	20B1WEC732	Machine Learning for Wireless Communications	3	0	0	3	3
7	Open Elective	20B1WEC733	Signal Processing for Machine Learning	3	0	0	3	3

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

OPEN ELECTIVE-III

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC637	Principles of Wireless Communication	2	0	0	2	2
2	Open Elective	18B1WEC674	Principles of Wireless Communication Lab	0	0	2	1	2
3	Open Elective	18B1WEC639	Software Defined Radio and Applications	2	0	0	2	2
4	Open Elective	18B1WEC676	Software Defined Radio Lab	0	0	2	1	2
5	Open Elective	20B1WEC734	Digital Systems	3	0	0	3	3
6	Open Elective	20B1WEC735	Artificial Intelligence Techniques for Genomic Signal Processing	3	0	0	3	3
7	Open Elective	20B1WEC736	Image Sensing and Reconstruction	3	0	0	3	3

OPEN ELECTIVE-IV

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC739	Optimization Techniques in Engineering	3	0	0	3	3
2	Open Elective	18B1WEC740	Electrical Machines	3	0	0	3	3
3	Open Elective	18B1WEC741	Biomedical Signal Processing	3	0	0	3	3
4	Open Elective	20B1WEC731	Automation and Robotics	3	0	0	3	3

OPEN ELECTIVE-V

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC843	Industrial Internet of Things	3	0	0	3	3
2	Open Elective	18B1WEC844	Wireless Ad Hoc and Sensor Networks	3	0	0	3	3
3	Open Elective	18B1WEC845	Satellite Communication	3	0	0	3	3
						Total	3	3

B.TECH. ELECTRONICS & COMMUNICATION ENGINEERING

SYLLABUS

Electrical Science

COURSE CODE: 18B11EC211

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: None

Course Objectives:

1. To introduce various circuit elements.
2. To analyze different DC and AC circuits using various circuittheorems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic parameters related to DC and AC circuit.	Familiarity
CO-2	Understanding electrical principle, laws, and working of electrical machines.	Familiarity
CO-3	Understanding different theorems to analyze DC and AC circuits.	Usage
CO-4	Understanding sinusoidal steady state analysis of various AC circuits.	Usage
CO-5	Demonstrate knowledge of and apply the theory of transformers and induction motors.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	DC Circuits: Electrical circuit elements (R, L and C), Voltage and current sources, series and parallel combination of elements, star and delta connections, Kirchhoff current and voltage laws, analysis of simple circuits and dc excitation using Node and Mesh analysis. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits	9
2	AC Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase AC circuits consisting of R, L, C, RL, RLC combinations (series and parallel), resonance.	9
3	Sinusoidal steady state analysis: Representation of sine function, Phasor diagrams, Impedance and admittances, AC circuit analysis, Effective or RMS values, Average power and Complex power.	8
4	Transformers: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.	5
5	Electrical Installations: Types of wires and cables, earthling, types of batteries, important characteristics for batteries, elementary calculations for energy consumption, power factor improvement and battery backup.	5
6	Electrical Machines: Introduction to machines, single-phase induction motor, construction, working, loss components and efficiency, staring and speed control of induction motor.	6
	Total lectures	42

Suggested Text Book(s):

1. W.H. Hayt, J. E. Kemerlay & S.M. Durbin: Engineering Circuit Analysis, 6th Ed., TATA McGraw Hill, 2006.
2. J. Hiley, K. Brown, & I.M. Smith: Electrical and Electronic Technology, 10th Ed., Pearson, 2019.
3. D.C. Kulshreshtha: Basic Electrical Engineering, 1st Ed., McGraw Hill Education, 2011.

Suggested Reference Book(s):

1. Ozgur Ergul: Introduction to Electrical Circuit Analysis, 1st Ed., Wiley , 2017.
2. V.N. Mittle and Arvind Mittal: Basic Electrical Engineering, 2nd Ed., Tata McGraw Hill, 2015.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/108102097/3 (Prof. S.C. Dutta Roy, IIT Delhi)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Electrical Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	1	1	1	1	1	3	2
CO-2	3	2	2	2	3	2	1	1	1	1	2	3	1.92
CO-3	3	3	3	3	2	2	1	1	1	1	1	3	2
CO-4	3	3	3	3	2	2	1	1	1	1	1	3	2
CO-5	3	3	3	3	3	2	1	1	1	1	2	3	2.17
Average	3	2.8	2.8	2.8	2.4	2	1	1	1	1	1.4	3	

Electrical Science Lab

COURSE CODE: 18B17EC271

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. The primary objective of this course is to provide a thorough understanding of circuit analysis and measurement of various electrical parameters.
2. Analysis of a given circuit depending on types of elements - DC analysis, Transient analysis and Frequency analysis.
3. To acquire hands on experience of conducting various experiments on electrical machines.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understanding basic electrical sources and measuring devices: Power supply, Multimeter, CRO/DSO and Function Generator.	Familiarity
CO2	Understand the basic working principle of a transformer and the operation of electrical machines.	Usages
CO3	Practical implementation of the fundamental electrical theorems and modeling of simple electrical systems.	Usages
CO4	Accurate measurement of voltage, current, power and impedance of any circuit.	Usages
CO5	DC analysis, Transient analysis and Frequency analysis of a given circuit depending on types of elements.	Assessment
CO6	Teamwork skills for working effectively in groups and develop analytical skills to compare experimental results with theoretical concepts.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to Power supply & Multimeter.	2
2	To determine the equivalent resistance of a circuit using color code and to verify it using a multimeter. To verify Voltage divider and Current divider.	2
3	To verify Delta to Star and Star to Delta conversion.	2
4	Introduction to CRO & Function Generator	2
5	To verify Kirchoff's voltage law (KVL) and Kirchoff's Current Law (KCL)	2
6	To verify Superposition Theorem	2
7	To verify Norton's Theorem	2
8	To verify Thevenin's Theorem and Maximum Power Transfer Theorem	2
9	To study the transient response of series RC circuits using different values and R and C	2
10	Determination of frequency response of current in RLC circuit with sinusoidal ac input	2
11	To determine the turns ratio and polarities of transformer windings.	2
12	To obtain the equivalent circuit parameters from OC and SC tests, and to estimate efficiency & regulation at various loads.	2
Total Lab hours		24

Approved in Academic Council held on 25.10.2018

Suggested Resources:

1. W.H. Hayt, J. E. Kemerlay & S.M. Durbin, “Engineering Circuit Analysis”, Eighth Edition, McGraw Hill, 2012.
2. Van Valkenburg, “Network Analysis”, Prentice-Hall India, 2001.
3. D.C. Kulshreshtha, “Basic Electrical Engineering”, First Edition, McGraw Hill, 2011.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Program Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	2	2	2	3	1	1	1	1	1	1.92
CO2	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	3	2	3	3	3	2	1	1	1	1	1	1	1.83
C06	3	3	3	3	2	2	2	3	2	2	2	2	2.42
Average	3.00	2.83	2.83	2.50	2.50	2.17	1.67	1.33	1.17	1.17	1.33	1.17	

Electronic Devices and Circuits

COURSE CODE: 18B11EC313

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: None

Course Objectives:

1. Understanding the principle of operation of various electronic devices.
2. Learn characteristics and applications of Diode, Bipolar junction Transistor and Field effect transistors for the design and analysis of variety of electronic circuits.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the construction and working of a diode and its application as an electronic switch. Its use in clipper and clamper circuits as a wave shaping electronic component.	Familiarity
CO-2	Understand the construction and working of a BJT and the different biasing networks used to stabilize the operating point for it to work in the active region or saturation and cut off region.	Familiarity
CO-3	Small signal analysis of BJT using the transistor and hybrid equivalent models. Estimation of various parameters (gain, input/output impedance) of CE and CB configurations.	Assessment
CO-4	Understand the construction and working of a JFET, Depletion type and enhancement type MOSFET. Applications of JFET, and CMOS in design of logic gates.	Assessment
CO-5	Understanding the various biasing schemes for FET amplifiers, and FET small signal analysis using Ac equivalent model.	Usage
CO-6	Understanding the Low-frequency response of BJT amplifier, Low- frequency response of FET amplifier, High frequency transistor models, frequency response of single stage and multistage amplifiers.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Intrinsic and extrinsic semiconductor, Charge carriers, Energy bands, Carrier transport: diffusion current, drift current, mobility and resistivity, Poisson and continuity equation, P-N junction characteristics, I-V characteristics, and small signal switching models, Diode Equivalent Circuits, Diode equation, Ideal diode, Zener and avalanche breakdown, Zener diode, Diode Circuits: Half-wave and full-wave rectifiers, Clippers, Clampers, Voltage regulator.	7
2	Transistor construction & operation, Various configurations (such as CE, CB, CC) and their I/O characteristics, Biasing schemes for BJT amplifiers, Transistor Saturation, Load-Line Analysis, Bias stability.	8
3	Transistor models (transistor and hybrid equivalent models), Estimation of various parameters (gain, input/output resistance) of CE, CB and CC transistor amplifiers, Effect of R_L and R_S.	8
4	Basic construction, operation and characteristics of JFETs, Depletion- type MOSFET and Enhancement-type MOSFET, Various configurations (such as CS, CG, CD) of FETs and their features	6
5	Various biasing schemes for FET amplifiers, Q-point, Bias stability, FET small signal analysis: Model, AC equivalent circuit	8

6	Low-frequency response of BJT amplifier, Low-frequency response of FET amplifier, High frequency transistor models, frequency response of single stage and multistage amplifiers.	5
Total lectures		42

Suggested Text Book(s):

1. Robert L. Boylestad and Lois Nashelsky "Electronic Devices and Circuit Theory", 9th Edition, PHI, 2007.

Suggested Reference Book(s):

1. Sedra Smith, "Microelectronic Circuits", 5th Edition, Oxford Press, 2012.
2. Bell "Electronic Devices and Circuits", 5th Edition, Oxford Press, 2011.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117103063/
2. Link to topics related to course: https://ocw.mit.edu/courses/electrical-engineering-and-computer- science/6-012-microelectronic-devices-and-circuits-spring-2009/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Class performance, Tutorials & Assignments - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Electronic Devices and Circuits)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	1	3	3	3	3	2	2	2	1	2	1	2.17
CO-2	3	3	3	2	3	2	2	1	1	2	2	2	2.17
CO-3	3	2	3	2	2	2	2	1	1	1	1	1	1.75
CO-4	3	3	3	3	3	3	2	2	2	2	2	2	2.5
CO-5	3	3	3	2	3	1	1	2	2	1	1	2	2
CO-6	3	3	3	3	3	2	2	2	1	2	1	2	2.25
Average	3	2.5	3	2.5	2.84	2.17	1.84	1.67	1.5	1.5	1.5	1.67	

Electronic Devices and Circuits Lab

COURSE CODE: 18B17EC373

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: None

Course Objectives:

1. To analyze the characteristics and applications of Diode, BJT, and FET.
2. To design the amplifiers using BJT & FET and analyze their frequency responses

Course Outcomes:

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

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the V-I characteristics of diodes and its application as a switch and in wave shaping circuits.	Familiarity
CO-2	Design of voltage regulator circuits using zener diode and half wave / full wave rectifiers using PN junction diodes.	Familiarity
CO-3	Understand the V-I characteristics of BJTs and its use in design of voltage and current amplifiers	Usage
CO-4	Understand the Drain and transfer characteristics of FETs and its use in design of logic gates	Usage
CO-5	Design of single stage RC coupled amplifiers using BJTs and verifying the AC equivalent model for them.	Assessment
CO-6	Study the frequency response of BJTs and FETs	Assessment

List of Experiments

S. No	Description	Hours
1	To plot the characteristics of a diode in forward and reverse biased conditions.	2
2	i) To plot the Zener diode characteristics and find the Zener voltage. ii) To plot its transfer characteristics for a given load.	2
3	To implement a Half-Wave Rectifier circuit with and without a capacitive filter and to calculate its ripple factor.	2
4	To implement a full-Wave Rectifier circuit with and without a capacitive filter and to calculate its ripple factor.	2
5	To implement diode clipper and clampers circuits and observe the output waveforms on the CRO.	2
6	To plot input and output characteristics of a transistor in Common- Emitter configuration.	2
7	To compare the performance of fixed bias, emitter stabilized bias and voltage divider bias circuit.	2
8	To investigate the effect of R2 and RE on the stability of operating point for voltage divider bias circuit.	2
9	To design single stage CE amplifier using BJT and calculate the h- parameter model.	2
10	To plot the drain and transfer characteristics of a JFET in common- source configuration.	2
11	To design a two stage RC coupled amplifier and observe frequency response	2

12	To design a RC coupled amplifier and observe frequency response	2
Total Lab hours		24

Suggested Resources:

1. Robert L. Boylestad and Lois Nashelsky “Electronic Devices and Circuit Theory”, 9th Edition, PHI, 2007.
2. Sedra Smith, “Microelectronic Circuits”, 5th Edition, Oxford , 2012.
3. Bell “Electronic Devices and Circuit ”, 5th Edition, Oxford, 2011
4. Link to NPTEL course contents: https://nptel.ac.in/courses/117103063/
5. Link to topics related to course: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic- devices-and-circuits-spring-2009/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Average	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.17	1.17	1.17	1.3	1.5	

Automatic Control Systems

COURSE CODE: 18B11EC311

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: Fundamentals of Electrical Circuits

Course Objectives:

1. To understand procedures for developing mathematical models of physical systems, and related analytical and numerical methods for predicting their behavior.
2. To develop the skills of designing compensating networks according to the desired design specifications.
3. To understand and design advance control systems for industrial applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	The ability to analyze any physical system using mathematical model.	Familiarity
CO-2	The skill to analyze the response of any LTI system.	Assessment
CO-3	The ability to design control system with desired specifications both in time and frequency domain.	Assessment
CO-4	The ability to derive, interpret and solve problems using modern state space control methods for continuous time and discrete time systems.	Assessment
CO-5	The skill to apply advance control schemes for various applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Control System Concepts and Classification: Open loop, Closed loop, Continuous, Discrete, Linear and non-linear control systems	2
2	Mathematical Models of Systems: Laplace and z-transform, Impulse response and transfer function, Block-diagram model and signal flow graphs, Masons gain formula	5
3	Time Domain Analysis: Standard test input signals, Transient and steady state responses of first and second order systems, Steady state errors, Control of transient response, Basic control actions and their effects on transient and steady state responses	7
4	Stability Analysis: Absolute stability, Relative stability, Routh- Hurwitz criterion, Root loci, Properties and construction of root loci, Effects of adding and moving poles and zeros, Root locus of conditionally stable systems	7
5	Frequency Domain Analysis: Frequency response, Frequency domain specifications, Bode and Nyquist plots, Gain margin and phase margin, Conditionally stable system	6
6	Compensator Design: Introduction, Phase lead compensation, Phase lag compensation, Design of phase-lead and phase-lag compensation by Bode plot and root locus methods, Concepts and applications of P, PD, PI and PID controllers	6
7	State Variable Technique: Derivation of state model of LTI continuous time systems, State equations, State transition matrix, Solution of state equations, Stability, Controllability and observability	5
8	Basics of Nonlinear System Analysis: Linearization, Describing function and Phase plane methods, Stability concepts and Lyapunov functions	4
Total lectures		42

Suggested Text Book(s):

1. M. Gopal, “Control Systems: Principle and Design”, 4th Edition, Tata McGraw-Hill, 2012.
2. B.C. Kuo, “Automatic Control Systems”, 9th Edition, Wiley India, 2014.

Suggested Reference Book(s):

1. K. Ogata, “Modern Control Engineering”, 5th Edition, Pearson Education, 2010.
2. R.C. Dorf and R.H. Bishop, “Modern Control Systems”, 12th Edition, 2007.
3. N. S. Nise, “Control Systems Engineering”, 7th Edition, Wiley India, 2013.

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/108102043/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Automatic Control Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	1	2	1	1	1	1	2	1.7
CO-2	3	2	1	3	2	1	1	1	1	1	1	2	1.6
CO-3	3	3	2	1	2	1	1	1	1	1	1	2	1.6
CO-4	3	3	3	1	2	1	1	1	2	1	1	2	1.8
CO-5	3	2	2	2	3	1	1	1	1	1	1	2	1.7
Average	3	2.4	2	1.8	2.2	1	1.2	1	1.2	1	3	2.4	

Automatic Control Systems Lab

COURSE CODE: 18B17EC371

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To use computational tools in the modeling, simulation and analysis of control systems.
2. To understand procedures for modeling of physical systems, and related analytical and numerical methods for predicting their behavior.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understanding of mathematical modeling of electrical-mechanical systems and knowing their behavior.	Familiarity
CO2	The skill to analyze the response of any LTI system using software tools.	Assessment
CO3	The ability to design any system with desired specifications both in time and frequency domain and analyze systems using different techniques.	Assessment
CO4	Design of different types of controller and tuning their parameters to get optimized results.	Usage

List of Experiments

S. No	Description	Hours
1	To determine a transfer function and draw its pole-zero plot for (a) mechanical system (b) electrical system.	2
2	To obtain the overall transfer function of a given complex system represented in either the block diagram representation or signal flow graph representation by using masons gain formula.	2
3	To obtain the time response of a given system and obtain the steady state error for different inputs.	2
4	To obtain the time-domain specifications of a given second order systems for step input.	2
5	To determine the stability of a given LTI system using locations of poles.	2
6	To determine the range of the forward path gain for the system to be stable using root locus technique.	2
7	To design, simulate and analyze the stability and frequency domain specifications of LTI systems using Bode and Nyquist plots.	2
8	To design compensating networks to achieve the desired time domain and frequency domain specifications using (a) root locus and (b) bode plots.	2
9	To design and analyze the state space model of given LTI systems.	2
10	To study and analyze the responses of proportional, proportional derivative, proportional integral and proportional integral derivative controllers.	2
11	To perform Zeigler-Nichols tuning methods for tuning controller parameters.	2
12	To design and analyze state-feedback controller using pole-placement technique (Ackerman's formula).	2

13	To design and analyze a servomechanism control system in Simulink.	2
14	To design and simulate a nonlinear control system and analyze the effects of various nonlinear elements on the system performance.	2
Total Lab hours		28

Suggested Resources:

1. N. S. Nise, "Control Systems Engineering", 7th Edition, Wiley India, 2013.
2. K. Ogata, "Modern Control Engineering", 5th Edition, Pearson Education, 2010.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	2	2	1	3	1	1	1	2	1	1	1	1.58
CO2	3	3	2	2	3	1	1	1	2	1	1	1	1.75
CO3	2	3	2	2	1	1	1	1	2	1	1	1	1.50
CO4	2	2	3	1	1	1	1	1	2	1	1	1	1.42
Average	2.50	2.50	2.25	1.50	2.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00	

Digital Electronics and Logic Design

COURSE CODE: 18B11EC312

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: None

Course Objectives:

1. To understand the fundamental characteristics of digital logic levels.
2. To apply the knowledge to understand digital electronics circuits.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.	Familiarity
CO2	To understand and examine the structure of various number systems and its application in digital design.	Familiarity
CO3	The ability to understand, analyze and design various combinational and sequential circuits.	Usage
CO4	Ability to identify basic requirements for a design application and propose a cost effective solution.	Usage
CO5	The ability to identify and prevent various hazards and timing problems in a digital design	Assessment
CO6	To develop skill to build, and troubleshoot digital circuits.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Fundamentals of Digital Systems and logic families: Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems- binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes.	7
2	Combinational Digital Circuits: Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices.	9
3	Sequential circuits and systems: A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D types flipflops, applications of flipflops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple(Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters. Finite state machines, Design of synchronous FSM.	12
4	Logic Families: Characteristics of digital lCs, digital logic families, RTL,DTL, TTL, Schottky TTL, I^2L and CMOS logic, interfacing CMOS and TTL, Tri-state logic.	5
	A/D and D/A Converters: Digital to analogue converters: weighted resistor/converter, R-	

5	2R Ladder D/A converter, specifications for D/A converters, sample and hold circuit, analogue to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters.	6
6	Programmable logic devices: Commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).	3
Total lectures		42

Suggested Text Book(s):

1. Kumar, "Fundamentals of Digital Circuits", 4th Edition, Prentice Hall India, 2016.
2. M. M. Mano, Michael D Ciletti, "Digital Logic and Computer Design", 4th Edition, Pearson Education India, 2008.
3. R. P. Jain, "Modern Digital Electronics", 4th Edition, McGraw Hill Education, 2010.

Other useful resource(s):

1. https://onlinecourses.nptel.ac.in/noc18_ee33/ (Prof. Santanu Chattopadhyay, IIT Kharagpur)
2. https://nptel.ac.in/courses/117106086/ (Prof. S. Srinivasan, IIT Madras)

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Digital Electronics and Logic Design)	PO 1	PO 2	PO 3	PO 4	PO 5	PO- 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Average
CO1	2	2	2	2	3	2	1	1	3	2	2	3	2.08
CO2	3	3	2	3	3	3	3	1	1	3	3	3	2.42
CO3	3	3	3	3	3	3	2	1	2	3	2	3	2.50
CO4	3	2	3	1	2	3	1	3	1	2	3	3	2.17
CO5	3	3	2	3	3	3	1	2	1	3	2	3	2.42
CO6	2	3	3	3	3	2	2	2	3	3	1	2	2.42
Average	2.67	2.67	2.50	2.50	2.83	2.67	1.66	1.66	1.83	2.67	2.17	2.83	

Digital Electronics & Logic Design Lab

COURSE CODE: 18B17EC372

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: None

Course Objectives:

1. To provide students basic experimental experiences in constructing digital circuits.
2. Design simple digital systems based on digital abstractions.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	To acquire knowledge about electronic components and hardware devices required for designing digital electronics circuits.	Familiarity
CO2	Foster ability to identify, analyze and design combinational circuits.	Familiarity
CO3	Foster ability to design various synchronous and asynchronous sequential circuits.	Usage
CO4	To acquire knowledge about internal circuitry and logic behind any digital system.	Usage
CO5	To develop skill to build, and troubleshoot digital circuits.	Assessment

List of Experiments

S. No	Description	Hours
1	To implement Logic gates using TTL ICs (7400, 7402, 7404, 7408, 7410, 7411, 7420, 7427, 7432, and 7486).	2
2	Implementation of Combinational Circuits.	2
3	To verify NAND and NOR gates are universal gates.	2
4	Implementation of Combinational Logic Design using 74** ICs.	2
5	Simplification of Boolean expression using Karnaugh Map Method.	2
6	To design a 4 bit Binary to Gray code Converter, bit Gray to Binary code Converter, 3 bit Binary to Excess-3 code Converter.	2
7	To implement Adder and Subtractor circuits:- (Half and Full using simple gates and universal gates).	2
8	Implement multiplexer using gates and TTL IC's.	2
9	To verify the truth table of Binary (2 bit) to decimal decoder and octal to decimal decoder.	2
10	To verify the truth table of one bit and two bit Comparators using logic Gates.	2
11	To verify the truth tables for each (a) DDL OR gate (b) DDL AND gate (c) TTL OR gate (d) TTL AND gate (e) TTL NAND gate (f) TTL NOR gate.	2
12	Functional table verification of Latches: • SR-Latch with NOR Gates • SR-Latch with NAND Gates • SR-Latch with control input using NAND Gates • D Latch • T Latch	2
Total Lab hours		24

Suggested/Resources:

1. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India.
2. M. M. Mano, "Digital Logic and Computer Design", Pearson Education India.
3. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education.
4. https://onlinecourses.nptel.ac.in/noc18_ee33/ (Prof. Santanu Chattopadhyay, IIT Kharagpur)
5. https://nptel.ac.in/courses/117106086/ (Prof. S. Srinivasan, IIT Madras)

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.80	2.60	2.20	1.20	1.00	1.00	1.00	1.20	1.40	

Python Lab

COURSE CODE: 18B17EC474

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Develop problem solving ability using python.
2. Learn python programming approach to solve engineering problems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand the python program development environment, debugging, and executing.	Familiarity
CO2	To understand the usage of control statements in python program.	Usage
CO3	To practice programming in python for solving some simple problems leading to specific applications.	Usage
CO4	Able to design a project on python.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to Python, Python IDE, Variable types and basic operators in Python.	2
2	Programs on conditional statements using if statement, if-else statement, and nested if statement.	2
3	Programs on loop control statements using while loop, for loop, and nested loop.	2
4	Programs on string handling with and without importing toolbox.	2
5	Usage of list and tuples in the program.	2
6	Programs for creating and using dictionaries.	2
7	Definition, declaration, and call of functions in python.	2
8	Programs using classes and objects.	2
9	Program on basic file handling operations like opening and closing of a file, creating a text file, copy the content of one file into another.	2
10	Handling of exceptions in python.	2
11	Programs for sorting the sequence of numbers using different sorting algorithms.	2
12	Mini project.	2
Total Lab hours		24

Suggested/Resources:

1. A N Kamthane and A A Kamthane: Programming and Problem Solving with Python, 1st Edition, McGraw Hill Education, 2017.
2. A Downey: Learning with Python, 1st Edition, Dreamtech Press, 2015.
3. M C Brown: Python The Complete Reference, 1st Edition, McGraw Hill Education, 2001.

Approved in Academic Council held on 25.10.2018

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	1	1	2	2	1	1	1	1	1	3	1.67
CO2	3	3	3	3	3	2	1	1	1	1	1	3	2.08
CO3	3	3	2	3	3	2	1	1	1	1	2	3	2.08
CO4	3	3	3	3	3	2	1	1	1	1	3	3	2.25
Average	3.00	3.00	2.25	2.50	2.75	2.00	1.00	1.00	1.00	1.00	1.75	3.00	

Analog Integrated Circuits

COURSE CODE: 18B11EC411

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: Basic Electronics and Electrical circuit Analysis

Course Objectives:

1. To provide the student with an understanding of the fundamental characteristics, operations, stabilization, and feedback techniques of operational amplifiers.
2. To make the students acquainted with the applications of special ICs like timers, PLL circuits, regulator circuits, ADCs.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.	Familiarity
CO-2	Elucidate and design the linear and non-linear applications of an opamp and special application ICs.	Usage
CO-3	Explain and compare the working of multivibrators using special application IC 555 and general purpose opamp.	Usage
CO-4	Develop skills to design simple filter circuits and various amplifiers and can solve problems related to it.	Assessment
CO-5	Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to Operational Amplifiers: Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR, General operational amplifier stages and internal circuit diagrams of IC 741, Op- Amp basics, Ideal properties, Op-Amp specifications, DC and AC performance characteristics, slew rate, Open and closed loop configurations, Parameters of OP- Amps.	9
2.	Feedback topologies & Oscillators: Negative feedback in amplifier: Voltage-Series, Voltage-Shunt feedback, Current-Series, Current- Shunt feedback, Effect of feedback on gain, bandwidth etc., Calculation of stability, gain margin and phase margin. Positive Feedback in oscillators: Review of the basic concept, Barkhousen criteria for oscillators. Design of oscillator circuits: Clapp, Colpitt, Hartley, Wein Bridge and RC phase shift Oscillator.	9
3.	OP-AMP applications: Inverting & Non-inverting configuration, DC & AC amplifiers, Peaking Amplifier, Summing, Scaling and Averaging Amplifiers, Voltage to current and current to voltage converter, Op- amp as integrator and differentiator, Precision diode, Logarithmic and Anti-logarithmic Amplifier, Zero crossing detector, A/D and D/A Converters.	8
4.	Active Filter & Wave shaping circuits: First order and second order filter design: Low pass, High pass, Band pass, Band Reject & All pass, Universal active filter, Multi-vibrators (Astable, Mono-stable, Bi- stable), Schmitt Trigger, Sample and Hold Circuit, Clippers and Clampers, Comparator.	8
5.	Waveform generators and special function ICs: Square wave generator, Triangular wave generator, Saw-tooth wave generator, Timer IC 555, Voltage-Controlled Oscillator (VCO), Phase-Locked Loop (PLL).	8

Total lectures	4 2

Suggested Text Book(s):

1. R. Gayakwad, “Op-amps and Linear Integrated Circuits”, 4th ed., Prentice Hall of India.
2. D. Roy Choudhary S. Jain, “Linear Integrated Circuits”, 4th ed., New Age International (P) limited.

Suggested Reference Book(s):

1. William D. Stanley, “Operational amplifiers and Linear Integrated Circuits”, 4th ed, Pearson.
2. Sergio Franco, “Design With Operational Amplifiers and Analog Integrated Circuits”, 3rd ed., Mcgraw Higher Education.
3. Johan H. Huijsing, Operational Amplifiers – Theory and Design, 3rd edition, Springer.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117103063
2. Link to topics related to course:
   - https://nptel.ac.in/courses/122104013/11
   - https://nptel.ac.in/courses/108101091
   - https://nptel.ac.in/courses/117103063/17

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Analog Integrated Circuits)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	3	1	1	1	2	2	1	2	2
Average	2	2.6	2.6	2.6	2.8	1	1	1	2	2.2	1.4	2	

Analog Integrated Circuits Lab

COURSE CODE: 18B17EC471

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: Basic Electronics lab, Electrical Circuit Analysis Lab

Course Objectives:

1. To provide students a thorough understanding of the analog circuits using different ICs.
2. To learn generation of different kind of waveforms using opamps.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand basics of different electronics circuits using op amps.	Familiarity
CO-2	Learn how to generate different frequencies using various oscillators.	Familiarity
CO-3	Design different types of filters.	Usage
CO-4	Design Schmitt Trigger using op amp.	Usage
CO-5	Learn the generation of different waveforms using op amp.	Assessment
CO-6	Study the working of op amp as multivibrator.	Assessment

List of Experiments

S. No.	Description	Hours
1	To become familiar with the use and characteristics of a 741 Op-Amp, in an ideal amplifier configuration as an; inverting amplifier, noninverting amplifier, and voltage follower.	2
2	Simulate and design Adder and Subtractor circuits using Op-Amp.	2
3	Simulate and design Integrator and Differentiator using operational amplifier and characterize their performance in various regions of operation.	2
4	Design and verify the characteristics of RC pahse shift oscillator for required frequency	2
5	Design and verify the characteristics of Wein Bridge oscillator for required frequency	2
6	Simulate and design 1st order HPF and LPF filters and plot their Frequency responses, respectively.	2
7	Simulate and design a Schmitt trigger, using a standard IC741 Op-Amp, to produce a custom voltage transfer characteristic.	2
8	Simulate and design triangular/square waveform generator using IC741	2
9	Simulate and design a monostable multivibrator for required pulse width using IC555 Timer	2
10	Simulate and design astable multivibrator for required frequency and duty cycle using IC555 Timer	2
11	Simulate and design and A-D converter using OPAMP 741	2
12	Simulate and design and D-A converter using OPAMP 741	2
	Total Lab hours	24

Suggested/Resources:

1. R L Boylestad and Nachelsky: Electronic Devices & circuit Theory, 10th Ed.Pearson.
2. Adel S. Sedra, Kenneth C. Smith : Microelectronics Circuits, 5th Ed., Oxford University Press, 2004
3. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/11710306
   - https://nptel.ac.in/courses/117103063 /1
   - https://nptel.ac.in/courses/117103063 /7
   - https://nptel.ac.in/courses/117103063/17

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.80	2.60	2.20	1.20	1.00	1.00	1.00	1.20	1.40	

Fundamentals of Signals and Systems

COURSE CODE: 18B11EC412

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: Basic mathematics like integration, differentiation, differential equations, and trigonometry formulae

Course Objectives:

1. To understand the various types of signals, types of systems, characteristics, operations, and sampling theorem.
2. To learn the different transform like Fourier series, Fourier Transform, Laplace Transform and Z-Transform and also understand their importance for signals and systems analysis.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Classify signals and systems based on their properties and determine the mathematical representations of signals and systems.	Familiarity
CO-2	Explain the role of convolution in the analysis of LTI systems and also able to formulate and solve differential /difference equations describing LTI systems.	Familiarity
CO-3	Analyze the spectral characteristics of signals using Fourier analysis and analyze system properties based on impulse response and Fourier analysis.	Usage
CO-4	Apply the Laplace transform and Z- transform for analysis of continuous-time and discrete-time signals and systems.	Usage
CO-5	Understand the process of sampling and the effects of under sampling.	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1	Continuous-time and discrete-time signals, signal energy and power, periodic signals, even- odd signals, exponential and sinusoidal signals, Unit impulse and step functions, continuous and discrete time systems, system classifications, system properties.	8
2	Convolution integral and convolution sum, properties of LTI systems, LTI systems described by differential and difference equation, response of LTI systems.	5
3	Fourier series representation of continuous and discrete time signals, properties, Fourier Transform representation of continuous-time signals, properties, system characterization by linear constant coefficient difference equation.	13
4	The Laplace Transform, ROC, Properties of Laplace-transform, analysis and characterization of LTI systems using Laplace Transform.	6
5	The z-transform, ROC and pole-zero-plot, properties of z-transform, analysis and characterization of LTI system using z-transform, Stability criterion.	7
6	Sampling, types of sampling, Analog to digital conversion, Signal reconstruction.	3
	Total lectures	42

Suggested Text Book(s):

1. A.V. Oppenheim & A.S. Willsky & S.H. Nawab: Signals & Systems, 2nd Edition, Prentice- Hall of India, 2015.

Suggested Reference Book(s):

1. B.P. Lathi: Signal Processing and Linear Systems, 2nd Edition. Oxford University Press, 2006.
2. Simon Haykin, Barry Van Veen, Signals & Systems, 2nd Edition., John Willey and Sons, 2007

Other useful resource(s):

1. http://nptel.ac.in/courses/108104100/ (Prof Aditya K. Jagannatham, IIT Kanpur)
2. https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/video-lectures/ (Prof. Alan V. Oppenheim)

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Fundamentals of Signals and Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	2	1	1	1	1	3	3	3	2
CO-2	2	3	3	3	2	1	1	1	2	3	3	3	2.3
CO-3	3	3	3	3	3	1	1	1	2	3	3	3	2.4
CO-4	3	3	3	3	3	1	1	1	2	3	3	3	2.4
CO-5	3	3	2	3	2	1	1	1	2	3	3	3	2.3
Average	2.6	3	2.6	2.8	2.4	1	1	1	1.8	3	3	3	

Fundamentals of Signals & Systems Lab

COURSE CODE: 18B17EC472

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: None

Course Objectives:

The primary objective of this course is

1. To provide a thorough understanding and analysis of signals and systems using MATLAB.
2. To become familiar with some signal processing capabilities of MATLAB.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand basics of MATLAB syntax, functions and programming.	Familiarity
CO2	Generate and characterize various continuous and discrete time signals.	Familiarity
CO3	Perform the basic operations on the signals.	Usage
CO4	Design and analyze linear time-invariant (LTI) systems and compute its response.	Usage
CO5	Analyze the spectral characteristics of signals using Fourier analysis.	Assessment
CO6	Analyze the systems using Laplace transform and Z-transform.	Assessment

List of Experiments:

S. No	Description	Hours
1	Introduction to MATLAB	2
2	To create user defined functions for generating sinusoidal signal, delta function, unit step function and periodic signal.	2
3	To create user defined functions for signal operation: signal addition, time shifting, time scaling and time inversion.	2
4	To compute convolution of two signals and verify its properties.	2
5	To compute auto-correlation and cross-correlation of two signals and verify its properties.	2
6	To obtain the response of LTI system defined by linear constant coefficient difference Equations	2
7	To synthesize the periodic signal using Fourier series.	2
8	To analyze the spectrum of the signal using Fourier transform and verify its properties.	2
9	To compute and plot the impulse response and pole-zero diagram of transfer function using Laplace transform.	2
10	To compute and plot the impulse response and pole-zero diagram of transfer function using Z-transform.	2
11	To create user defined functions for upsampling and downsampling of given discrete time signals.	2
12	To demonstrate the effects of aliasing arising from improper sampling.	2
Total Lab hours		24

Suggested/Resources:

1. Oppenheim, Alan S. Willsky, S. Hamid Nawab, Signals and Systems, 2nd Edition, PHI, India, 2015.
2. Alex Palamides, Anastasia Veloni, Signals and Systems Laboratory with MATLAB, 1st Edition, CRC Press, 2010.
3. Sudhakar Radhakrishnan , Practicing Signals and Systems Laboratory Using MATLAB, Lambert Academic Publishing, 2011.
4. https://www.iitg.ac.in/cseweb/vlab/signals-and-systems-laboratory/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.83	2.83	2.50	2.17	1.33	1.17	1.17	1.17	1.33	1.50	

Modern Analog and Digital Communication

COURSE CODE: 18B11EC413

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: None

Course Objectives:

1. Introduce students to basic concepts of analogue and digital communicationsystems.
2. To acquaint the students with various modulation and demodulation techniquesused for communication.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	To familiarize students with the fundamentals of analog and digital communication systems.	Familiarity
CO2	To familiarize students with basic techniques used for modulation and demodulation of signal.	Familiarity
CO3	Understanding of various approaches to convert analog signal to digital signal.	Assessment
CO4	Analyze mathematical background for communication signal analysis.	Assessment
CO5	To analyze performance of a communication system.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Review of fundamental concepts: Review of Fourier series and Fourier transforms, Power Spectral Density, review of probability and random processes, spectral analysis, Gaussian process, Gaussian and white noise characteristics.	4
2	Modulation techniques: Concept of modulation and demodulation, Continuous wave (CW) modulation: AM, DSB, SSB, and VSB modulation, Angle modulation - PM & FM wave equations; relationships between PM and FM. Narrow band FM. Spectra of AM and FM waves. AM and FM detectors. Phase Lock loop (PLL) and its application as FM demodulator, Discriminator, FM Pre-emphasis and De-emphasis, capture effect. Comparison of CW modulation systems. Receivers for CW modulation: Superheterodyne receivers	13
3	Pulse modulation: Sampling process, Pulse modulation: Pulse amplitude modulation (PAM); pulse width modulation (PWM); pulse position modulation (PPM), Quantization, Pulse code modulation (PCM), differential pulse code modulation (DPCM); delta modulation (DM). Noise consideration in PCM and DM. Line coding schemes, Comparison of RZ, NRZ, Polar, Unipolar, Manchester, and their spectral analysis.	7
4	Baseband Pulse Transmission: Baseband transmission, matched filter, probabilty of error of matched filter, Inter symbol Interference and Nyquist criterion, Eye-pattern, Signal to noise ratio.	5
5	Pass band Digital Modulation schemes: Amplitude shift keying (ASK), Phase shift keying (PSK), Frequency shift keying (FSK) and Quadrature amplitude modulation (QAM). Basics of CPFSK and MSK, Signal constellations, Probability of error analysis of digital modulation schemes. Comparison of bandwidth and bit rate of digital modulation schemes. Multiplexers, Timing and frequency synchronization: TDM, FDM, North American Digital Hierarchy, T1 carrier, carrier synchronizers, symbol synchronization, early late gate synchronizer	13
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin, "An introduction to analog and digital communications", 2nd Ed., John Wiley & Sons,2012
2. B.P.Lathi, "Modern Analog and Digital Communication Systems", 4th Ed., Oxford.,2017
3. Taub Schilling, "Principles of Communication Systems", 4th Ed., McGrawHill.,2007

Other useful resource(s):

1. https://nptel.ac.in/courses/117101051/ (Prof. Bikash Kumar Dey, IIT Bombay)
2. https://onlinecourses.nptel.ac.in/noc17_ec11/preview (Prof. Goutam Das, IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course Outcomes (Modern Analog and Digital Communication)	PO 1	PO 2	PO 3	PO 4	PO 5	PO- 6	PO 7	PO 8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	1	2	2	2	1	1	1	1	2	1	2	1.58
CO2	2	3	2	2	2	1	1	1	1	2	1	2	1.67
CO3	3	3	3	2	2	2	2	1	2	2	1	1	2.00
CO4	2	2	3	3	2	1	1	2	1	2	1	2	1.83
CO5	3	3	3	2	3	1	1	1	1	2	2	2	2.00
Average	2.6	2.4	2.6	2.2	2.2	1.2	1.2	1.2	1.2	2	1.2	1.8	

Modern Analog and Digital Communication Lab

COURSE CODE: 18B17EC473

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: None

Course Objectives:

1. To make the students familiar with the basic analog and digital communication circuits.
2. To design the circuits to convert analog signal into digital signal and vice versa.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand basic elements of a communication system.	Familiarity
CO2	Able to design analog modulation circuits as amplitude and frequency modulation.	Assessment
CO3	Design various line coding techniques.	Assessment
CO4	Design the circuit to convert analog signals to digital signals.	Assessment
CO5	Design different digital modulation circuits.	Usage

List of Experiments

S. No	Description	Hours
1	To design and implement Amplitude modulator and Demodulator.	2
2	To design and implement Frequency Modulator and Demodulator.	2
3	To design and implement Pulse Amplitude Modulator (PAM)	2
4	To design and implement Pulse Width Modulator (PWM).	2
5	To design and implement Pulse Position Modulator (PPM).	2
6	To design and implement sample and hold circuit.	2
7	Design and Generation of random binary signals.	2
8	Generation Unipolar NRZ, Polar NRZ, Unipolar RZ and Polar RZ line codes.	2
9	Design and implementation of Delta Modulator for analogue signals	2
10	Design, implementation and study of BASK Modulator and demodulator	2
11	Design, implementation and study of BPSK Modulator and demodulator	2
12	Design, implementation and study of BFSK Modulator and demodulator.	2
Total Lab hours		24

Suggested/Resources:

1. Simon Haykin, “An introduction to analog and digital communications”, 2nd Ed., John Wiley & Sons.,2012.
2. B.P.Lathi, “Modern Analog and Digital Communication Systems”, 4th Ed., Oxford.,2017.
3. https://nptel.ac.in/courses/117101051/ (Prof. Bikash Kumar Dey, IIT Bombay)

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.83	2.50	2.17	1.33	1.17	1.17	1.17	1.33	1.50	

Principles of Digital Signal Processing

COURSE CODE: 18B11EC511

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Basic knowledge of Signals and Systems

Course Objectives:

1. To provide the knowledge of different aspects of transform techniques including analog and digital communication schemes used in modern telecommunication systems.
2. Discussion of basic concepts of energy-power signal, use of Fourier series and Fourier Transform, correlation function and power spectral density.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To interpret, represent and process discrete/digital signals and systems	Familiarity
CO-2	To acquire thorough understanding of frequency domain analysis of discrete time signals	Usage
CO-3	To acquire the ability to design & analyze DSP systems like FIR and IIR Filter etc.	Usage
CO-4	To deal with practical implementation issues such as computational complexity, hardware resource limitations as well as cost of DSP systems or DSP Processors.	Assessment
CO-5	To apply important algorithmic design paradigms and method of analysis.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction of discrete signals and systems: Signal energy and power, periodic signals, even-odd signals, exponential and sinusoidal signals, Unit impulse and step functions, discrete time systems and their classifications. Analysis of Discrete LTI Systems. Convolution Sum and Linear Constant Coefficients Difference Equations.	5
2	Z-Transforms: Origin of Z – transform, Region of Convergence, Properties of Z – transform, Pole – zero plot, Inverse Z – transform, Analysis of LTI systems using Z – transform.	5
3	Fourier Analysis: Fourier series representation of discrete time signals, properties. Frequency sampling theorem. Discrete Fourier Transform and its properties, Radix-2 Fast Fourier Transform, decimation in time and frequency. Real value FFT and Chirp Z-transform.	9
4	Filter Design: Frequency response characteristics, Window based FIR filter design, Linear phase FIR filter design, IIR filter design using Bilinear Transformation, Frequency Transformation, Butterworth Design and Chebyshev Design method, Realization of FIR and IIR filter.	5
5	Multi-rate rate signal processing: Introduction to multi-rate rate signal processing, Up-sampling and down sampling, Filter design with sampling rate conversion, Introduction and applications of adaptive filters.	9
6	Random Signal Analysis: Random Signal Analysis & Spectral Estimation, Autocorrelation and cross correlation with examples, power spectral density and Spectral estimation	9
Total lectures		42

Suggested Text Book(s):

1. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing”, 4th Edition, Prentice Hall, 2007.
2. A. V. Oppenheim and R. W. Schafer, “Digital Signal Processing”, 1st Edition, Pearson Education, 2015.

Suggested Reference Book(s):

1. B.P. Lathi, “Principles of Signal Processing and Linear Systems”, 1st Edition, Oxford International Publication, 2009.
2. Mitra, S.K, “Digital Signal Processing: A Computer Based Approach”, 4th Edition, TMH, 2011.
3. Tamal Bose, “Digital Signal and Image Processing”, 1st Edition, John Wiley & Sons, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117102060/
2. Link to topics related to course:

   https://nptel.ac.in/courses/117102060/1
   https://nptel.ac.in/courses/117102060/12
   https://nptel.ac.in/courses/117102060/28
   https://nptel.ac.in/courses/117102060/41

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Principles ofDigital Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.8
Average	2.4	2.4	2.4	2.4	2.2	2.0	1.0	1.0	1.0	2.2	1.0	2.0	

Principles of Digital Signal Processing Lab

COURSE CODE: 18B17EC571

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To provide a thorough understanding and analysis of digital signal processing systems using LabVIEW.
2. To familiar with usage of code compressor studio.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand the basics of Lab VIEW Programming and code compressor studio.	Familiarity
CO2	Generate the discrete time signals using sampling and conversion of analog signals in to digital signals.	Familiarity
CO3	Analyze the FFT Algorithm based frequency domain representation.	Usage
CO4	Design the FIR and IIR filter for specified parameters.	Usage
CO5	Apply the adaptive filtering for systems identification.	Assessment
CO6	Perform the linear and circular convolution using DSP kit to get the LTI system response..	Assessment

List of Experiments

S. No	Description	Hours
1	Getting Familiar with LabVIEW.	2
2	Generate a discrete signal by sampling a sinusoidal signal and I investigate the aliasing effect.	2
3	Convert analog signal to digital signal (A/D) and digital signal to analog signal (D/A) using LabVIEW	2
4	Design FIR filter using LabVIEW to meet specifications on their frequency response using window design.	2
5	Design IIR Filter using LabVIEW to meet specifications on their frequency response using the bilinear transformation.	2
6	Use LabVIEW to analyze and display signals in the frequency- domain using the FFT algorithm.	2
7	Design an adaptive filter for system identification using LabVIEW.	2
8	Getting familiar with code compressor studio.	2
9	Perform and verify linear convolution of two signals using DSP Kit.	2
10	Perform and verify circular convolution of two signals using DSP Kit.	2
11	Binary Phase Shift Keying using LabVIEW.	2
12	Design of FIR Filter by interfacing MATLAB with code composer studio.	2
Total Lab hours		24

Suggested/Resources:

1. T. H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3rd Edition, Prentice-Hall of India, 2010.
2. Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning, 2002.

Approved in Academic Council held on 25.10.2018

3. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: Fundamentals of Computer Algorithms, 2nd Edition, Universities press, 2007
4. https://nptel.ac.in/courses/106104019/26
5. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.80	2.60	2.20	1.20	1.00	1.00	1.00	1.20	1.40	

Microprocessor and Interfacing

COURSE CODE: 18B11EC512

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: None

Course Objectives:

1. To study the architecture, instruction set and interfacing of the Intel microprocessors.
2. To gain proficiency in assembly language programming.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand Standard Architecture of Intel Microprocessors	Familiarity
CO-2	Learn the instruction set of Intel 80x86 processors and to gain proficiency in assembly language programming	Usage
CO-3	Know the concepts associated with interfacing a microprocessor to memory and to I/O devices and to learn the programming of peripheral I/O devices	Usage
CO-4	Learn the control components of a microprocessor based system though the use of interrupts	Assessment
CO-5	Acquaint with the background knowledge for understanding next-generation CPUs	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	Overview of the Intel Family of the Microprocessors. Introduction to 8085 Microprocessor	4
2	The 8086 microprocessor architecture, Addressing Modes; Register Addressing; Immediate Addressing; Direct Data Addressing; Register Indirect Addressing; Base- Plus-Index Addressing; Register Relative Addressing; Base Relative-Plus-Index Addressing	4
3	8086 Instruction Set	4
4	Using assembly language with C/C++; Using Assembly Language with C++ for 16- Bit DOS Applications, Mixed Assembly and C++ Objects	2
5	Programming the 8086 microprocessor; Modular Programming, Using the Keyboard and Video Display, Disk Files	2
6	8086 Hardware specifications; Pin-Outs and the Pin Functions, Clock Generator (8284A), Bus Buffering and Latching, The 8288 Bus Controller	4
7	8086 Memory Interface; Memory Devices, Address Decoding, Memory Interface, Dynamic RAM	4
8	Basic I/O Interface; I/O Port Address Decoding, Programmable Peripheral Interface (8255), Programmable Interval Timer (8254), Programmable Communications Interface (16550), ADC(ADC804) and DAC (DAC830)	6
9	Interrupts; 8259A Interrupt controller	2
10	Direct memory access and DMA-controlled I/O; 8237 DMA controller	2
11	The arithmetic coprocessor; MMX, and SIMD technologies, 8087 arithmetic coprocessor	2
12	Bus interface; ISA Bus, PCI Bus, Parallel Printer Interface, Serial COM Ports, Universal Serial Bus (USB), Accelerated Graphics Port (AGP)	2
13	Intel Pentium and Core2 Processors	4
Total lectures		42

Suggested Text Book(s):

1. Berry B.Brey, “The Intel Microprocessors : Architecture, Programming, and Interfacing,” 8th Ed., Prentice Hall, 2009.
2. Ramesh Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085,” 6th Ed., Penram, 2013.

Suggested Reference Book(s):

1. Douglas V Hall, “Microprocessors & Interfacing,” 3rd Ed., McGraw Hill, 2017.
2. Yu-Cheng Liu,Glenn A. Gibson , “The 8086/8088 Family Architecture, Programming & design”, 2nd Ed., PHI, 2011.
3. Kenneth Ayala “The 8086 microprocessor programming and Interfacing the PC,” 1st Ed., Cengage Learning, 2007.
4. Tom Shanley, “Protected Mode Software Architecture,” Addison-Wesley, 1996.

Other useful resource(s):

1. NPTEL ONLINE COURSES: Microprocessors and Microcontrollers
   https://nptel.ac.in/courses/106108100/ (Prof. Krishna Kumar ,IISc Bangalore)
   https://nptel.ac.in/courses/108105102/ (Prof. Santanu Chattopadhyay, IIT Kharagpur)
2. MIT OPEN COURSE WARE: Computer System Architecture
   https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-823-computer-system-architecture-fall-2005/ (Dr. Joel Emer, Prof. Krste Asanovic, Prof. Arvind)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Microprocessor and Interfacing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	x	3	3	3	2	x	x	x	x	x	1	1.17
CO2	3	3	3	2	2	2	x	x	3	3	2	3	2.17
CO3	3	3	3	3	2	2	x	x	3	2	2	3	2.17
CO4	3	3	3	2	2	3	x	x	1	x	x	3	1.67
CO5	3	3	3	2	3	3	x	x	x	x	x	3	1.67
Average	2.80	2.40	3.00	2.40	2.40	2.40	0.00	0.00	1.40	1.00	0.80	2.60	

Microprocessor and Interfacing Lab

COURSE CODE: 18B17EC572

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: Digital Electronics & Logic Design Lab

Course Objectives:

1. To develop, implement, and debug 8086 assembly language programs
2. To familiarize the students with memory organization and interfacing of microprocessor with various peripheral devices.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Gain proficiency with using assembly language to develop microprocessor based applications	Familiarity
CO-2	Learn control components of a microprocessor based system though the use of interrupts	Usage
CO-3	Gain practical experience in programming memory and peripheral devices like timers/counters, parallel peripheral devices, serial communication interfaces and I/O devices	Usage
CO-4	Gain practical experience in programming with coprocessor and DMA controller	Usage
CO-5	Develop a microprocessor based system, using assembly language programming concepts, for handling a real life task	Assessment

List of Experiments

S. No.	Description	Hours
1	Introduction to 8085/8086 based systems, ET-8085LCD /ET-8086LCD	2
2	To add, subtract, multiply and divide two 16bit nos. stored at locations 1000:0000H and 1000:0002H. Store the results starting from 1000:0004H. Find the total program memory size and number of machine cycles to execute the program.	2
3	To sort an array of 16 bytes stored at memory location starting from 1000:0300H. Store the array in ascending order at memory location starting from 1000:0310H and array in descending order at memory location starting from 1000:0320H.	2
4	To read a temperature in degree centigrade from keyboard when prompted, convert to degree Fahrenheit and display it on the LCD of ET-8086LCD microprocessor trainer kit	2
5	To interface an array of LEDs using 8255 parallel peripheral interface	2
6	To read a sensor input data from Port-A of 8255, filter it and output at Port-B of 8255	2
7	To program the 8253 timer for generating delay	2
8	To use 8259 interrupt controller for interfacing external interrupts	2
9	To communicate between two microprocessor kits using 8251 serial communication interface	2
10	To do floating point operations using mathematical coprocessor 8087	2
11	To do data transfer using DMA controller 8089	2
12	To create, edit and display a text file in PC using BIOS and DOS interrupts	2
	Total Lab hours	24

Suggested Resources:

1. Berry B.Brey, “The Intel Microprocessors : Architecture, Programming, and Interfacing,” 8th Ed., Prentice Hall, 2009.

2. Kenneth Ayala, “The 8051 microcontroller,” 3rd Ed., Thomson, 2005
3. Ramesh Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085,” 6th Ed., Penram, 2013.
4. Official IA-32 Programmer Reference Manuals online at: https://software.intel.com/en-us/articles/intel-sdm

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	2	3	2	1	3	2.33
CO2	3	3	3	3	1	1	x	x	1	1	x	2	1.50
CO3	3	3	3	3	2	1	x	1	2	2	1	3	2.00
CO4	2	3	1	3	2	x	x	1	x	1	x	3	1.33
CO5	3	3	3	3	2	x	x	2	3	3	3	3	2.33
Average	2.80	3.00	2.60	3.00	1.80	0.80	0.20	1.20	1.80	1.80	1.00	2.80	

Electromagnetic Waves

COURSE CODE: 18B11EC513

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: Basics of Engineering Mathematics

Course Objectives:

1. To lay the foundations of electromagnetic engineering and its applications in modern communication systems.
2. To analyze the wave propagation on transmission lines and wave guides.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To apply vector calculus to static electric-magnetic fields in different engineering situations.	Familiarity
CO-2	To analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.	Familiarity
CO-3	To examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.	Usage
CO-4	To analyze the nature of electromagnetic wave propagation in guided medium which are used in microwave applications.	Assessment
CO-5	To analyze the wave propagation on two wire transmission lines and to study the applications of transmission lines in real time applications.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Review of Fields: Review of scalar and vector fields. Electrostatic and Magneto static Fields.	4
2	Maxwell's Equations: Inconsistency of Amperes law, Continuity equation, Displacement current, Maxwell's equations, Boundary conditions.	4
3	Wave propagation in space: Wave propagation in free space, Conductors and dielectrics, Polarization, Plane wave propagation in conducting and non conducting media, Phasor notation, Phase velocity, Group velocity; Reflection at the surface of the conductive medium, Surface Impedance, Depth of penetration. Transmission line analogy.	11
4	Poynting theorem: Poynting theorem, Poynting Vectors and power loss in a plane conductor.	4
5	Transmission Lines: Transmission line equations, characteristic impedance, open and short circuited lines, standing wave and reflection losses. Impedance matching, Smith Chart, Simple and double stub matching.	6
6	Waveguides: Rectangular and circular wave guides- Modes in rectangular and cylindrical coordinates, characteristics, power transmission and losses, excitation of modes. Microwave coaxial connectors. Rectangular, Circular and semi-circular cavity resonators, Q factor.	8
7	Radiation Basics: Scalar and vector potentials. Radiation from a current filament, half-wave dipole and small loop antennas. Antenna characteristics, radiation pattern, radiation intensity, directivity and power gain. Antenna arrays, effective area and Friss equation.	5

Total lectures	42

Suggested Text Book(s):

1. Hayt Jr, William H. John A. Buck, “Engineering Electromagnetic”. 8th Edition, Tata McGraw-Hill, 2013.
2. Pozar, David M. “Microwave engineering”4th Edition, John Wiley & Sons, 2011.
3. Ballanis, Constantine A. “Antenna theory analysis and design”, 3rd John Willey and Son's Inc., New York, 2005.

Suggested Reference Book(s):

1. Sunil Bhooshan, “Fundamentals of Engineering Electromagnetic”, 1st Edition, Oxford University press, 2012.
2. Cheng, David Keun. “Field and wave electromagnetic”, 2nd Edition Pearson Education India, 2011.
3. Elliot, Robert S. “Antenna theory and design”. Revised Edition, John Wiley & Sons, 2005.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117103065/
4. Link to topics related to course:
   - https://nptel.ac.in/courses/117103065/1
   - https://nptel.ac.in/courses/117103065/5
   - https://nptel.ac.in/courses/117103065/7
   - https://nptel.ac.in/courses/117103065/10

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Electromagnetic Waves)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.8
Average	2.4	2.4	2.4	2.4	2.2	2.0	1.0	1.0	1.0	2.2	1.0	2.0	

Wireless and Data Communication

COURSE CODE: 18B11EC611

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the fundamentals of wireless and data communication networks.
2. To allow the students to learn network architecture and protocols of trending wireless networks.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of wireless communication system and various wireless standards.	Familiarity
CO-2	Have the basic knowledge of computer networks and its applications in communication engineering.	Familiarity
CO-3	Understand the behavior of wireless channel.	Usage
CO-4	Have the knowledge of data sharing and their protocols.	Usage
CO-5	Brief the recent protocols and standards of various communication networks.	Assessment
CO-6	Get familiar with the recent wireless communication systems.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Review of Wireless Communication: Introduction to Wireless Communication, Basic building blocks of wireless system: source coding & channel coding, base band & band pass signal representation; 1G, 2G, 2.5G, 3G, 4G and 5G wireless standards and their Comparison; Multiple Access techniques: TDMA, FDMA, CDMA, OFDMA.	6
2	Wireless Channel: Linear Time Varying System; Path loss model; Multipath Propagation; Doppler Shift; Parameters of Wireless Multipath Channel; Small-scale and large-scale fading; Shadowing, Types of Fading: flat fading, frequency selective fading, slow fading and fast fading; Capacity of wireless channel: Capacity of AWGN, Flat Fading and Frequency Selective Channels.	10
3	Data Communication: OSI vs TCP/IP model; Wired vs Wireless; Circuit switching/ Packet switching; Flow control and error control; CRC; Connection oriented/connection less transmission; Bit stuffing.	7
4	MAC, Network and transport layer protocols: Dynamic multiple access methods: ALOHA, slotted ALOHA, CSMA/CD etc; Routing algorithms: DSDV, LSR, AODV; Broadcasting methods: flooding, spanning tree, multicasting; UDP, TCP, IP, IPv4, IPv6, QoS.	8
5	Wireless Networks: Introduction to WiFi; 802.11, 802.11a and 802.11 b Wireless LANs; Frame structure; Modes of operation; Data rates; Power management; Handoff strategies, Medium access control etc. Bluetooth networks: Piconet, scatternet, frame structure, data rates; synchronous and asynchronous services, power saving etc	8
6	Recent Trends: Introduction to WiMAX and ZigBee Networks; Software Defined Radio; UWB Radio; Wireless Adhoc Network and Mobile Portability; Security issues and challenges in a Wireless network.	3

Total lectures	42

Suggested Text Book(s):

1. T.S. Rappaport, "Wireless Communication", 2nd Edition, Prentice Hall., 2010.
2. A. Tanenbaum, "Computer Networks", 5th Edition, Prentice Hall, 2011.
3. Bahrouz Forouzan, "Data communication & Networking," 5th Edition, McGraw Hill, 2017.

Suggested Reference Book(s):

1. William Stallings, "Data and Computer Communications," 10th Edition, Pearson.,2013.

Other useful resource(s):

Link to NPTEL course contents:

1. https://nptel.ac.in/courses/117102062/36
2. https://nptel.ac.in/courses/106105082/31

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Wireless and Data Communication)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	1	3	1	1	1	1	1	2	1	2	1.58
CO-2	3	3	1	3	2	1	1	3	1	2	1	2	1.92
CO-3	3	3	2	3	2	1	2	3	1	2	1	2	2
CO-4	3	3	3	3	2	1	2	3	1	2	1	2	2.17
CO-5	3	3	3	3	3	1	2	3	2	2	1	2	2.33
CO-6	3	3	3	3	3	1	3	3	3	2	3	2	2.67
Average	3	3	2.17	3	2.17	1	1.83	2.67	1.5	2	1.33	2	

VLSI Technology

COURSE CODE: 18B11EC612

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: None

Course Objectives:

1. To bring both Circuits and System views on design together so as to offers a profound understanding of the design of complex digital VLSI circuits.
2. To use computer aided simulation and synthesis tools for hardware design.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the static and dynamic behavior of MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) and the secondary effects of the MOS transistor model.	Familiarity
CO-2	To be aware about the trends in semiconductor technology, and how it impacts scaling and its effect on device density, speed and power consumption.	Familiarity
CO-3	To understand MOS transistor as a switch and its capacitance.	Usage
CO-4	Student will be able to design digital systems using MOS circuits (Static and Switching characteristics of inverters).	Usage
CO-5	Able to learn Layout, Stick diagrams, Fabrication steps.	Usage
CO-6	Understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to VLSI technology, VLSI design flow, Digital Design Cycle, Physical Design Cycle.	3
2	MOS fundamentals, Device Structure and Physical Operation, Current- Voltage Characteristics, channel length modulation, body effect, biasing of MOSFETs, capacitances in MOS, VLSI circuit and system representation.	11
3	Logic gate characteristics, Design of MOS inverter with different loads, Determination of pull up and pull down ratio for an nMOS inverter driven by another n MOS inverter, Design of W/L, power dissipation, propagation delay, and noise margin analysis.	11
4	CMOS inverter, static and dynamic characteristics of CMOS inverter, DC Characteristics: NAND and NOR Gates, NAND and NOR transient response, System design using HDL.	11
5	Stick diagram, Layout, Fabrication.	6
Total lectures		42

Suggested Text Book(s):

1. Sung-Mo Kang, Yusuf Leblebici : CMOS Digital Integrated Circuits Analysisand Design, Tata McGraw-Hill, 2003.
2. Adel S. Sedra, Kenneth C. Smith: Microelectronics Circuits, 5th Ed., Oxford University, 2004.
3. John P. Uyemura: Introduction to VLSI Circuits and Systems, John Wiley & Sons, Inc., 2002.

Approved in Academic Council held on 25.10.2018

Suggested Reference Book(s):

1. Neil Weste and David Harris CMOS VLSI Design", 4th Ed., Addison Wesley, 2011.
2. Douglas A Pucknell et al, "Basic VLSI Design", 3rd Ed., Prenctice Hall, 2004.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108106069/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Class performance, Tutorials & Assignments - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (VLSI Technology)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	3	2	2	2	1	1	1	2	3	2.08
CO2	3	3	3	2	2	2	2	1	1	2	1	3	2.08
CO3	3	3	3	3	3	2	1	1	1	1	1	2	2
CO4	3	3	3	3	3	3	1	1	1	1	1	2	2.08
CO5	3	2	2	2	3	2	1	1	1	1	1	2	1.75
CO6	3	3	3	3	3	3	3	1	1	1	1	3	2.33
Average	3.00	2.83	2.67	2.67	2.67	2.33	1.67	1	1	1.17	1.17	2.50	

VLSI Technology Lab

COURSE CODE: 18B17EC672

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: None

Course Objectives:

1. To study the constructs, conventions and design capabilities of the Verilog HDL and to learn to implement a given algorithm into an FPGA breaking it into modules and sub modules.
2. To study gate level , dataflow (RTL), behavioral, and switch level modeling, describes leading logic synthesis methodologies using the xilinx platform to write test benches and simulate the digital system designs

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Apply the techniques of design, simulation and synthesis of digital circuits to design FPGA based systems or/and ASICs using Xilinx design tools	Familiarity
CO2	Explain and design the test benches for verification of the given IP core or HDL based design.	Usage
CO3	Able to explain the System Modeling with Tasks and Functions	Usage
CO4	Design digital circuits for implementing a signal processing algorithm using different Verilog modeling styles.	Assessment

List of Experiments

S. No	Description	Hours
1	Learn how to use of XILINX ISE simulator by writing the Verilog code to simulate a half adder; where a, b are 1-bit input	1
2	Write data flow Verilog HDL model for Half Adder using different modeling technique	1
3	Write data flow Verilog HDL model for Full Adder	1
4	Using structural modeling of Verilog HDL perform the following: Half adder with proper test stimulus. Full adder (using half adder module of part 1) with proper test stimulus	2
5	Write down Verilog HDL code of the following Data flow model of 2x1 Multiplexer with proper test stimulus. Structural model of 2x1 Multiplexer with proper test stimulus.	2
6	Write the hardware description of a 4:1 multiplexer Using behavioural modelling Using structural modelling Using 2:1 multiplexer	2
7	Write down Verilog HDL code of 2x1 Multiplexer and 4x1 Multiplexer using if-else statement, case statement and ternary operator.	2
8	Write the hardware description of a 2:1 multiplexer and 4:1 multiplexer, each input and output of this multiplexer is of 4-bit.	2
9	Write the hardware description of a 4-bit adder/Subtractor	2
10	Write data flow Verilog HDL model for Encoder/ Decoder using any modeling technique	2
	Simulate the Verilog HDL code for the following	

11	• D-Latch using proper test stimulus. • D-flip flop using proper test stimulus.	2
12	Write the Verilog HDL code for a JK Flip flop, and its test-bench	1
13	Write the hardware description of a 8-bit register with shift left and shift right modes of operation	2
14	Write the Verilog HDL code of a 4-bit PRBS (pseudo-random Binary sequence) generator using a linear feed-back shift register and test it. Choose your own polynomial for the generator	2
Total Lab hours		24

Suggested/Resources:

1. John P. Uyemura: Introduction to VLSI Circuits and Systems, John Wiley & Sons, , Inc, 2002
2. Samir Palnitkar, "Verilog HDL", Pearson Education (2nd edition)

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.80	2.60	2.20	1.20	1.00	1.00	1.00	1.20	1.40	

Advance Communication Lab

COURSE CODE: 18B17EC673

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Understand the concepts of various digital modulation techniques.
2. To get familiar with the practical implementation of various communication systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of LabView, MATLab and WiCOMM-T kit	Familiarity
CO-2	Understand the design, application and practical implementation of various digital modulation techniques.	Usage
CO-3	Gain practical experience of the functioning of advance communication systems.	Usage
CO-4	Analyze the performance of communication systems.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to LabView, Matlab and WiComm-T (SDR) kit.	2
2	Implementation of Quadrature Phase Shift Keying Modulation and Demodulation system. • Constellation plots • Phase and frequency offset	2
3	Implementation of Quadrature Amplitude Modulation and Demodulation (QAM) • 16-QAM • 64-QAM	2
4	Implementation of Gaussian Minimum Shift Keying (GMSK) modulation and demodulation system.	2
5	Performance analysis of baseband digital communication link.	2
6	Eye diagram measurement for Inter Symbol Interference (ISI).	2
7	To demonstrate Time Division Multiplexing and Demultiplexing.	2
8	To demonstrate Frequency Division Multiplexing and Demultiplexing.	2
9	Implementation of source coding techniques.	2
10	Implementation of channel coding and error control coding techniques.	2
11	To demonstrate GSM communication system.	2
12	To demonstrate OFDM communication system.	2
Total Lab hours		24

Suggested/Resources:

1. T.S. Rappaport, "Wireless Communication", 2nd Edition, Prentice Hall, 2002.
2. Lazos Hanzo: OFDM and MC-CDMA:a primer, 1st Edition, Wiley-IEEE Press, 2006.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	2	3	2	1	2	1	2	1	3	2.08
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	3	3	2	1	1	1	1	2	1	3	2.00
CO4	3	3	3	3	2	1	1	1	1	1	1	3	1.92
Average	3.00	3.00	2.75	2.75	2.50	1.25	1.00	1.25	1.00	1.50	1.00	3.00	

Network Analysis and Synthesis

COURSE CODE: 18B1WEC534

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Circuit analysis in the S domain using Laplace transforms. Analysis of two port networks.
2. Design and analysis of filters and attenuators. Elements of realizability and synthesis of one port networks.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the need and foundation of network analysis	Familiarity
CO-2	Analyze two port networks, filters and attenuators	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains for network analysis and synthesis.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Laplace transform and its application in circuit analysis : Laplace Transformation, laplace transforms of some important functions, properties of laplace transforms, step function, impulse function, laplace transform of periodic functions, inverse transforms, initial and final value theorms. Circuit elements in the S domain, Transfer function, use of transfer function in circuit analysis, the transfer function and the convolution integral, the transfer function and the steady state sinusoidal response, the impulse function in circuit analysis.	8
2	S- Domain Analysis: Concept of complex frequency, physical interpretation of complex frequency, transform impedance and transform circuits, series and parallel combinations of elements, terminal pair or ports, network function for one port and two port networks, poles and zeros of network functions, significance of poles and zeros, properties of driving point functions, properties of transfer functions, necessary condition for a driving point function, necessary condition for transfer functions, time domain response from pole zero plot, amplitude and phase response from pole zero plot, stability criteria for an active network, routh criteria.	9
3	Two- Port networks: Two port networks, open circuit (Z) parameters, short circuit (Y) parameters, transmission (ABCD) parameters, inverse transmission (A' B'C'D')parameters, Hybrid (H) parameters, Inverse Hybrid(G) parameters, inter relationships of different parameters, interconnection of two port networks, T and ∏ representations, terminated two port network, lattice network, Image networks.	8
4	Filters and Attenuators: Classification of filters, filter networks, equation of filter networks, classification of pass band and stop band, characteristic impedance in the pass band and stop bands, constant –K low pass filter, constant –K high pass filter, m derived T- section, band pass filter, band elimination filter, attenuators, T- type attenuator, ∏- type attenuator, lattice attenuator, bridged –T attenuator, L- type attenuator, equalizers, inverse network, series equalizer, full series equalizer, shunt equalizer, full shunt equalizer, constant – resistance equalizer, bridged –T attenuation equalizer, bridged –T phase equalizer, lattice attenuation equalizer, lattice phase equalizer.	9
5	Elements of realizability and synthesis of one port networks : Hurwitz polynomials, positive real functions, frequency response of reactive one ports, synthesis of reactive one ports by foster's method, synthesis of reactive one ports by Cauer's method, synthesis of R-L network by foster's method, synthesis of R-L network by Cauer's method, synthesis of R-C network by foster's method, synthesis of R-C network by Cauer's method.	8
Total lectures		42

Suggested Text Book(s):

1. A sudhakar, shyammohan S palli" Circuits and networks Analysis and synthesis", Fifth Edition, Tata Mcgraw Hill.
2. M E Van Vakenburg,"Network Analysis and synthesis", Third edition, Pearson

Suggested Reference Book(s):

1. Ravish R Singh, "Network Analysis and synthesis", Tata Mcgraw Hill.

Other useful resource(s):

Link to topics related to course: https://nptel.ac.in/courses/106105154

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Network Analysis and Synthesis)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	3	3	1	1	1	2	2	2	2	2.08
CO-2	2	3	2	3	2	1	1	1	2	2	1	2	1.83
CO-3	2	3	3	2	2	1	1	1	2	2	1	2	1.83
CO-4	2	3	3	3	2	1	1	1	2	3	1	2	2.00
Average	2.25	2.75	2.75	2.75	2.25	1	1	1	2	2.25	1.25	2	

Communication Engineering

COURSE CODE: 18B1WEC535

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Signals & Systems, Basic Course in Probability.

Course Objectives:

1. To understand the use of communication in the field of satellites and the concept of spread spectrum.
2. To make the students familiar with the implications of laws of information theory and coding with reference to the application in communication engineering.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Students will be familiar with the various fields/trends of communications like Satellite communication, Information theory and coding, and spread spectrum technique related to radio and telecommunication.	Familiarity
CO-2	To analyze the error performance of digital modulation systems in the presence of noise.	Assessment
CO-3	Design link power budget for satellite communication.	Assessment
CO-4	Design the channel based on given constraint using information theory.	Assessment
CO-5	Apply various codes like linear block codes, convolution codes etc. for channel performance analysis.	Usage
CO-6	Analyze the performance of spread spectrum systems in jamming environment.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Baseband Transmission and Pass band Digital Modulation: Matched Filter, Inter Symbol Interference, Eye Pattern, Overview of ASK, FSK, PSK, and QAM, Basics of MSK, Signal Constellations, Probability of error analysis of modulation schemes.	6
2	Communication Link Analysis: The Channel, Error-Performance Degradation, Sources of Signal Loss and Noise, Received Signal Power and Noise Power, Link Budget Analysis, Noise Figure, Noise Temperature, System temperature, Sample Link Analysis.	9
3	Fundamental Limits in Information Theory: Uncertainty, Information, Entropy, Source-Coding Theorem, Data Compaction, Discrete Memoryless Channels, Mutual Information, Channel Capacity, Channel-Coding Theorem.	9
4	Error-Control Coding: Introduction, Linear Block Codes, Syndrome, Syndrome Decoding, Cyclic Codes, Generator Polynomial, Parity-Check Polynomial, Convolution Codes, Code tree, Trellis Diagram, Maximum Likelihood Decoding of Convolution Codes, Viterbi Algorithm.	10
5	Spread-Spectrum Modulation: Introduction, Pseudo-Noise Sequences, Direct Sequence Spread Spectrum with coherent BPSK, Signal-Space Dimensionality and Processing Gain, Frequency Hopping Spread Spectrum.	8
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin, "Communication Systems", 4th Ed., John Wiley & Sons, 2004.
2. Bernard Sklar and P. K. Ray, "Digital Communications: Fundamentals and Applications", 2nd Ed., Pearson Education, 2012.

Suggested Reference Book(s):

1. B. P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", 4th Ed., Oxford, 2010.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/117105131/16
Link to NPTEL course contents: https://nptel.ac.in/courses/117101053/1
Link to NPTEL course contents: https://nptel.ac.in/courses/117105136/1

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Communication Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO-2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO-3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO-4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO-5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
CO-6	3	3	2	2	2	3	3	2	2	3	3	3	2.58
Average	3.00	3.00	2.83	2.50	2.17	2.17	1.83	1.83	1.17	2.00	2.50	3.00	

Fundamentals of Digital Image Processing

COURSE CODE: 18B1WEC536

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Describe and explain basic principles of digital image processing.
2. Design and implement algorithms for basic and advanced image analysis
3. Assess the performance of image processing algorithms and systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Analyze general terminology of digital image processing.	Familiarity
CO-2	Examine various types of images, intensity transformations and spatial filtering.	Familiarity
CO-3	Develop Fourier transform for image processing in frequency domain.	Assessment
CO-4	Evaluate the methodologies for image segmentation, restoration etc.	Usage
CO-5	Implement image process and analysis algorithms.	Usage
CO-6	Apply image processing algorithms in practical applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Digital Image Fundamentals: Introduction, Image sensing and acquisition, Image Sampling and quantization, Spatial and Gray level resolution, Zooming and Shrinking, Relationships between pixels, Linear and Nonlinear operations.	7
2	Image Enhancement in the Spatial Domain: Gray Level Transformation, Histogram Processing Techniques, Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filters.	8
3	Image Enhancement in the Frequency Domain: Properties of frequency domain, two dimensional Fourier Transform and its properties, Correspondence between filtering in spatial and frequency domain, Smoothing and Sharpening frequency domain filters, Homomorphic Filtering.	6
4	Image Restoration: Model of the Image Degradation/Restoration Process, Noise Models, Noise reduction in spatial domain and frequency domain, Inverse filtering, Wiener filtering.	6
5	Image Compression: Fundamentals of image compression, Image compression models, Variable length coding, Huffman coding, Near optimal variable length coding, Arithmetic coding, Constant area coding, Run length coding, Image compression standards (JPEG, JPEG2000).	7
6	Image Segmentation: Detection of discontinuities (point, line edge), Edge Linking and Boundary Detection, Thresholding, Basic global Thresholding, Adaptive Thresholding, Region-Based Segmentation.	8
Total lectures		42

Suggested Text Book(s):

1. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, fourth Edition, Pearson Education, 2018.

Suggested Reference Book(s):

1. Anil K. Jain, “Fundamentals of Digital Image Processing”, First Edition, PHI Learning Pvt. Ltd, 2015.

2. Willliam K Pratt, “Digital Image Processing”, Fourth Edition, John Willey, 2007.
3. S.Sridhar, ”Digital Image Processing”, Second Edition, Oxford University Press, 2016
4. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Fundamentals of Digital Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	2	1	1	2	2	2	2	1.92
CO-2	3	3	3	3	3	1	1	1	2	2	1	2	1.08
CO-3	3	2	2	2	3	2	1	1	2	2	1	2	1.92
CO-4	3	3	3	3	2	1	1	1	2	3	2	2	2.17
CO-5	3	3	2	3	2	2	2	2	2	3	3	2	2.42
CO-6	3	2	3	3	2	2	2	1	2	2	3	2	2.00
Average	3.00	2.50	2.50	2.67	2.3	1.67	1.33	1.17	2.00	2.33	2.00	2.00	

Digital Filter Design and Applications

COURSE CODE: 18B1WEC631

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Signals & Systems

Course Objectives:

1. To understand the basics and practical limitations of digital filterdesign.
2. To study the digital filters applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of the digital Filters	Familiarity
CO-2	Design and analysis of the FIR filters	Usage
CO-3	Design and analysis of the IIR filters	Usage
CO-4	Understand the limitation of IIR and FIR Filters in implementation	Familiarity
CO-5	Study the applications of digital filters	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1.	Introduction to Filters: Butterworth filters, Chebyshev filters, Elliptical Filters, Bessel Filters, FIR filters, IIR Filters.	10
2.	FIR Filters: One dimensional FIR filter design using rectangular window, triangular window, hamming window, dolph-chebyshev window, and Kaiser window. Two dimensional FIR filter design.	10
3	IIR Filters: One dimensional and two dimensional IIR filter design.	06
4.	Practical Considerations in implementation Coefficient Quantization in Digital Filters, Scaling in Fixed-Point Arithmetic, Quantization Noise.	04
5.	Applications of Digital Filters, Noise suppression, Enhancement of selected frequency ranges, Removal or attenuation of selected frequencies, Bandwidth limiting. Analysis of digital filters for signal and image processing using MATLAB, and LABVIEW.	12
	Total	42

Suggested Text Book(s):

1. Andreas Antoniou, Digital Filters: Analysis, Design and Applications, Second edition, Tata Mc Graw Hill, 1999.
2. M. Ahmadi, M. Azimi-Sadjadi, R. Gorgui-Naguib, R. King, A. Kwabwe,Digital Filtering in One and Two Dimensions, 1st Edition, Springer Science & Business Media,1989.
3. Jackson, Leland B. Digital Filters and Signal Processing: with MATLAB®Exercises. Springer Science & Business Media, 2013.

Suggested Reference Book(s):

1. Wu-Sheng Lu, Two-Dimensional Digital Filters, 1st Edition, CRC Press,2001.
2. Winder, Steve, Analog and digital filter design, 2nd Edition, Newness Publishers, 2002
3. Schaumann, Rolf, Haiqiao Xiao, and Van V. Mac. "Design of Analog Filters 2nd Edition (The Oxford Series in Electrical and Computer Engineering)." (2009).
4. C. Britton Rorabaugh, “Digital Filter Designer's Handbook: With C++ Algorithms”,2nd,Volume1, McGraw-Hill, 1997
5. Jolyon M.DeFreitas, Digital Filter Design and solutions, Artech house publishers, 2005

6. Andreas Antoniou, Digital Filters: Analysis, Design and Applications, Second edition, Tata Mc Graw Hill, 1999
7. Taylor, Fred. Digital filters: principles and applications with MATLAB. Vol. 30. John Wiley & Sons, 2011.

Other useful resource(s):

1. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/lecture-17-design-of-fir-digital-filters/, I Prof. Alan V. Oppenheim
2. http://web.stanford.edu/class/archive/ee/ee264/ee264.1072/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital Filter Design and Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	1	1	1	1	3	1	1	1.8
CO-2	3	3	3	3	3	1	1	1	2	2	2	2	2.2
CO-3	3	3	3	3	3	1	1	1	2	2	2	3	2.3
CO-4	3	3	3	3	3	3	3	3	3	2	2	2	2.8
CO-5	3	3	3	3	3	3	3	3	3	2	2	1	2.7
Average	3	3	3	2.8	2.8	1.8	1.8	1.8	2.2	2.2	1.8	1.8	

Intelligent Control Systems

COURSE CODE: 18B1WEC632

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Fundamentals of Control Systems

Course Objectives:

1. To explain the basic disciplines of artificial intelligence, and show the possibilities of their application in control systems, for creation of intelligent control systems.
2. To study the control-theoretic foundations such as stability and robustness analysis in the framework of intelligent control.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Obtain a basic understanding of artificial intelligence techniques and know how these techniques are applied to engineering problems	Familiarity
CO-2	Select appropriately from a range of techniques when implementing control systems.	Assessment
CO-3	Know control-theoretic foundations such as stability and robustness in the frame work of intelligent systems and control.	Assessment
CO-4	Design and develop control system using artificial intelligence techniques and exposure to many real world control problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Intelligent Control Systems: Machine intelligence, Sensors, Actuators, Controllers, External I/O devices, Applications	4
2	Computational Intelligence Techniques Applied to Control Systems Design I: Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks	8
3	Computational Intelligence Techniques Applied to Control Systems Design II: Fuzzy logic, Knowledge representation and inference mechanism, Fuzzy neural networks, Deep neural networks, Optimization techniques	8
4	Typical and Special Fuzzy Controllers: Fuzzy and expert control, Parametric optimization of fuzzy logic controller, System identification using neural and fuzzy neural networks	6
5	System Stability and Robustness Analysis: Lyapunov's stability theory and Passivity Theory	4
6	Adaptive Control: Direct and Indirect adaptive control, and Self-tuning Pill Controllers	6
7	Applications to Engineering Problems: Robot manipulator control, Flight control, Under-actuated systems control, Creation of a Neural Networks with MATLAB Neural Network Toolbox	6
Total lectures		42

Suggested Text Book(s):

1. Kevin M. Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park, CA, 1998.
2. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing", Pearson, 1997.

Suggested Reference Book(s):

1. Panos J. Antsaklis, Kevin M. Passino, eds., "An Introduction to Intelligent and Autonomous Control", Kluwer

Academic Publishers, Norwell, MA, 1993.
2. T. Nanayakkara, F. Sahin, and M. Jamshidi, Intelligent Control Systems with an Introduction to Systems of Systems, CRC Press, 2008.
3. A. E. Ruano, "Intelligent Control Systems using Computational Intelligence Techniques", IET, 2005.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108104049/
2. Link to COURSERA course contents: https://www.coursera.org/learn/neural-networks-deep-learning/home/welcome

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Intelligent Control Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	2	1	1	1	2	2	2	2.2
CO-2	2	3	3	3	2	2	1	1	2	1	1	2	2
CO-3	2	2	2	3	2	2	1	1	1	2	1	3	1.8
CO-4	2	2	3	3	2	1	1	2	2	2	2	2	2
CO-5	2	2	3	3	3	2	1	1	2	1	1	2	2
Average	2.2	2.4	2.8	3	2.4	1.8	1	1.2	1.6	5	2.2	2.4	

Optical Communication Systems

COURSE CODE: 18B1WEC633

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Communication Systems

Course Objectives:

1. To understand the constituents of the fiber optics communication system and optoelectronics.
2. To have an in depth knowledge of practically used optical communication systems

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand basics of optical communication systems.	Familiarity
CO-2	The principles that govern optical communication systems.	Familiarity
CO-3	Behavior of light as electromagnetic waves in different types of fibers.	Assessment
CO-4	The hardware components required to implement optical communication systems.	Assessment
CO-5	To efficiently design an optical communication system for practical purpose.	Usage
CO-6	The practical techniques involved in optical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Fiber optics and Optoelectronics, Historical developments, Fiber optic communication system, Advantages, Emergence as a key technology, Role of Fiber optics technology.	5
2	Ray Propagation in Optical Fibers: Review of fundamental laws of optics, Ray propagation in Step-index and Graded-index Fibers, Effect of material dispersion, The combined effect of multipath and material dispersion, Calculation of rms pulse width.	8
3	Wave propagation in Waveguides: Maxwell's equations, Solution in a inhomogeneous medium, Planar optical waveguide, TE modes of a symmetric step-index planar waveguide, Power distribution and confinement factor, Modal analysis of an ideal SI optical fiber.	8
4	Single-mode Fibers and Multimode Fibers: Single-mode fibers, Characteristics parameters of SMFs, Dispersion in SMFs, Attenuation in SMFs, Graded-index fibers, Limitations of multimode fibers.	7
5	Optoelectronic Sources and Detectors: Fundamental aspects of semiconductor physics, the p-n junction, Current densities and injection efficiency, The basic principle of optoelectronic detection. Types of photodiodes, Photoconducting detectors, Noise considerations.	8
6	Optoelectronic Modulators and Amplifiers: Review of basic principles, Electro-optic modulators, Semiconductor optical amplifiers.	6
Total lectures		42

Suggested Text Book(s):

1. Optical Fiber Communications, John M Senior, 3rd Edition, PHI, 2009.
2. Fiber Optic Communication Systems, Govind P. Agarwal, 4th Edition, Wiley, 2010.
3. Fiber Optics and Optoelectronics, R.P. Khare Oxford University Press, 2015

Suggested Reference Book(s):

1. Fiber Optic Communications, S. Kumar and M. J. Deen, Wiley,2014.
2. Optical Fiber Communications, G. Keiser, 5th Edition, Tata McGraw Hill, 2009.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117101002/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.66	2.66	2.66	2.66	1	1	1	2	2.5	1.66	2	

Microwave Theory and Techniques

COURSE CODE: 18B1WEC746

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basics of Electromagnetic Engineering

Course Objectives:

1. To learn the basic principles of microwave generators and amplifiers.
2. To have foundations on microwave design principles and measurement.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To identify different microwave components and their applications.	Familiarity
CO-2	To study the performance of specialized microwave tubes such as klystrons.	Familiarity
CO-3	To understand the principle of operation of magnetrons, traveling wave tubes and BWOs.	Assessment
CO-4	To understand the working principle of microwave solid state devices and their applications.	Assessment
CO-5	To design of microwave filters, amplifiers and oscillators.	Usage
CO-6	To learn about microwave power, VSWR, impedance and attenuation measurements.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to microwaves, Scattering matrix of microwave waveguide junction, properties of S-matrix, E-plane tee, H-plane tee, magic tee, attenuators, directional couplers, ferrite devices, Faraday rotation, gyrator, isolator, circulators and cavity resonators.	8
2	Microwave Tubes: Limitations and losses of conventional tubes at microwave frequencies, microwave tubes-O-type and M-type classifications. O-type tubes: Two cavity klystron-structure, reentrant cavities, velocity modulation process and apple gate diagram, bunching process and small signal theory- expression for output power and efficiency. Reflex Klystron-Structure, velocity modulation and apple gate diagram, mathematical theory of bunching, power output, efficiency, oscillating modes and output characteristics.	9
3	Microwave Crossed-Filed Tubes: M-Type tubes: Introduction, cross filed effects, magnetrons-different types, cylindrical travelling wave magnetron-Hull cut-off and Hartree conditions, mode of resonance and PI-mode of operations, separation of PI-mode, output characteristics, Backward wave crossed field oscillator (Carcinotron).	6
4	Helix TWTs: Significance, types and characteristics of slow wave structures, structure of TWT and amplification process (qualitative treatment), suppression of oscillations, gain considerations.	5
5	Microwave Solid state Devices: Introduction, classification, applications. TEDs-Introduction, Gunn diodes-principle, RWH theory, characteristics, modes of operations, IMPATT diode, TRAPATT Diode, BARITT diode, PIN diode, Tunnel diode.	7
6	Microwave Design Principles and Measurements: Microwave Filter Design, Microwave Amplifier Design, Low Noise Amplifier Design, Microwave Oscillator Design, VSWR and impedance measurement, attenuation measurement and power measurement.	7
Total lectures		42

Suggested Text Book(s):

1. Samuel Y.Liao, " Microwave Devices and Circuits", 3rd Edition, Pearson education, 2003.
2. R.E.Collin, "Foundations for microwave Engineering", 2nd Edition, Tata Mc Graw Hill, 1992.
3. Pozar, David M. "Microwave engineering", 4th Edition, John Wiley & Sons, 2013.

Suggested Reference Book(s):

1. Annapurna Das, Sisir.K.Das, "Microwave Engineering",1st Edition, Tata McGraw Hill, 2000.

Other useful resource(s):

1. Link to topics related to course: https://nptel.ac.in/courses/108101112

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Microwave Theory and Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	1	1	2	1	2	2	2	2	1	1.58
CO-2	2	3	3	3	3	1	2	1	1	2	1	1	1.92
CO-3	3	2	2	2	3	1	1	1	2	2	2	1	1.83
CO-4	2	3	3	3	2	1	2	1	1	3	1	2	2.0
CO-5	3	3	3	3	2	1	1	1	2	3	2	1	2.08
CO-6	3	3	2	2	3	1	1	1	1	2	1	2	1.83
Average	2.5	2.5	2.5	2.33	2.33	1.16	1.33	1.16	1.5	2.33	1.5	1.33	

Next Generation Communication Systems

COURSE CODE: 18B1WEC745

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of wireless communication and probability theory

Course Objectives:

1. To analyze the channel parameters effects on communication system.
2. Understanding of advanced techniques employed for improvement of communication system.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of communication system and various standards used in different generation.	Familiarity
CO-2	Understand the modeling of channel used in communication.	Familiarity
CO-3	Analyze the effect of various parameters on the performance of communication system.	Assessment
CO-4	Demonstrate the various techniques for performance improvement of communication system	Assessment
CO-5	Apply advanced techniques to next generation communication system	Usage

Course Contents:

Unit	Contents	Lectures required
1	CDMA: Introduction to various generation of cellular communication systems and standards, Introduction to CDMA and Spread Spectrum, Generation and Properties of PN Sequences, correlation between PN Sequences, Walsh Code, Variable tree OVSF, LFSR, Rake Receiver, Near-Far effect, Multi user CDMA uplink and downlink.	9
2	Channel Characterization of Next generation communication system: BER and SNR analysis of wired and wireless channels, Effect of various channel parameters on performance of wireless communication system, Doppler shift.	6
3	Diversity & Equalization: Diversity System Model, Receiver Diversity: selection diversity, feedback diversity, maximal ratio combining, equal gain combining, Equalizers, Types of Equalizers: linear equalizers, non-linear equalizers.	9
4	Principles of OFDM and MIMO wireless communication: Introduction to OFDM, OFDM Block Diagram, MIMO Wireless Communication, Benefits of MIMO Technology, MIMO OFDM Building Block, Capacity Comparisons of SISO, SIMO, MISO, and MIMO.	9
5	Singular Value Decomposition, Software Defined Radio , Cognitive Radio	9
Total lectures		42

Suggested Text Book(s):

1. T.S. Rappaport, “Wireless Communication”, 2nd Edition, Prentice Hall.,2002.
2. A.Goldsmith, “ Wireless communication” 1st Edition , Cambridge University Press,2005.
3. Ye Li and Gordon L. Stuber, “Orthogonal Frequency Division Multiplexing for Wireless Communications” 1st Edition, Springer, 2006.

Suggested Reference Book(s):

1. Huseyin Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007.

2. Hui Liu, "OFDM based broadband wireless networks: design and optimization" , 1st Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117104099/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Next Generation Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	1	2	2	2	1	2	2	2	1.92
CO-2	3	3	3	3	2	2	1	1	1	2	2	2	2.08
CO-3	3	3	3	3	2	1	1	1	1	2	1	1	1.83
CO-4	2	3	3	2	2	1	1	1	1	2	1	3	1.83
CO-5	3	2	2	2	3	2	2	1	1	2	2	2	2.00
Average	2.6	2.8	2.6	2.4	2	1.6	1.4	1.2	1	2	1.6	2	

FPGA based Instrumentation System Design

COURSE CODE: 18B1WEC744

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Digital Electronics, Basic Electronics

Course Objectives:

1. Learn and understand the FPGA design flow
2. Learn to implement basic arithmetic circuits and DSP algorithms in FPGA using IP cores.
3. Learn to determine circuit speed, to check timing violations and techniques to fix them.
4. Learn to apply the knowledge gained to break an algorithm into arithmetic functions and implement in FPGA with/without using IP cores.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Explain the concept and basic structures of Field Programmable Gate Array (FPGA), and techniques to implement programmable logic circuits using typical FPGA design flow	Familiarity
CO-2	Implementing basic arithmetic circuits and ASICs for simple DSP functions, such as filters using user defined or vendor provided IP cores	Assessment
CO-3	Determining circuit speed, checking timing violations and techniques to fix the timing violations.	Usage
CO-4	Design issues in cross clock domains communication in high-speed ASIC design	Assessment
CO-5	Break any given algorithm to sub-modules and implement the same on FPGA using HDLs and various IP cores	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to FPGA : From discrete logic to FPGAs, flexibility and functionality, FPGA vs Programmable DSPs, FPGA technology - roadmap, clocking, data and sample rates, slices and configurable logic blocks, memory and registers, performance ratings, families DSP and FPGAs: FPGA elements for DSP algorithms, FPGA- Based System Design Examples	6
2	Verilog HDL: Data types, operators, Multiplexers, decoders, adders, Subtractor, de-multiplexers, flip-flops, counters, state machine, ALU with adder/Subtractor and shifter, multiply and divide hardware synthesis, memory, using a test bench for verification and simulation Concept of state machine and VHDL implementation, simulation synthesis, verification, : FSM Types, Implementation in HDLs, a simple computer design, other Design examples and case studies	12
3	Digital System Design: Combinational and sequential circuits, Classification of sequential circuits, Registers. Design & analysis of synchronous and asynchronous sequential circuits: Counters.	6
4	Embedded Systems & FPGAs: FPGA as a systems on chip platform, FPGA on-chip network standards, FPGAs as custom microcontroller and hybrid DSP microcontroller devices, Multiple cock domains on chip, Multi FPGA systems, multiple-clock domains, program and data memory, SRAM and DRAM., ROM, PAL, and PLA, Timing Constraints, using IP cores: instantiation and simulations	6
5	Instrumentation System: Basic concepts, Weighted Resistor D/A converter, A/D Converter, programmable ICs, digital potentiometers, various data communication and interfacing protocols (UART, SPI, I2C and others) and FPGA implementation case studies	12
Total lectures		42

Suggested Text Book(s):

1. Michael D. Ciletti: Advanced Digital Design with the Verilog HDL, 2nd Edition, Pearson, 2011.
2. Jean- Pierre Deschamps, Gustavo D. Sutter, Enique Cano: Guide to FPGA Implementation of Arithmetic Functions, Springer, 2012.

Suggested Reference Book(s):

1. Hamblen, J.O, Hall, T.S, and Furman, M.D., "Rapid Prototyping of Digital Systems, SOPC Edition." Springer, 2008.
2. Zainalabedin, Navabi, "Digital Design and Implementation with Field Programmable Devices", Springer, 2005.
3. Jean- Pierre Deschamps, Gery Jean Antoine Bioul, Gustavo D. Sutter, "Synthesis of Arithmetic Circuits-FPGA ASIC and Embedded Systems" , a John Wiley & sons, inc, publication, 2006.

Other useful resource(s):

1. FPGA manufacturer's web resources:
   Altera Inc.: https://www.altera.com/products/general/fpga/stratix-fpgas/about/stx-asic-prototyping.html
   Xilinx: https://www.xilinx.com/applications/asic-prototyping.html
2. Other Journal/research resources:
   http://biomedical-engineering-online.biomedcentral.com/articles/10.1186/1475-925X-13-126
   http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.470.6049&rep=rep1&type=pdf
3. NPTEL Resources
   https://nptel.ac.in/courses/117108040/
   https://nptel.ac.in/courses/117106092/55
   https://nptel.ac.in/syllabus/117108040/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (FPGA based Instrumentation System Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	2	2	x	1	3	3	1	2	1.67
CO-2	3	2	3	1	2	2	x	x	3	1	1	2	1.67
CO-3	3	3	3	2	3	2	x	x	3	2	1	2	2.00
CO-4	3	3	3	2	3	2	x	x	3	2	1	2	2.00
CO-5	3	3	3	3	3	2	x	x	3	2	1	2	2.08
Average	3	2.6	3	1.8	2.6	2	0	0	3	1.6	1	2	

Optimum Array Processing

COURSE CODE: 18B1WEC743

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Linear Algebra, Signals & Systems and Discrete-Time Signal Processing

Course Objectives:

1. To introduce traditional methods of array signal processing for multi-antenna transceivers.
2. To develop a deeper understanding of several major topics of array processing including spatial filtering (beamforming), direction of arrival estimation.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Extrapolate the fundamentals of arrays, signal models in various domains.	Familiarity
CO-2	Apply the principal techniques of smart beam conformation and estimation of the direction multichannel arrival.	Assessment
CO-3	Design in array processing algorithms that solve specific problems in the field of communications.	Assessment
CO-4	Evaluate the advantages of using multiple antennas for the reception and/or transmission of radio navigation.	Assessment
CO-5	Analyze the implications at system level of the use of antenna arrays in different applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Array Processing, Applications, Uniform Linear Array, Array Steering, Array Performance Measures, Linear Aperture, Broadband Arrays, Uniform Rectangular Arrays.	6
2	Optimum Waveform Estimation: Optimum Beamformers, Discrete Interference, Spatially Spread Interference, Beamforming for Correlated Signal and Interferences, Broadband Beamformers	8
3	Adaptive Beamformers: Estimation of Spatial Spectral Matrices, Recursive Least Squares (RLS), Gradient Algorithms, LMS Algorithms, Eigenspace and DMR Beamformers.	9
4	Parameter Estimation: Maximum Likelihood (ML) Estimator, Parameter Estimation Model, Cramer-Rao Bounds, Maximum Likelihood Estimation, Quadratic Algorithms, Subspace Algorithms, Sensitivity, Robustness, and Calibration.	10
5	Optimum Detection: Classic Binary Detection, Matched Subspace Detector, Spatially Spread Gaussian Signal Processes, Adaptive Detection.	9
Total lectures		42

Suggested Text Book(s):

1. Harry L. Van Trees: Optimum Array Processing: Part IV of Detection, Estimation, and Modulation Theory, 1st Edition, Wiley-Interscience, 2002.
2. Simon Haykin: Array Signal Processing, 1st Edition, Prentice Hall, 1984.

Suggested Reference Book(s):

1. Jacob Benesty, Israel Cohen, Jingdong Chen: Fundamentals of Signal Enhancement and Array Signal Processing, 1st Edition, Wiley-IEEE Press, 2017.
2. Steven M. Kay: Fundamentals of Statistical Signal Processing, 1st Edition, Prentice Hall, 1993.

Approved in Academic Council held on 25.10.2018

Other useful resource(s):

1. Link to NPTEL course contents: Array Processing and Array Gain with Uniform Linear Arrays https://nptel.ac.in/courses/117104117/16
2. Link to MITOPENCOURESEWARE: Adaptive Antennas and Phased Arrays https://ocw.mit.edu/resources/res-ll-002-adaptive-antennas-and-phased-arrays-spring-2010/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Optimum Array Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	1	1	1	1	1	2	1	3	1.67
CO-2	3	3	2	2	2	1	1	1	1	2	2	3	1.92
CO-3	3	3	3	2	3	1	1	1	1	2	3	3	2.17
CO-4	3	3	3	3	2	3	2	1	1	3	3	3	2.50
CO-5	3	3	3	3	3	2	1	1	2	3	3	3	2.50
Average	3.00	2.80	2.60	2.40	2.20	1.60	1.20	1.00	1.20	2.40	2.40	3.00	

Antenna and Wave Propagation

COURSE CODE: 18B1WEC742

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To make students understand the fundamental theory and concepts of antenna and propagation of waves.
2. Make them aware to the radiation characteristics of different types of antennas, their measurement and applications of various antennas.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fundamental theory and concepts of radiation, antenna and significance of antenna parameters.	Familiarity
CO-2	Assess the power and usefulness of UHF, VHF and Microwave Antennas, microstrip patch antennas their requirements, specifications, characteristics and design relations.	Assessment
CO-3	To define and distinguish between different phenomenon of wave propagation (ground wave, space wave and sky wave), their frequency dependence, and estimate their characteristics, identifying their profiles and parameters involved.	Assessment
CO-4	Reveal different applications of the various types of antenna to solve engineering and other problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	ANTENNA FUNDAMENTALS: Introduction, Radiation Mechanism – single wire, 2 wire, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Beamwidths, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency Antenna temperature and signal to noise ratio.	7
2	RADIATION OF ELECTRIC DIPOLE: Potential functions and the electromagnetic field, Oscillating electric dipole derivations for E and H field components in spherical coordinate systems, Power Radiated by a current element, Application to antennas, Radiation from quarter wave monopole and half wave dipoles, equality of directional patterns and effective lengths of transmitting and receiving antennas, directional properties of dipole antennas, antenna feeding methods.	8
3	ANTENNAS FOR SPECIAL APPLICATIONS: Broadband antenna, Frequency-independent antenna, log periodic antennas, Antennas design consideration for satellite communication, antenna for terrestrial mobile communication systems, GPR, Embedded antennas, UWB, Plasma	6
4	ANTENNA MEASUREMENTS: Radiation Pattern measurement, Distance requirement for uniform phase, uniform field amplitude requirement, Introduction to phase measurement; Gain Measurement: Comparison method, Near field method, Introduction to current distribution measurement, Measurement of antenna efficiency, measurement of Noise figure and noise temperature of an antenna polarization measurement, Anechoic Chamber measurement.	7

5	WAVE PROPAGATION - I: Concepts of Propagation – frequency ranges and types of propagations. Ground Wave Propagation–Characteristics, Parameters, Wave Tilt, Flat and Spherical Earth Considerations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF & Skip Distance – Calculations for flat and spherical earth cases, Optimum Frequency, LUHF, Virtual Height, Ionospheric Abnormalities, Ionospheric Absorption.	7
6	WAVE PROPAGATION – II: Fundamental Equation for Free-Space Propagation, Basic Transmission Loss Calculations. Space Wave Propagation – Mechanism, LOS and Radio Horizon. Tropospheric Wave Propagation – Radius of Curvature of path, Effective Earth's Radius, Effect of Earth's Curvature, Field Strength Calculations, M-curves and Duct Propagation, Tropospheric Scattering.	7
Total lectures		42

Suggested Text Book(s):

1. E.C.Jordan and Balmain: Electromagnetic waves and Radiating Systems, 2nd Edition, PHI, 2006
2. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 2nd Edition,2007.

Suggested Reference Book(s):

1. John D.Kraus, Ronald J Marhefka and Ahmad S Khan: Antennas for all Applications, Tata McGraw-Hill Book Company, 3rd Edition, 2007.
2. G.S.N.Raju: Antenna Wave Propagation, Pearson Education, 1st Edition,2004.
3. R.E.Collins, "Antenna and Radiowave propagation", 3rd Edition, Mc Graw Hill, 2005.

Other resources/ learning website:

www.nptel.ac.in
www.antenna-theory.com

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Antenna and Wave Propagation)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	3	2	1	1	1	2	3	3	2.17
CO-2	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-3	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-4	3	3	3	3	3	3	3	2	3	3	3	3	2.92
Average	3	3	2.75	2.75	3	2.25	1.5	1.25	1.5	2.25	2.5	3	2.40

OFDM and Applications

COURSE CODE: 18B1WEC736

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn the fundamental concepts of high rate OFDM communication system focusing on the physical layer.
2. Analyze the design requirements of various OFDM standards.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Learn the fundamentals of OFDM communication system.	Familiarity
CO-2	Performance analysis of OFDM signals over AWGN and wideband channels.	Assessment
CO-3	Demonstrate the challenging issues in OFDM system.	Assessment
CO-4	Apply OFDM to the practical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction and Basics of OFDM: High rate wireless applications; Wireless channel; Interference and noise; OFDM concept and system model- block diagram, design of the OFDM signal, OFDM system model, FFT implementation, cyclic extension, power spectrum and spectrum efficiency, synchronization errors; Channel capacity and OFDM; Comparison with single-carrier; Design example; Performance of an uncoded OFDM system.	10
2	Impairments of Wireless Channels to OFDM Signals: Time varying impairments; Effect of sampling clock offset; Effect of timing offset; Effect of delay spread; System Non Linearity. Other Multicarrier Modulation; Mathematical modeling and analytical evaluation of the BER of OFDM System.	8
3	OFDM Transmission over Gaussian channels and wideband channels. Synchronization: Overview of synchronization schemes- timing offset estimation, frequency offset estimation, acquisition versus tracking; Timing offset estimation-pilot based methods, non-pilot based methods; Frequency offset estimation- pilot based methods, non-pilot based methods; Joint time and frequency offset estimation and correction.	8
4	OFDM versus-MC-CDMA Peak Power Ratio: The peak power problem; Distribution of PAP ratio; Maximum PAPR of an N subcarrier OFDM signal; PAPR reduction with signal distortion; Limits for distortion-less PAPR-reduction; Techniques for distortion-less PAPR reduction-selective mapping, optimization techniques, modified signal constellation; PAPR reduction effect on the system performance; PAPR reduction for multicarrier CDMA.	8
5	OFDM applications: MIMO OFDM- synchronization for MIMO OFDM, A practical OFDM system: Fixed broadband wireless access, system requirements, parameter selection, communication protocol, frame structure, MAC consideration and conformance.	8
Total lectures		42

Suggested Text Book(s):

1. Ye Li and Gordon L. Stuber: Orthogonal Frequency Division Multiplexing for Wireless Communications,

1st Edition, Springer, 2006.
2. Ramjee Prasad: OFDM for Wireless Communications Systems, 1st Edition, Artech House Publishers, 2004.
3. Lazos Hanzo: OFDM and MC-CDMA: A primer, 1st Edition, Wiley-IEEE Press, 2006

Suggested Reference Book(s):

1. Richard Van Nee: OFDM for Wireless Multi-Media Communication, 1st Edition, Artech, House Publishers, 2000.
2. Hui Liu: OFDM based Broadband Wireless Networks: Design and Optimization, 1st Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117104099/
2. Link to topics related to course:
   https://nptel.ac.in/courses/117104099 /27
   https://nptel.ac.in/courses/117104099 /28
   https://nptel.ac.in/courses/117104099 /29
   https://nptel.ac.in/courses/117104099 /30
   https://nptel.ac.in/courses/117104099 /31
   https://nptel.ac.in/courses/117104099 /34

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (OFDM and its Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	3	1	1	1	2	2	1	3	1.92
CO-2	3	3	3	3	3	2	1	1	2	2	1	3	2.25
CO-3	2	2	3	3	2	1	1	1	2	1	1	3	1.83
CO-4	2	1	3	3	3	2	1	1	1	1	1	2	1.75
Average	2.5	2	3	2.5	2.75	1.5	1	1	1.75	1.5	1	2.75	

Robotic Systems and Control

COURSE CODE: 18B1WEC737

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Differential equations and Linear algebra, knowledge of Control Systems

Course Objectives:

1. The Robotics' chief objective has always been associated with working for new and updated technologies for example embedded systems, microcontrollers and VLSI.
2. To use the robotic system for logic building & programming and to solve many engineering problems.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Students will be equipped with the automation and brief history of robot and applications.	Familiarity
CO-2	Students will be equipped with the principles of various sensors, actuators and their applications in robots.	Assessment
CO-3	Be able to analyze any physical system using mathematical model.	Assessment
CO-4	Be able to do the path planning on robotic systems using various control strategies.	Assessment
CO-5	Students will be equipped with the simulation and hands on robotic kits	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Robotics: Introduction – brief history, types, classification and usage, Science and Technology of robots, textbooks and research journals, introduction to simulation environment.	3
2	Elements of Robots -- joints, links, actuators, and sensors: Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force- torque sensors, proximity and distance measuring sensors, and vision.	10
3	Robot Arm Kinematics and Dynamics: forward kinematics, Inverse kinematics, Lagrange formulation of dynamics	8
4	Motion Planning and Control: Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators	10
5	Modeling and Control of Flexible Robot Manipulators: Models of flexible links and joints, Kinematic modeling of multi-link flexible robots, Dynamics and control of flexible link manipulators, Numerical simulations studies	6
6	Robot Programming: MATLAB and other simulation platforms, Hands on experiment on robotic kits, working and implementing various Ad-on modules.	5
Total lectures		42

Approved in Academic Council held on 25.10.2018

Suggested Text Book(s):

1. J. J. Craig, "Introduction to Robotics- Mechanics and Control", Pearson, 3rd Edition, 2009.
2. Spong and Vidyasagar, "Robot Dynamics and Control", Wiley Student Edition, John Wiley and Sons, 2013.

Suggested Reference Book(s):

1. Sciavicco and Siciliano, "Modeling and Control of Robot Manipulators", Springer, 2nd Edition, 2002.
2. D.K. Pratihar, "Fundamentals of Robotics", Narosa Publishing House, 1st Edition, 2017.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/112101099/
2. Other links to course material: https://nptel.ac.in/downloads/112101098/
3. Material provided by IIT Bomaby under eLSI project

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Robotic Systems and Control)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	1	1	2	3	3	1.9
CO-2	3	3	3	2	3	2	1	1	1	1	2	3	2
CO-3	3	3	3	3	3	3	2	1	3	2	2	3	2.6
CO-4	3	3	3	3	3	3	2	1	2	2	3	3	2.5
CO-5	3	3	3	3	3	3	2	1	2	1	2	3	2.4
Average	3	3	2.8	2.6	2.8	2.6	1.6	1	1.8	1.6	3	3	

Time-Frequency Analysis and Applications

COURSE CODE: 18B1WEC738

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Signals and Systems

Course Objectives:

1. Study and analyze various spectral analysis and time-frequency analysistools.
2. Study the time-frequency analysis tools based algorithm for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept of the spectral analysis.	Familiarity
CO-2	Familiar with the basics concept of the short time Fourier transform /continuous wavelet transform.	Assessment
CO-3	Understand the basic concept of the distribution based Time-Frequency Analysis tools.	Assessment
CO-4	Develop the TFA based algorithms for various applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to spectral analysis: Parametric and Non-Parametric methods.	6
2.	Basics of Time Frequency Analysis: Basic Concepts & Definition, Duration-Bandwidth Principle, Joint Energy Density, Short-time FT, its Properties & Applications, MATLAB based implementation of STFT	6
3.	Wavelet transforms: Continuous Wavelet Transform and its Computational aspects, Scale to Frequency conversion, Scalogram, Scaling Function and Wavelets, Applications of CWT, MATLAB based implementation of wavelet transform.	8
4	Distributions based time-frequency tools: Wigner-Ville Distributions, Interference in WVD, its Applications, Cohen's class, Smoothed WVD, Ambiguity Functions, Affine Class, and MATLAB based implementation of distribution based time-frequency analysis tools.	8
5.	Case studies: Radar and Sonar, Economic Data Analysis with the Gabor Spectrogram, Gabor Spectrogram in Ultrasonic Nondestructive Materials testing, Applications of Time-Frequency Analysis in spectrum sensing, Biomedical signal processing, Genomics data analysis.	14
Total lectures		42

Suggested Text Book(s):

1. Hayes MH. Statistical digital signal processing and modeling. John Wiley & Sons; 2009.
2. Boashah B. Time-frequency signal analysis and processing: a comprehensive reference. Academic Press; 2015.

Suggested Reference Book(s):

1. S. Mallat, A Wavelet Tour of Signal Processing - The Sparse Way. Elsevier, Third Edition, 2009.
2. Cohen, Leon, Time-frequency analysis. Vol. 778. Prentice hall, 1995.
3. Chen, Victor C., and Hao Ling. Time-frequency transforms for radar imaging and signal analysis. Artech house, 2002.

Other useful resource(s):

1. http://nptel.ac.in/courses/117101001/: The lecture series on Wavelets and Multi-rate Digital Signal Processing

created by Prof. Vikram M. Gadre in NPTEL.

2. Time-frequency toolbox (MATLAB) is available for download from http://tftb.nongnu.org/
3. http://nptel.ac.in/courses/117101001/1

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Time-Frequency Analysis and its Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	2	1	1	1	1	3	3	3	2
CO-2	2	3	3	3	3	1	1	1	2	3	3	3	2.3
CO-3	3	3	3	3	3	1	1	1	2	3	3	3	2.4
CO-4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	2.5	3	2.75	2.75	2.75	1.5	1.5	1.5	2	3	3	3	

Design of Modern Antennas

COURSE CODE: 18B1WEC852

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Transmission lines and E.M waves.

Course Objectives:

The main objective of the course is to

1. Learn the mechanism of antenna, antenna performance parameters.
2. Design and analysis of various antennas for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To define overall needs and constraints of RF systems and antennas.	Familiarity
CO-2	To understand the mechanism of antenna radiation.	Familiarity
CO-3	To design and analyze various antennas for specific application.	Usage
CO-4	Size reduction techniques, Broad banding and multi band operation techniques in antenna design.	Usage
CO-5	Evaluate the opportunities involving technology, a product or a service required for developing a startup idea.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: antenna types, radiation mechanism, use of potential functions, radiated field, far field, antenna parameters, radiation pattern, directivity, numerical evaluation of directivity, gain, efficiency, impedance, loss resistance, polarization, linear polarization, circular and elliptic polarization, equivalent area, Friss equation.	6
2.	Dipole Antennas: Potential functions for analysis of radiated fields, Duality theorem, Reciprocity theorem for antennas, Radiation from current element, infinitesimal dipole, finite length dipole, half wave dipole	6
3.	Antenna Arrays: Analysis and Synthesis Review of antenna array basics, Linear arrays, circular array, planar (2D) arrays, sum and difference patterns, Effect of mutual couplings, Phased array antennas, scan Principles, Non uniform arrays, Dolph Chebyshev Arrays Binomial Arrays.	6
4	Broadband and Frequency Independent Antennas Helical antenna: Normal mode and axial mode helix Spiral antennas, Log Periodic antennas.	5
5.	Aperture Antennas Radiation from an aperture in an infinite ground plane, Radiation from rectangular and circular apertures, Radiation from a slotted rectangular waveguide Horn antenna: E plane and H plane sectoral horns, Pyramidal horn, Conical horn Reflector antennas parabolic reflector, methods of analysis, dual reflector antennas, offset reflector antenna, gain and efficiency calculations, scanning properties and cross polarization Lens antennas and their applications	7
6	Microstrip Antennas Rectangular patch antenna: cavity and transmission line models, Circular patch antenna Coupling mechanisms, circular polarization, Microstrip arrays, Broadband and Multi band microstrip antennas, Compact Microstrip Antennas.	7
7	Dielectric Resonator Antennas Introduction, radiation mechanism, advantages of DRA, types of DRA, feeding techniques, design method, modes.	5
Total lectures		42

Suggested Text Book(s):

1. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 3rd Edition, 2009.
2. Antennas for All Applications, J. D. Kraus and R. J. Marhefka, McGraw-Hill, Inc, 3rd Ed., 2007.

3. Rectangular Dielectric Resonator Antennas, Rajveer S. Yaduvanshi Harish Parthasarathy, Springer, 1st Ed, 2016.

Suggested Reference Book(s):

1. Antennas and Radio wave Propagation, R. E. Collin, McGraw-Hill, Inc, 3rd Ed, 2005.
2. Modern Antenna Design, T. A. Milligan, John Wiley & Sons, 2nd Ed., 2005.
3. Antenna Arrays, R. L. Haupt, John Wiley & Sons, Inc., 1st Ed., 2010.
4. Antenna Theory and Microstrip Antennas, D. G. Fang, CRC Press, 1st Ed., 2009.

Other useful resource(s):

Link to NPTEL course contents

1. https://nptel.ac.in/courses/108101092/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Design of Modern Antennas)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	2	1	1	1	2	2	2	2.2
CO-2	2	3	3	3	2	2	1	1	2	1	1	2	1.9
CO-3	2	2	2	3	2	2	1	1	1	2	1	3	1.8
CO-4	2	2	3	3	2	1	1	2	2	2	2	2	2
CO-5	2	2	3	3	3	2	1	1	2	2	1	2	2
Average	2.2	2.4	2.8	3	2.4	1.8	1	1.2	1.6	1.6	1.4	2.2	

Soft Computing Techniques

COURSE CODE: 18B1WEC851

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Develop the skills to gain a basic understanding of neural network theory and fuzzy logic theory.
2. Introduce students to artificial neural networks and fuzzy theory from an engineering perspective

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fuzzy logic and the concept of fuzziness and concepts of neural networks	Familiarity
CO-2	Demonstrate knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic	Assessment
CO-3	Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications	Assessment
CO-4	Apply fuzzy rules and neural network learning rules and design paradigms to solve engineering and other Problems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to fuzzy set theory: Probabilistic reasoning, Fuzzy sets, mathematics of fuzzy set theory, operations on fuzzy sets, comparison of fuzzy and crisp set theory.	4
2	Fuzzy mapping: one to one mapping, max-min principle, extension principle, implication rules – mamdani implications. Membership functions: Universe of discourse, mapping inside fuzzy domain, fuzzy membership mapping methods, and application to real world problems.	10
3	Artificial Neural Networks (ANN) and their biological roots and motivations. Comparison Between Artificial and Biological Neural Networks, Applications of Neural network. Network Architecture ,Taxonomy of neural networks: feed forward and recurrent networks with. Merits and limitations of neurocomputing.	8
4	Types of learning, supervised and unsupervised learning laws . Learnig Laws : Hebb's rule, Delta rule, Widrow - Hoff (The Least-Mean-Square) learning rule, correlation learning rule, instar and outstar learning rules, Competitive learning, Credit Assignment Problem, Error Correction learning, Memory based learning.	9
5	The Perceptron and its learning law, Classification of linearly separable patterns, Multi-Layer Perceptron, Supervised Learning, Back-Propagation Learning law. Feed forward networks, Recurrent Networks.	6
6	Winner takes-all Networks, Competitive Learning, Kohonen's Self organizing Maps, Introduction to Adaptive Resonance Theory.	5
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin: Artificial Neutral Networks, 2nd Edition, Pearson, 2008.
2. Yegna Narayanan: Artificial Neural Networks, 2nd Edition, Prentice-Hall of India, 2010.
3. S.N. Sivanandam, S.N Deepa: Principles of Soft Computing, 3rd Edition, Wiley, 2019.

Approved in Academic Council held on 25.10.2018

Suggested Reference Book(s):

1. Bart Kosko: Neural Network and Fuzzy Systems: A Dynamic System Approach to Machine, Prentice-Hall 1998
2. L. Fausett: Fundamentals of Neural Networks: Architectures, Algorithms, and Applications, Prentice-Hall, Reprint 2013
3. Jack M. Zurada: Introduction to Artificial Neural Systems, PWS Publishing Co., 2nd Edition, 2002.

Other useful resource(s):

Link to NPTEL course contents

1. http://nptel.ac.in/courses/117105084/
2. http://nptel.ac.in/courses/108104049/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Soft Computing Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	2	1	1	1	2	2	2	1.92
CO-2	3	2	3	3	3	1	1	1	1	2	2	2	2.00
CO-3	3	2	3	3	3	2	1	1	1	2	2	2	2.08
CO-4	3	3	3	3	3	2	3	1	1	3	3	3	2.58
Average	3	2.25	2.75	2.75	3	1.75	1.5	1	1	2.25	2.25	2.25	2.15

Fault-Tolerant Communication Systems

COURSE CODE: 18B1WEC850

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Computer Communication Network

Course Objectives:

1. Apply the concepts of reliability and fault-tolerance for the communication systems.
2. Propose the communication system design approach for the service predictability.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Historical background and basic approaches of fault-tolerance in communication system.	Familiarity
CO-2	Integration of integrity, survivability, availability, protection & restoration.	Familiarity
CO-3	Routing schemes used for fault-tolerance.	Assessment
CO-4	Planning and testing of fault-tolerant architectures.	Assessment
CO-5	Fault-tolerant planning for the development of mission-critical communication and systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Historical perspective, best-effort service, guaranteed service, QoS. Fault, Failure and Error, reliability engineering in network design. Performance failure, breakdown failure, reliability, resiliency and performability.	6
2	Network availability, protection & restoration. Continuity and availability in communication network, Concepts and methodology of protection and restoration.	9
3	Fault-tolerant planning for MPLS based network, Optical networks and SONET/SDH network.	8
4	Fault-tolerant schemes for ad-hoc networks, sensor network and IoT.	8
5	Development routing schemes for handling proactive and passive faults.	6
6	Mission-critical network planning considering faults failure and recovery.	5
Total lectures		42

Suggested Text Book(s):

1. Jean-Philippe Vasseur, Mario Pickavet, Piet Demeester, Network Recovery: Protection and Restoration of Optical, SONET-SDH, IP, and MPLS, Elsevier, 1st edition, 2004.
2. Mathew Liotine, Mission-Critical Network Planning, Artech House, 1st edition, 2003.
3. Dhiraj K. Pradhan, Fault-tolerant Computer System Design, Prentice-Hall, 1st edition, 1996.

Suggested Reference Book(s):

1. Martin L. Shooman, Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design, John Wiley & Sons, 1st edition, 2002.
2. Arun K. Somani, Survivability and Traffic Grooming in WDM Optical Networks, Cambridge University Press,1st edition,2006.

Other useful resource(s):

1. Link to NPTEL course contents:

i. https://nptel.ac.in/courses/107106009/13,
ii. https://nptel.ac.in/courses/106106168/12

2. Link to topics related tocourse:
   i. http://www.staff.city.ac.uk/~sm377/FTcourse.html
   ii. http://www2.cs.uidaho.edu/~krings/CS449/index.html
   iii. http://euler.ecs.umass.edu/ece655/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes(2) -10 Attendance – 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Fault Tolerant Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	2	2	2	2	2	2	2	2.08
CO-2	2	3	3	3	1	1	3	3	3	2	1	1	2.16
CO-3	2	2	2	3	1	1	2	1	2	2	2	3	1.91
CO-4	3	1	3	2	3	2	1	2	2	3	1	2	2.08
CO-5	3	2	3	3	2	2	2	3	1	2	2	3	2.33
Average	2.6	2	2.6	2.6	1.8	1.6	2	2.2	2	2.2	1.6	2.2	

Cognitive Radio Networks

COURSE CODE: 18B1WEC849

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the principles, applications and challenges of cognitive radio technology.
2. Analyze the design of wireless networks based on cognitive radio technology.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the fundamental issues regarding dynamic spectrum access and radio-resource management.	Familiarity
CO-2	Analyze the emerging issues in cognitive radio network.	Assessment
CO-3	Apply different spectrum sharing models in the Cognitive Radio Network.	Assessment
CO-4	Apply efficient sharing of the unutilized spectrum among cognitive and licensed users while avoiding interference to the licensed user due to cognitive user's transmission	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Cognitive Radio: Spectrum scarcity, Spectrum white space, Fixed spectrum allocation, Software defined radio (SDR), Limitations of SDR, Evolution of cognitive radio, Dynamic spectrum access, Introduction to cognitive radio concept, Cognitive cycle, Functions of cognitive radio; spectrum sensing, spectrum management, spectrum mobility, Cognitive radio architecture, Interference temperature and its models.	8
2	Spectrum Sensing and Challenges in Cognitive Radio Network: Hypothesis model for spectrum sensing, Types of spectrum sensing; Non-cooperative sensing, Cooperative sensing, Interference-based sensing, Matched filter detection, Energy detection, Cyclostationary feature detection, advantages and disadvantages of various spectrum sensing techniques, False alarm, Miss detection, Optimal sensing framework for infrastructure based cognitive radio network. Research challenges in spectrum sensing, spectrum management and spectrum mobility, potential applications of cognitive radio, IEEE 802.22 for WRANs	8
3	Spectrum Sharing and Management: Dynamic spectrum Access (DSA): models and architectures, Opportunistic spectrum access (OSA), Antenna Systems, MIMO systems, Smart antenna and beamforming. SDR architecture, Software tunable analog radio components, Reconfigurable digital radio technologies.	8
4	Cross Layer Adaptation and Security in Cognitive Radio: Why we need cross-layer design, adaptation and optimization, Cognitive radio cross layer design, security challenges in cognitive radio. OFDM for Cognitive Radio: OFDM based cognitive radio, Why OFDM is a good fit for Cognitive radio, Challenges to cognitive OFDM systems, Multiband OFDM, A step toward cognitive-OFDM: standards and technologies.	9
5	Cognitive Radio Regulation and Standardization: regulatory issues and new spectrum management regimes, spectrum planning, Spectrum authorization, Standards and international activities. UWB Cognitive Radio: Introduction, Fundamentals of impulse radio Ultra Wideband, Cognitive radio requirements versus IR-UWB, Merging impulse radio with cognitive radio.	9
Total lectures		42

Suggested Text Book(s):

1. Ekram Hossain, Dusit Niyato and Zhu Han: Dynamic Spectrum Access and Spectrum Management in Cognitive Radio Networks, 1st Edition, Cambridge University Press, 2009.
2. Huseyin Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007.
3. Bruce A. Fette: Cognitive Radio Technology, 2nd Edition, Academic Press, April 6, 2009.

Suggested Reference Book(s):

1. Yang Xiao and Fei Hu: Cognitive Radio Networks, 1st Edition, CRC Press, 2008.
2. Linda E. Doyle: Essentials of Cognitive Radio, 1st Edition, Cambridge University Press, 2009.

Other useful resource(s):

Link to GIAN IIT Kanpur course contents (10 lecture series):
https://www.youtube.com/watch?v=SljXFf0vgvw&list=PL48UwQJyfW3SmrjLgl5LrVciqfWz9XazY

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Cognitive Radio Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	2	1	2	2	3	2.08
CO-2	3	3	3	3	2	1	1	1	2	2	1	2	2
CO-3	3	3	3	2	2	2	1	2	2	2	1	3	2.17
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	3	3	2.75	2.5	2	1.5	1	1.5	1.75	2.25	1.5	2.75	

RF Engineering

COURSE CODE: 18B1WEC848

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of Electromagnetic Engineering

Course Objectives:

1. To lay strong foundations in RF and microwave engineering.
2. To apply the theoretical knowledge acquired in the design of different components in microwave systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To have a thorough knowledge of RF and microwave components	Familiarity
CO-2	To have a thorough knowledge about different parameters involved in microwave receiver and their significance	Assessment
CO-3	To have a thorough knowledge about different parameters involved in microwave receiver and their significance	Assessment
CO-4	To design different RF filters according to certain specifications	Usage
CO-5	To understand active microwave components and their use in different applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Review of Waves and Transmission Lines: Wave Propagation, Transmission Line Equations, Reflection, Transmission, and impedance for a Terminated Transmission Line, Voltage Standing-Wave Ratio, Decibels, insertion Loss, Return Loss, Smith Charts, S-Parameters, Impedance Matching Networks.	5
2	Receiver System Parameters: Typical Receivers, System Considerations, Natural Sources of Receiver Noise, receiver Noise Figure and Equivalent Noise Temperature, Compression Points, Minimum detectable Signal and Dynamic Range, Third-Order Intercept Point and Intermodulation, spurious Responses, Spurious-Free Dynamic Range	8
3	Transmitter and Oscillator Systems: Transmitter Parameters, Transmitter Noise, Frequency Stability and Spurious Signals, Frequency Tuning, Output Power, and Efficiency, Intermodulation, Crystal Reference Oscillators, Phase-Locked Oscillators, frequency Synthesizers	6
4	Design of RF filters: Periodic Structures, Filter Design by the Image Parameter Method, Filter Design by the Insertion Loss Method, Characterization by Power Loss Ratio Filter transformations, Filter Implementation, Stepped-Impedance Low-Pass	9
5	Fabrication Technologies: Lumped Elements for RF circuits: Basic Design of Lumped elements, Lumped element modeling, printed inductors, MIM capacitor and Interdigital capacitor, Monolithic Integrated circuit technology (MIC), Monolithic microwave integrated circuit (MMIC) technology, material, RF printed circuit boards.	9
6	Wireless Communication Systems: Friis Transmission Equation, Space Loss, Link Equation and Link budget, Effective Isotropic Radiated Power and G/T Parameters, Radio/Microwave Links, Satellite Communication Systems, Mobile Communication Systems and Wireless cellular phones, Personal Communication Systems	5
Total lectures		42

Suggested Text Book(s):

1. Kai Chang, "RF and Microwave Wireless Systems",1st Edition, John Wiley & Sons, 2002.
2. Pozar, David M. "Microwave engineering", 4th Edition, John Wiley & Sons, 2013.
3. Bahl I.J "Lumped Elements for RF and Microwave Circuits"1st Edition, Artech House,2003.

Suggested Reference Book(s):

1. R.E.Collin, "Foundations for microwave Engineering", 2nd Edition, John Wiley & Sons, 2007.
2. Annapurna Das, Sisir.K.Das, "Microwave Engineering",1st Edition, Tata McGraw Hill, 2000.

Other useful resource(s):

Link to NPTEL course contents:
https://nptel.ac.in/courses/117101119/
https://nptel.ac.in/courses/117105138/

Link to topics related to course:
https://nptel.ac.in/courses/117105138/ 1 to 18
https://nptel.ac.in/courses/117101119/ 1 to 14

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (RF Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.8
Average	2.4	2.4	2.4	2.4	2.2	2.0	1.0	1.0	1.0	2.2	1.0	2.0	

Medical Image Processing

COURSE CODE: 18B1WEC847

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce various medical imaging modalities.
2. To teach the requirement and development of different blocks of computer aided diagnosis for medical images.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.	Familiarity
CO-2	Acquire an ability to analyze and process medical images.	Usage
CO-3	Understand different feature extraction techniques and classifiers used for image classification.	Usage
CO-4	Understand the role of computer aided diagnosis for medical images.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Image Processing:- Acquisition of Images, Image Sampling and quantization; Spatial and histogram based enhancement; Noise modeling, Image restoration. Image transformation.	8
2	Edge Detection and Image Segmentation: Gradient based edge detectors. Intensity thresholding based image segmentation; Region growing and region splitting algorithm; watershed segmentation.	8
3	Medical Imaging Modalities: Working principle, applications and limitations of Computed tomography , X-ray, Magnetic resonance imaging, Ultrasound imaging, and Positron emission tomography; Various Artifacts.	6
4	Image Texture: Types of texture parameters: Statistical analysis of texture (First order statistics and Second order statistics), Grey level co-occurrence matrix, grey-level run length matrix.	8
5	Pattern classification: Supervised and Unsupervised pattern classification, Neural Network classifier, Support Vector Machines.	6
6	Case Studies: Pre-processing, Segmentation, Feature extraction, and Classification of medical images.	6
Total lectures		42

Suggested Text Book(s):

1. Chris Solomon, Toby Breckon: Fundamental of Digital Image Processing, 1st Ed., John Wiley & Sons, 2011.
2. Rangaraj M. Rangayyan: Biomedical Image Analysis, 1st Ed., CRC Press, New York , 2004.

Suggested Reference Book(s):

1. RC Gonzalez, RE Woods, Digital Image Processing, 3rd Ed., Pearson Publisher, 2008.
2. Kayvan Najarian, Robert Splinter: Biomedical Signal and Image Processing, 2nd Ed., CRC Press, 2012

3. Tamal Bose: Digital Signal and Image Processing, 1st Ed., John Wiley & Sons, 2003.

Other useful resource(s):

http://www.nptelvideos.in/2012/12/digital-image-processing.html (Prof P.K. Biswas, IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Medical Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	2	3	1	2	1	2	2.42
CO-2	3	3	3	3	2	0	0	1	2	3	1	1	1.83
CO-3	3	3	3	3	3	1	1	1	1	2	1	1	1.92
CO-4	3	3	3	3	3	3	2	3	2	2	3	3	2.75
Average	3.00	3.00	3.00	3.00	2.75	1.75	1.25	2.00	1.50	2.25	1.50	1.75	

Design of Dependable Systems

COURSE CODE: 18B1WEC846

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Graph Theory and Computer Communication Network

Course Objectives:

1. Incorporate the concepts of dependability in the design of critical systems.
2. Propose an architectural framework for the design of systems based on information and communication technologies.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Introduction to dependability attributes such as availability, reliability, safety, QoS, SLA in systems.	Familiarity
CO-2	Familiarization with dependability analysis approaches.	Familiarity
CO-3	Application of methodologies used dependability modeling.	Usage
CO-4	Design of dependability schemes on practical systems.	Usage
CO-5	Evaluation of survivability of networks, dependability evaluation of networks.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Dependability attributes: availability, reliability, safety, QoS, SLA.	5
2	Analysis Approach of Dependability: The failure process, failure semantics, fault handling and maintenance, failure rate, probability distributions, series/parallel systems, Markov models.	6
3	Dependability modeling: Block diagrams and state diagrams - discrete and continuous time Markov models. Fault Trees and Fault Injection. Modeling of software failure, prediction of software failure rates, and impact of software failures on systems behavior.	8
4	Design of Dependability: Fault tolerance, types of redundancy, design principles and mechanisms. Fault detection, tolerance and recovery, Lifetime improvement.	8
5	Prediction of hardware failure rates: Software/hardware and architectural approaches space, information and time redundancy. Design for testability. Model-driven approaches Diagnosis.	7
6	Internet QoS, survivability of networks, dependability evaluation of networks taking the traffic carrying (QoS) requirements into account. QoS guarantee analysis. Some applications of dependability in IT related services.	8
Total lectures		42

Suggested Text Book(s):

1. Ajit Kumar Verma, Srividya Ajit, Dependability of Networked Computer-based Systems, Springer Series in Reliability Engineering, 1st edition, 2013.

2. J.C. Geffroy, G. Motet, Design of Dependable Computing Systems, Springer-Science-Business Media B.V., 1st edition, 2002.

3. J.C. Laprie, Dependability: Basic Concepts and Terminology, Springer-Verlag,1st edition,1992.

Suggested Reference Book(s):

1. Dhiraj K. Pradhan, Fault-tolerant computer system design, Prentice-Hall,1st edition, 1996.
2. M.L. Shooman, Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design, Wiley, 1st edition, 2002.
3. Krishna B. Misra, Handbook of Performability Engineering, Springer, 1st edition,2008.

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc16_oe01/preview
2. Link to topics related to course:https://www.mdh.se/utbildning/livslangtlarande/prompt/design-of-dependable-and-fault-tolerant-embedded-systems-1.120193?l=en_UK

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Design of Dependable Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	2	2	2	2	2	2	2	2
CO-2	2	2	2	2	3	2	2	1	1	3	2	2	2
CO-3	3	2	2	2	2	3	3	2	2	2	3	2	2.33
CO-4	2	3	2	3	3	2	3	2	3	3	2	3	2.6
CO-5	2	2	3	2	2	3	3	1	2	2	2	2	2.16
Average	2.4	2.2	2.2	2	2.4	2.4	2.6	1.6	2	2.4	2.2	2	

Artificial Intelligence Techniques

COURSE CODE: 18B1WEC838

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are good programming skills, basic data structures and algorithms, and some university level mathematics.

Course Objectives:

1. Learn to create expert systems which exhibit intelligent behavior.
2. Learn to create expert systems which exhibit the capability to learn, demonstrate, explain and advice its users.
3. Learn to help machines finding solutions to the complex problems.
4. Learn to design human like machines in a computer friendly manner.
5. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze the need and foundation of Artificial Intelligence	Familiarity
CO-2	Study the Intelligent agents that receive percepts from the environment and perform actions	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Artificial Intelligence (AI): The History and foundations of AI, Philosophy of AI, Intelligent Agents and Knowledge based Systems, AI Problem Solving, AI Learning and AI Perception, Real World AI.	8
2	Intelligent Agents: Agents and Environments, The concept of Rationality, Performance Measures, The structure of Agents, Agent Programs, Simple reflex Agents, Model based reflex Agents, Goal based Agents, Utility based Agents, Learning Agents.	8
3	Problem Solving: Problem solving Agents, Formulating Problems, Searching for Solutions, Uninformed Search Strategies, Breadth first search, Depth first search, Depth limited Search, Bidirectional search, Informed Search Exploration, Constraint Satisfaction Problems.	7
4	Knowledge and Reasoning: Knowledge based agents, Reasoning Patterns in Propositional Logic, Forward and Backward Chaining, Back tracking Algorithm, First Order Logic, Knowledge Representation, Uncertain Knowledge and Reasoning	7
5	Learning, Perception and Action: Learning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees, Ensemble Learning, Knowledge in Learning, Statistical Learning, Reinforcement Learning, Perceptional Analysis, Communication as Action	6
6	Applications of AI Techniques: Semantic Interpretation, Probabilistic Language Processing, Robotic Hardware and Software Architectures, Probabilistic Inference, Planning and Search, Localization, Tracking and Control.	6
Total lectures		42

Suggested Text Book(s):

1. Stuart J. Russel and Peter Norvig: Artificial Intelligence: A Modern Approach, Third Edition, Pearson Education Limited, 2014.
2. E. Rich and K. Knight: Artificial Intelligence and Applications, Third Edition, Tata McGraw Hill, 2012.

Suggested Reference Book(s):

1. P. Kulkarni and P. Joshi: Artificial Intelligence, Second Edition, PHI Learning Private Limited, 2015.
2. P. H. Winston: Artificial Intelligence and Applications, Third Edition, PHI Learning Private Limited, 2017.

Other useful resource(s):

Link to topics related to course:

https://nptel.ac.in/courses/106105077/
https://nptel.ac.in/courses/106105079/
https://www.tutorialspoint.com/artificial_intelligence/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Artificial Intelligence Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Radar Principles and Applications

COURSE CODE: 18B1WEC839

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic Knowledge of Electromagnetic Engineering

Course Objectives:

1. To acquire fundamentals of radar systems.
2. To identify different components used in radar system and analyze different types of radar systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To know the basic building blocks of a radar system.	Familiarity
CO-2	To have an in-depth knowledge on different types of signals that are used in radar systems.	Familiarity
CO-3	To know about the ambiguity function and its significance in radar signal processing.	Assessment
CO-4	To know the principle of operation of sonar and sound propagation in water.	Assessment
CO-5	To apply the knowledge acquired in this course in real time applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to radar and radar equation, radar wave propagation. Radar block diagram, resolutions in range velocity, radar equation, types of radars. Atmospheric effects on radar wave propagation. Radar cross section, radar displays.	6
2	CW,FM and MTI radar systems: Doppler radar, CW radar, FMCW radar, multiple frequencies CW radar, MTI radar, delay line cancellers, staggered pulse repetitive frequencies, pulse Doppler radar, limitations of MTI radar.	8
3	Radar waveforms: Matched filter, Pulse compression, ambiguity function, LFMCW, HFM waveforms, Doppler invariant waveforms.	8
4	Radar antennas and radar tracking: Radar antennas and radar tracking Antenna basics, antenna arrays, analysis and synthesis of antenna arrays. Buttler's matrix, tracking of radar. Synthetic aperture radar.	9
5	Radar transmitters and receivers: Noise figure, amplifiers, mixers, power dividers and phase shifters.	8
6	Introduction to sonar: Under water propagation, types of sonar, sonar transducers.	3
Total lectures		42

Suggested Text Book(s):

1. Peebles, Peyton Z. "Radar principles" ,Wiley India Edition, John Wiley & Sons, 2007.
2. Skolnik, Merrill I. " Introduction to radar systems", 3rd Edition, McGraw-Hill Education,2002.
3. Elliot, Robert S. "Antenna theory and design", Wiley India Edition, John Wiley & Sons, 2007.
4. Lawrence J.Ziomek, "An introduction to Sonar Systems Engineering", 1st Edition, CRC Press,2017.

Suggested Reference Book(s):

1. Stutzman, Warren L., and Gary A. Thiele. "Antenna theory and design", Wiley India Edition, John Wiley & Sons, 2012.

2. Pozar, David M. “Microwave engineering”, 4th Edition, John Wiley & Sons, 2013.
3. Cheng, David Keun. “Field and wave electromagnetics”, 2nd Edition, Pearson Education India, 1989.
4. Mark. A Richards, “Fundamentals of Radar Signal Processing”, 2nd Edition, McGraw-Hill Professional Engineering, 2014.

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/101108056/
2. Link to topics related to course:
   https://nptel.ac.in/courses/101108056/1 to 7
   https://ocw.mit.edu/resources/res-ll-001-introduction-to-radar-systems-spring-2007/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Radar Principles and Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.5
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.6
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	1.8
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.5
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.6
Average	2.4	2.4	2.4	2.4	2.2	2.0	1.0	1.0	1.0	2.2	1.0	2.0	

Industrial Automation and Control

COURSE CODE: 18B1WEC840

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Electrical Networks, Control Systems

Course Objectives:

1. Overall exposure to the technology of Industrial Automation and Control as widely seen in factories of all types both for discrete and continuous manufacturing.
2. To explain the general architecture of Industrial Automation Systems and develop automation systems using PLC programming.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Students will be able to handle any kind of process by framing it in block diagram, mathematical model and different process variables.	Familiarity
CO-2	Students will be able to handle different types of controller like electronic, pneumatic and hydraulic.	Assessment
CO-3	Understand principle of working of various signal conditioners used with Temperature, Displacement, Optical and various miscellaneous other sensors.	Assessment
CO-4	Students will be able to implement different control schemes to various processes.	Assessment
CO-5	Students will be able to design relay logic for various processes.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to industrial automation and Control, Architecture of industrial automation systems	2
2	Sensors and Measurement Systems: Temperature measurement; Pressure and force measurements; Displacement and speed measurement; Flow measurement techniques; Measurement of level, humidity, pH etc	8
3	Signal conditioning and processing; Estimation of errors and calibration	4
4	Motion Actuators: Types of motion and motion conversion, Electric linear actuators, Electric rotary actuators, Fluid-power linear actuators, Fluid-power rotating actuators	4
5	Process Control: PID control, Controller tuning, Implementation of PID controllers, Special control structures : Feed-forward and ratio control, Predictive control, Cascade control, Overriding control, Selective control, Split rangecontrol	8
6	Sequence Control, PLCs and Relay Ladder Logic: Scan cycle, RLL syntax; Structured design approach; Advanced RLL programming; Hardware environment	8
7	Robotics and Numerical Control : Basic robot definitions, Basic manipulator configurations, Numerical control systems, Robot kinematics, Robot grippers, Robot sensors, Robot programming, General considerations for robot applications	8
Total lectures		42

Suggested Text Book(s):

1. S. Mukhopadhyay, S. Sen and A. K. Deb, “Industrial Instrumentation, Control and Automation”, Jaico

Publishing House, 2013.
2. George Stephanopoulos, “Chemical Process Control: An Introduction to Theory and Practice”, 1st edition, Prentice Hall India, 2012.

Suggested Reference Book(s):

1. R. Krishnan, “Electric Motor Drives, Modelling, Analysis and Control”, Prentice Hall India, 2002.
2. Herbert E. Merritt, “Hydraulic Control Systems”, Wiley, 1991.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108105062/
2. Link to SWAYAM course contents: https://swayam.gov.in/course/4440-industrial-automation-and-control

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Industrial Automation and Control)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	2	1	1	2	3	3	2
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	2.2
CO-3	3	3	3	3	3	3	3	1	3	3	3	3	2.8
CO-4	3	3	3	3	3	3	3	1	3	3	3	3	2.8
CO-5	3	3	3	3	3	3	3	1	3	3	3	3	2.8
Average	3	3	2.8	2.6	2.8	2.6	2	1	2.2	5	3	3	

Bio Electronic Sensors

COURSE CODE: 18B1WEC841

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To learn about transducers, bio-sensors, bio-potentials electrodes and bio-signal amplifiers.
2. To understand the various bio-potentials generated in human body and the instrumentation used to acquire it.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Gain knowledge on sensors, actuators and transducers	Familiarity
CO-2	Learn to design circuits of bio-sensor for electrical and nonelectrical signals	Usage
CO-3	Acquaint with different types of amplifiers used for biosensors	Familiarity
CO-4	Learn about bio-potential and bio-potential amplifiers	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to Sensor, Bio electronics, Bioelectronics Sensor, Systems biology and Synthetic biology	4
2	Electrodes, Sensors and transducers: Sensor/Actuators, Active v/s passive sensors, sensor error sources, sensor terminology, Types of Sensors, Bio sensor, Block diagram of Bio-sensor for electrical and non electrical signals, electrodes for biophysical sensing, transducers, performance parameters of sensors, complete circuit diagram of bio sensor.	8
3	Bio-potential Electrodes: The electrode-electrolyte interface, polarization, polarizable and non-polarizable electrodes, Electrode behavior and circuit models, body surface recording electrodes, internal electrodes, micro electrode, macro electrode	4
4	Bio-electric Amplifiers: Voltage, current, power amplifiers, Low gain, medium gain, high gain amplifiers	6
5	Bio-potentials: ECG, EEG, EMG, ERG, EOG, its amplitude and bandwidth, Electrodes for Bio-potential Recordings, Electrical Interference Reduction.	6
6	Bio-potential Amplifiers: Operational amplifiers, basic amplifier configurations, multiple input circuits, differential amplifiers, signal processing circuits, isolation amplifiers, IMRR, ECG Amplifier, functional block, interference from electric devices, transient protection, common mode and other interference reduction circuits, Driven right leg circuit, amplifiers for other bio-potential signals, pre amplifier.	8
7	Bio-signal Amplifiers : Instrumentation amplifier, Chopper Amplifier, Carrier Amplifier	6
Total lectures		42

Suggested Text Book(s):

1. Carr, J.J., Brown, J.M., "Introduction to Biomedical Equipment Technology," 4th Ed., Pearson, 2001.
5. Reddy, D.D., Hussian, O.M., Gopal, D.V. R., Rao, D. M., Sastry, K.S. "Biosensors and Bioelectronics," I.K. International Pub., 2012

Suggested Reference Book(s):

1. Webster JG (Ed.), "Medical Instrumentation, Application and Design," 4th Ed., John Wiley & Sons, 2016.
2. Chatterjee S and Miller A, "Biomedical Instrumentation Systems," Cengage Learning, 2018.
3. Gayakwad, R. A., "Op-amps and Linear Integarted Circuits," 4th Ed., PHI, 2000.

Approved in Academic Council held on 25.10.2018

Other useful resource(s):

NPTEL Online Courses: Biomedical Signal Processing - https://nptel.ac.in/courses/108105101/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO (Bio electronic Sensor)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	1	1	2	X	X	X	X	X	2	1.17
CO2	3	3	3	2	2	2	X	X	1	2	2	3	1.92
CO3	3	3	2	1	1	2	X	X	X	1	1	3	1.42
CO4	3	3	2	2	1	2	X	X	X	1	1	3	1.50
Average	3.00	3.00	2.25	1.50	1.25	2.00	0.00	0.00	0.25	1.00	1.00	2.75	

Optical Networks

COURSE CODE: 18B1WEC842

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Mathematical Physics

Course Objectives:

1. To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.
2. To make the students aware of the hardware used for practical purposes.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Recognize and classify the structures of Optical fiber and types.	Familiarity
CO-2	Discuss single hop and multihop fibers.	Assessment
CO-3	Analyze various coupling losses.	Assessment
CO-4	Get acquainted with optical switching.	Usage
CO-5	Get familiar with the recent optical networks used for practical purposes.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Optical Networking-Introduction and Challenges: Advantages of optical network, telecom network overview and architecture, WDM optical networks, WDM network evolution, WDM network construction, broadcast and select optical WDM network, wavelength routed optical WDM network.	7
2	Optical Networking Components/Building Blocks : Optical transmitters, semiconductor laser diode, tunable and fixed laser, laser characteristics, photodectors, tunable and fixed optical filters, channel equalizers, optical amplifiers and its characteristics, semiconductor laser amplifier, Raman amplifier, doped fiber amplifier, various switching elements.	8
3	Single and Multi-hop Networks: Introduction to single and multi-hop networks, Characteristics of single and multi-hop networks, experimental single hop networks: LAMBDANET, STARNET, SONATA, Rainbow, experimental multi-hop networks: Shufflenet, De Bruijn Graph, Hypercube.	8
4	Optical switching: Optical packet switching basics, slotted and unslotted networks, header and packet format, contention resolution in OPS networks, self routing, examples on OPS node architecture.	8
5	Optical Access and Metro Network: Introduction to access network, PON, EPON and WDN EPON: overview, principal of operation, architecture; dynamic wavelength allocation, STARGATE: overview, need, architecture, operation and application, gigabit Ethernet, radio over fiber network. Introduction to metro network, overview of traffic grooming in SONET ring, traffic grooming in WDM ring, Interconnected WDM networks, packet communication using tunable WADM.	11
Total lectures		42

Suggested Text Book(s):

1. Optical Network Series:Biswanath Mukherjee, Springer, 2006.
2. Optical Networks: R.Ramaswami and K.Sivarajan, Â Morgan Kaufmann Publishers, 2nd Edition, 2002.
3. Optical Switching Networks: Mayer & Martin, Cambridge University Press, 2008.
4. Optical Fiber Communications- Principles and Practice by John M Senior, 3rd Edition, Pearson Education India.

Suggested Reference Book(s):

1. Data Communication by Behrouz Â, A Forouzan, Mc Graw Hill, 4th Edition.
2. Optical Switching: Tarek S. El. Bawab, Springer.

Other useful resource(s):

1. http://www.iec.org/online/tutorials/acrobat/opt_net.pdf
2. http://www.pdf-search-engine.com/optical-networking-pdf.html
3. http://www.networktutorials.info/networkhowto/what_is_optical_networking.html
4. http://www.urec.fr/hd/DWDM/ALCATEL/optical_network.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Digital Systems

COURSE CODE: 20B1WEC734
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Digital Electronics

Course Objectives:

1. Design digital circuits based on the required application.
2. Design of complex digital circuits and implement them for real time applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To review the basic concepts of digital systems	Familiarity
CO-2	Understand the working of sequential circuits	Assessment
CO-3	Usage of different techniques for digital systems	Usage
CO-4	Study of different hazards and races countered by digital system	Usage

Course Contents:

Unit	Contents	Lectures required
1	Review of Digital Fundamentals: Digital fundamentals, minimization and design of combinational circuits, sequential machine fundamentals, Flip flops, sequential machine operations.	9
2	Sequential circuits-I: The finite state model (FSM), Components of FSM, Memory elements, Synthesis of synchronous sequential circuits, Serial binary adder, The Sequence detector using Mealy and Moore type models, Design of a parity-bit generator and n-bit gray code counter using state diagram concept.	9
3	Sequential circuits-II: Finite state machine – Basic definition, capabilities and limitation of finite state machines, mathematical representation of synchronous sequential machine, state equivalence & machine minimization, simplification of incompletely specified machines.	9
4	Asynchronous Sequential circuits: Introduction to asynchronous circuits, Timing diagram, State diagram & flow tables, Types of asynchronous circuits, ASM charts and their usage.	9
5	Hazards in Digital Circuits: Different types of hazards and races in digital circuits and the methods to eliminate those hazards, Introduction to usage of VHDL for digital systems.	8
Total Lectures		44

Suggested Text Book(s):

1. W. I. Fletcher: An Engineering approach to Digital Design, Pearson Education, 2015.
2. M. Morris Mano & M. D. Ciletti: Digital Design: With an introduction to the Verilog HDL, VHDL, and System Verilog, 6thedition, Pearson Education, 2018
3. Fundamentals of Digital Circuits: A. Anand Kumar, 3rd edition, PHI, 2015.

Suggested Reference Book(s):

1. Charles H. Roth: Digital System Design using VHDL, 3rd edition, CENGAGE Learning, 2018.
2. ZVI Kohavi: Switching and Finite Automata Theory, 2nd edition, Tata Mcgraw Hill, 2017.

Other Useful Resource(s):

Link to NPTEL course contents: 1. https://nptel.ac.in/courses/117105080/
2. https://nptel.ac.in/courses/117106086/ (Prof. S. Srinivasan, IIT Chennai)

Approved in Academic Council held on 25.10.2018

Evaluation Scheme:

S. NO.	Exam	Marks	Duration	Coverage/Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire semester	Assignment (2) – 10 Quizzes (2) – 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	2
CO-1	2	3	3	3	3	1	1	1	2	2	1	2	2.1
CO-1	2	2	2	2	3	1	1	1	2	2	1	2	2.1
CO-1	2	3	3	3	2	1	1	1	2	3	2	2	2.5
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.25	1.5	2	

Principles of Communication Systems

COURSE CODE: 18B1WEC635 COURSE

CREDITS: 2 CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: Signals & Systems. Course

Objectives:

1. To make the students familiar with the constituent elements of the communication systems such as transmitter, receiver and channel with their features.
2. To make students understand the various modulation techniques.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To be familiar with the need of modulation and various types of modulation.	Familiarity
CO-2	Assess and evaluate different analog and angle modulation and demodulation techniques.	Assessment
CO-3	Develop an ability to compare and contrast the strengths and weaknesses of various communication systems.	Assessment
CO-4	To understand the need of sampling and sampling theorem.	Assessment
CO-5	To understand the basics of various digitization techniques like PCM, DPCM, DM, ADM.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Basic elements of communication system; Analog and digital signals, bandlimited signals and systems, bandwidth.	3
2	Amplitude Modulation: AM Signal and Spectra, AM Current and Power Relation, AM generation and Demodulation, Double Side-Band Suppressed Carrier System (DSB-SC)'s Need, Generation and Demodulation, Single Side-Band Suppressed Carrier System (SSB-SC)'s Need, Generation and Demodulation.	9
3	Angle Modulation: Concept of Frequency and Phase modulation, Narrowband and Wideband FM, Carson's Rule of bandwidth, FM Generation and Detection, Comparison of AM and FM. .	8
4	Receivers and Multiplexing Techniques: TRF Receiver, Superheterodyne Receiver, Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM).	2
5	Sampling and Pulse Modulation Techniques: Sampling Theorem with proof, Reconstruction of Signal from Sampled Signal, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM).	5
6	Digitization Techniques and Line Coding: Basics of Quantization, Pulse Code Modulation (PCM), Differential PCM, Delta Modulation (DM), Adaptive Delta Modulation (DM).	3
Total lectures		30

Suggested Text Book(s):

1. B P Lathi and Zhi Ding, "Modern Digital and Analog Communication", 4th Ed., Oxford University Press, 2010.
2. R P Singh and S D Sapre, "Communication Systems: Analog and Digital", 3nd Ed., Tata McGraw-Hill Publishing Company Ltd., 2012.

Suggested Reference Book(s)

1. Simon Haykin, "Communication Systems", 4th Ed., John Wiley, 2001.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108104091/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Principles of Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO-2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO-3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO-4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO-5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
Average	3.00	3.00	3.00	2.60	2.20	2.00	1.60	1.80	1.00	1.80	2.40	3.00	

Principles of Communication Systems Lab

COURSE CODE: 18B1WEC672

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None.

Course Objectives:

To enhance the understanding of communication systems and devices.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	To understand the fundamentals of designing of a filter.	Familiarity
CO2	To design a laboratory set up for the understanding of Amplitude modulation and Angle modulation.	Usage
CO3	To design and understand the importance of Sampling.	Usage
CO4	To understand the practical implementation of PAM, PWM, PPM.	Usage
CO5	To understand transmission line encoding.	Usage
CO6	To practically design digitization techniques like PCM, DM.	Usage

List of Experiments:

S. No	Description	Hours
1	To design and obtain the frequency response of Low pass filter of cut- off frequency 1 KHz.	2
2	To design and obtain the frequency response of High pass filter of cut- off frequency 1 KHz.	2
3	To perform Amplitude modulation and its demodulation using Envelope detector. Measure the modulation index.	2
4	To perform Frequency modulation and its demodulation. Measure the modulation index.	2
5	To design Sample and Hold circuit.	2
6	To perform Pulse Amplitude modulation (PAM).	2
7	To perform Pulse Width modulation (PWM).	2
8	To perform Pulse Position modulation (PPM).	2
9	To perform Line coding techniques.	2
10	To perform Delta modulation.	2
11	To perform Time division multiplexing.	2
12	To perform Pulse code modulation and its demodulation.	2
Total Lab hours		24

Suggested/Resources:

1. B P Lathi and Zhi Ding, “Modern Digital and Analog Communication”, 4th Ed., Oxford University Press, 2010.
2. R P Singh and S D Sapre, “Communication Systems: Analog and Digital”, 3nd Ed., Tata McGraw-Hill Publishing Company Ltd., 2012.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
CO6	3	3	3	2	2	2	1	2	1	2	3	3	2.25
Average	3	3.00	3.00	2.50	2.17	2.0	1.5	1.83	1.00	1.83	2.50	3.00	

Fundamentals of Digital Signal Processing & Applications

COURSE CODE: 18B1WEC636

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: Prerequisites are Higher Engineering Mathematics, Different Transforms (Fourier, Laplace & Z - transforms), Basic knowledge of Signals and Systems.

Course Objectives:

1. Learn to represent signal in time domain.
2. Learn to analyze the representation of signal in frequency domain.
3. Learn to study the signal transformation tools like Fourier transform, Laplace transform and Z – transform.
4. To study the architectural features of DSP processor.
5. Learn to design a signal processor (digital filter) for a given problem.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze the interpretation of discrete/digital signals	Familiarity
CO-2	Study the frequency domain behavior of discrete / digital signals	Assessment
CO-3	Analysis and design of DSP filters	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Digital Signal Processing (DSP): Discrete-time sequences and systems, Properties of discrete time sequences and systems, Frequency domain representation of discrete time sequences and its analysis, Sampling theorem and reconstruction of band limited signals.	5
2	Linear Time Invariant (LTI) System: Discrete time LTI system and its analysis, Impulse Response and Convolution Sum, Properties of LTI system, Correlation of Discrete time sequences, LTI system defined by Linear Constant Coefficient Difference Equations.	5
3	Review of Z - transform: Z Transform and its properties, Region of Convergence (ROC) and Pole-Zero Plot, Analysis of discrete LTI systems using Z Transform, Causality and Stability Criterion.	5
4	Discrete Fourier Transform (DFT) & Fast Fourier Transform (FFT): Sampling in frequency domain and origin of DFT, Properties of DFT, Linear Convolution using DFT, Analysis of discrete LTI systems using DFT, FFT-Efficient Computation of DFT, Goertzel Algorithm, radix - 2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms.	6
5	DSP Filter Design and Realization: Structures for the Realization of Discrete time systems, Structures for FIR and IIR systems, Design of FIR filters, Design of IIR filters from analog filters, Frequency Transformations.	6
6	Applications of DSP: Applications of DSP in Speech Processing, RADAR systems, Image Processing and Biomedical Engineering.	3
Total lectures		30

Suggested Text Book(s):

1. A. V. Oppenheim, R. W. Schafer, and J. R. Buck, Discrete-Time Signal Processing, 2nd Edition, Pearson Education, 2008.

2. S. K. Mitra and Yonghong Kuo, Digital Signal Processing: A Computer- based Approach, 2nd Edition, Tata McGraw-Hill, 2011.

Suggested Reference Book(s):

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications. Pearson Education India, 2011.

Other useful resource(s):

Link to topics related to course:

i. https://nptel.ac.in/courses/117102060/
ii. https://www.tutorialspoint.com/digital_signal_processing/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Fundamentals of DSP & Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	2	2	2	2	2	2	2.08
CO-2	1	2	2	1	2	2	1	1	3	2	1	1	1.58
CO-3	1	3	3	3	1	2	2	1	3	3	1	2	2.08
CO-4	2	3	2	1	1	1	2	2	2	3	2	1	1.83
Average	1.5	2.5	2.5	2	1.5	1.5	1.75	1.5	2.5	2.5	1.5	1.5	

Fundamentals of Digital Signal Processing Lab

COURSE CODE: 18B1WEC673

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: Basic knowledge of MATLAB Programming for generation of signals and system analysis.

Course Objectives:

The objective of this course is to provide a thorough understanding and analysis of digital signal processing systems using MATLAB and LabVIEW.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understand the basics of Lab VIEW Programming and code compressor studio.	Familiarity
CO2	Generate the discrete time signals using sampling and conversion of analog signals in to digital signals.	Familiarity
CO3	Analyze the FFT Algorithm based frequency domain representation.	Usage
CO4	Design the FIR and IIR filter for specified parameters.	Usage
CO5	Apply the adaptive filtering for systems identification.	Assessment
CO6	Perform the linear and circular convolution using DSP kit to get the LTI system response..	Assessment

List of Experiments

S.No	Description	Hours
1	Getting Familiar with LabVIEW.	1
2	Generate a discrete signal by sampling a sinusoidal signal and I investigate the aliasing effect.	1
3	Convert analog signal to digital signal (A/D) and digital signal to analog signal (D/A) using LabVIEW	1
4	Design FIR filter using LabVIEW to meet specifications on their frequency response using window design.	1
5	Design IIR Filter using LabVIEW to meet specifications on their frequency response using the bilinear transformation.	1
6	Use LabVIEW to analyze and display signals in the frequency- domain using the FFT algorithm.	1
7	Design an adaptive filter for system identification using LabVIEW.	1
8	Getting familiar with code compressor studio.	1
9	Perform and verify linear convolution of two signals using DSP Kit.	1
10	Perform and verify circular convolution of two signals using DSP Kit.	1
Total Lab hours		10

Suggested/Resources:

1. T. H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3rd Edition, Prentice-Hall of India, 2010.
2. Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning, 2002.

3. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: Fundamentals of Computer Algorithms, 2nd Edition, Universities press, 2007
4. https://nptel.ac.in/courses/106104019/26
5. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

1	Mid Sem. Evaluation (P-1)	20 Marks
2	End Sem. Evaluation (P-2)	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
C06	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.80	2.60	2.20	1.20	1.00	1.00	1.00	1.20	1.40	

Principles of Wireless Communication

COURSE CODE: 18B1WEC637

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. To understand the fundamentals of wireless communication system.
2. Analyze the design criterion of recent mobile generations.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic blocks of wireless communication system design.	Familiarity
CO-2	Understand the concept of cellular communication.	Familiarity
CO-3	Analyze the effect of various parameters on the performance of communication system.	Assessment
CO-4	Demonstrate recent wireless communication standards.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Wireless Communication: Block diagram of communication system: source coding & channel coding, base band & band pass signal representation; 1G, 2G, 2.5G, 3G, 4G and 5G wireless standards and their Comparison; Multiplexing and multiple access techniques: FDD, TDD, FDMA,TDMA,CDMA, SDMA.	8
2	Cellular Concept: System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity: co-channel interference, adjacent channel interference, Trunking and Grade of Services, Improving Coverage & Capacity in Cellular System: cell splitting, sectoring and microcell concept, Near-far Problem, Hidden node problem.	9
3	Wireless channel characteristics: Friss equation, Path loss model, Multipath propagation, Doppler shift, Parameters of wireless Multipath Channel; Small-scale and large-scale fading; Shadowing, Types of fading: flat fading, frequency selective fading, slow fading and fast fading.	7
4	3G and 4G Networks: UMTS Network, UMTS Radio Interface, UTRAN, Handover, LTE Network, 802.16 WiMAX.	6
Total lectures		30

Suggested Text Book(s):

1. T.S. Rappaport: Wireless Communication, 2nd Edition, Prentice Hall., 2002.
2. A.Goldsmith: Wireless Communication, 1st Edition , Cambridge University Press, 2005.
3. David Tse and Pramod Viswanath: Fundamentals of Wireless Communication, 1st Edition, Cambridge University Press, 2005.

Suggested Reference Book(s):

1. Jochen Schiller : Mobile Communication, 2nd edition, Pearson, 2003.
2. Martin Sauter: Beyond 3G Bringing Networks, Terminals and the Web Together, 1st Edition, John Wiley & Sons, 2008.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/117102062/

Approved in Academic Council held on 25.10.2018

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Principles of Wireless Communication)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	2	1	2	1	2	2	3	2.18
CO-2	3	3	3	3	2	1	1	1	2	2	1	2	2
CO-3	3	3	3	2	2	2	1	2	2	2	1	3	2.17
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	3	3	3	2.5	2	1.5	1	1.5	1.75	2.25	1.5	2.75	

Principles of Wireless Communication Lab

COURSE CODE: 18B1WEC674

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Understand the various techniques of practical wireless communicationsystem.
2. To get familiar with the implementation of various blocks of practical wireless system.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of LabView, MATLab and WiCOMM-T kit	Familiarity
CO-2	Understand basics of various analog and digital modulation techniques.	Usage
CO-3	Gain practical experience of the functioning of wireless systems.	Usage
CO-4	Analyze the performance of practical wireless communication systems.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to various equipments of the lab.	2
2	Design, implementation and study of amplitude modulator.	2
3	Design, implementation and study of amplitude demodulator.	2
4	Design, implementation and study of amplitude shift keying modulator.	2
5	Design, implementation and study of amplitude shift keying demodulator.	2
6	Design of basic Direct Sequence- Code Division Multiple Access (DS-CDMA) system.	2
7.	Modeling and simulation of multipath fading channel.	2
8.	Bit error rate (BER) analysis of fading channel.	2
9	Analysis of Viterbi equalizer for cellular mobile communication system.	2
10	Analysis of adaptive equalization techniques.	2
11	Implementation of data compression technique for digital communication system	2
12	Mini project	2
	Total Lab hours	24

Suggested/Resources:

1. S. Haykin: Digital Communication Systems, Student Edition, Wiley,2013.
2. J.H. Reed: Software Radio: A Modern Approach to Radio Engineering, 1st Edition, Prentice Hall, 2002.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	1	3	2	1	2	1	2	1	3	2
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	3	3	2	1	1	1	1	2	1	3	2.00
CO4	3	3	3	3	2	1	1	1	1	1	1	3	1.92
Average	3.00	3.00	2.75	2.50	2.50	1.25	1.00	1.25	1.00	1.50	1.00	3.00	

Automation and Robotics

COURSE CODE: 20B1WEC731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Prerequisite: None

Course Objectives:

1. To develop the student's knowledge in various robot structures and their workspace.
2. To use the robotic system for logic building & programming and to solve many engineering problems.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
1	Learn about brief history, types, requirement and architecture of automation, and their applications	Familiarity
2	Learn about PLC, DCS and SCADA, and their applications	Assessment
2	Learn basic principles of robotics, its configurations, kinematics, dynamics, motion planning and control	Assessment
3	Acquire knowledge about the principles of various sensors, actuators and their applications in robots.	Assessment
4	Understand the concept of dynamics and control for a typical pick and place robot.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: History of automation, Automation systems, types of automation, Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Advantages and limitations of Automation, Industrial revolutions.	6
2	Automation components: Sensors and actuators, Electric, Hydraulic, Pneumatic, actuators, process control valves, Introduction of DC and AC servo drives for motion control. Controllers, Transmitters and Signal Conditioning: Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Analog and Digital signal conditioning for sensors, Smart and Intelligent transmitters	8
3	PLC, SCADA & Distributed control system: Elements of SCADA, Features of SCADA, MTU, RTU Functions, Applications of SCADA, Communications in SCADA, Introduction to DCS, Architecture, Input and output modules, Specifications of DCS	6

4	Introduction to Robotics: Definition of robot, types of robots, classification and usage, Terminology of robotics, Specifications of robot, Architecture of robotic systems, Robot Sensors and Machine Vision System: Internal and external sensors: position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder; Robot vision: image processing fundamentals for robotic applications	8
5	Robot Arm Kinematics and Dynamics:Position and orientation of a rigid body, Homogeneous transformations, Forward kinematics, Inverse kinematics, Lagrange formulation of dynamics	6
6	Motion Planning and Control: Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link and two-link manipulators, Independent joint PD and PID control, Control of a multi-link manipulator	6
Total lectures		42

Suggested Text Book(s):

1. J. J. Craig, "Introduction to Robotics- Mechanics and Control", Pearson,3rd Edition, 2009.
2. Spong and Vidyasagar, "Robot Dynamics and Control", Wiley Student Edition, John Wiley and Sons, 2013.
3. Madhuchhanda Mitra, SamarjitSen Gupta, "Programmable Logic controllers and Industrial Automation", Penram International, 2008
4. C.D. Johnson, "Process Control Instrumentation Technology", 8th Ed., PHI, 2015

Suggested Reference Book(s):

1. Sciavicco and Siciliano, "Modeling and Control of Robot Manipulators", Springer, 2nd Edition, 2002.
2. D.K. Pratihar, "Fundamentals of Robotics", Narosa Publishing House, 1st Edition, 2017.
3. AshitavaGhoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, 6thImpression, 2010. 8.
4. R. K. Mittal and I. J. Nagrath, "Robotics and Control", Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
5. Gregory K. McMillan, P. Hunter Vegas, "Process / Industrial Instruments and Controls Handbook," 6th Ed., McGraw Hill, 2019
6. Bela G. Liptak, KrisztaVenczel, "Instrument and Automation Engineers' Handbook: Process Measurement and Analysis," 5th Ed., CRC Press, 2016

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/112101099/
2. Other links to course material: https://nptel.ac.in/downloads/112101098/
3. Material provided by IIT Bombay under eLSI project: http://elsi.e-yantra.org/resources

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus

.				
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Automation and Robotics)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	2	2	1	1	2	2	2	**1.8**
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	**2.3**
CO-3	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
CO-4	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
CO-5	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
Average	**2.8**	**2.8**	**2.8**	**2.6**	**2.8**	**2.6**	**2.6**	**1**	**1.6**	**2.6**	**2.8**	**2.8**	

Software Defined Radio and Applications

COURSE CODE: 18B1WEC639

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. To know software defined radio technology and its challenges.
2. Analyze the design considerations of software defined radio.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the terminology of software defined radio.	Familiarity
CO-2	Understand the need of software defined radio system in next generation communication system.	Familiarity
CO-3	Analyze the design considerations for software defined radio system.	Assessment
CO-4	Demonstrate application areas of software defined radio technology.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to SDR: The need for Software Radios, What is a Software Radio, Characteristics, benefits and design principles of of a Software Radio.	6
2	Radio frequency implementation issues: Purpose of RF Front-End, Dynamic range: The principal challenge of receiver design, RF receiver front-end topologies, Enhanced flexibility of the RF chain with software radios, Transmitter architectures and their issues, Noise and distortion in the RF chain, ADC and DAC distortion.	7
3	Multirate signal processing: Introduction, Sample Rate Conversion Principles, Polyshase filters, Digital filter banks, Timing recovery in digital receivers using multirate digital filters.	4
4	Analog to digital and digital to analog conversion: Parameters of ideal data converters, Parameters of practical data converters, Techniques to improve data converter performance; Common ADC and DAC architectures	6
5	Digital hardware choices: Introduction, Key hardware elements; DSP Processors, Field programmable gate arrays, Trade-offs in using DSPs, FPGAs, and ASICs, Power management issues, Using a combination of DSPs, FPGAs, and ASICs	5
6	Case studies in software radio design.	2
Total lectures		30

Suggested Text Book(s):

1. J.H. Reed: Software Radio: A Modern Approach to Radio Engineering, 1st Edition, Prentice Hall, 2002.
2. P.B. Kenington: RF and Baseband Techniques for Software Defined Radio, 1st Edition, Norwood, MA, USA: Artech House, 2005.

Suggested Reference Book(s):

1. S. Haykin: Digital Communication Systems, Student Edition, Wiley, 2013.
2. H. Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007

Other useful resource(s):

Link to NPTEL course contents : https://nptel.ac.in/courses/108107107/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Software Defined Radio and Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	2	1	2	2	2	2
CO-2	3	3	3	3	2	1	1	1	2	2	1	2	2
CO-3	3	3	3	2	2	2	1	2	2	2	1	3	2.17
CO-4	2	3	3	3	2	1	1	1	2	3	2	3	2.17
Average	2.75	3	2.75	2.5	2	1.5	1	1.5	1.75	2.25	1.5	2. 5	

Software Defined Radio Lab

COURSE CODE: 18B1WEC676

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Understand the basic building blocks of software defined radio.
2. To achieve reconfigurability of communication system through software controlled parameters.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of MATLab and WiCOMM-T kit	Familiarity
CO-2	Attain flexibility in design and implementation of communication system.	Usage
CO-3	Gain practical experience of the functioning of next generation communication systems through SDR technology.	Usage
CO-4	Analyze the performance of reconfigurable software controlled digital communication systems.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to WiComm-T (SDR) kit and MATLab. Interfacing of WiComm-T kit with MATLlab Basic commands of MATLab.	2
2	Demonstration of baseband digital communication system and observe effect of filter roll-off factor on eye pattern.	2
3	Implementation of BPSK Modulation and Demodulation system.	2
4	Implementation of Quadrature Phase Shift Keying Modulation and Demodulation system.	2
5	Implementation of Amplitude Shift Keying Modulation and Demodulation system.	2
6	Implementation of Quadrature Amplitude Modulation and Demodulation (QAM).	2
7	Implementation of Gaussian Minimum Shift Keying (GMSK) modulation and demodulation system.	2
8	To demonstrate GSM communication system.	2
9	To demonstrate Time Division Multiplexing and Demultiplexing.	2
10	To demonstrate Frequency Division Multiplexing and Demultiplexing.	2
11	Implementation of source coding techniques.	2
12	Implementation of channel coding and error control coding techniques.	2
	Total Lab hours	24

Suggested/Resources:

1. S. Haykin: Digital Communication Systems, Student Edition, Wiley, 2013.
2. J.H. Reed: Software Radio: A Modern Approach to Radio Engineering, 1st Edition, Prentice Hall, 2002.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	2	3	2	1	2	1	2	1	3	2.08
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	3	3	2	1	1	1	1	2	1	3	2.00
CO4	3	3	3	3	2	1	1	1	1	1	1	3	1.92
Average	3.00	3.00	2.75	2.75	2.50	1.25	1.00	1.25	1.00	1.50	1.00	3.00	

Optimization Techniques in Engineering

COURSE CODE: 18B1WEC739

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the need and origin of the optimization methods.
2. To get a broad picture of the various applications of optimization methods used in engineering.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Cast engineering minima/maxima problems into optimization framework.	Familiarity
CO-2	Learn efficient computational procedures to solve optimization problems.	Familiarity
CO-3	To design algorithms, the repetitive use of which will lead reliably to finding an approximate solution.	Assessment
CO-4	Analyze and appreciate variety of performance measures for various optimization problems.	Assessment
CO-5	Understand importance of optimization of industrial process management.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Functions and Continuity, Optimization and Optimality, Optimization Problem Formulation, Engineering Optimization Problems, Classification of Optimization Algorithms, Order and Notations, Convergence Rate, Computational Complexity, Convexity, Stochastic Nature in Algorithms	6
2	Optimization Techniques and Algorithms: Unconstrained Optimization, Gradient-Based Methods, Newton's Method, Convergence Analysis, Steepest Descent Method, Line Search, Conjugate Gradient Method, Stochastic Gradient Descent, Subgradient Method, Gradient-Free Nelder–Mead Method	7
3	Constrained Optimization: Mathematical Formulation, Lagrange Multipliers, Slack Variables, Generalized Reduced Gradient Method, KKT Conditions, Penalty Method.	7
4	Approximation Optimization Methods: BFGS Method, Trust-Region Method, Sequential Quadratic Programming, Convex Optimization, Equality Constrained Optimization, Barrier Functions, Interior-Point Methods, Stochastic and Robust Optimization.	7
5	Modern Methods of Optimization: Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization.	7
6	Multi-Objective Optimization: Pareto Front and Pareto Optimality, Choice and Challenges, Weighted Sum Method, Utility Function Method, Multi-objective Genetic Algorithms, Multi-objective Particle Swarm Optimization	8
Total lectures		42

Suggested Text Book(s):

1. Parkinson, A.R., Balling, R., and J.D. Hedengren: Optimization Methods for Engineering Design, 2nd Edition, Brigham Young University, 2018.
2. Deb K: Optimization for Engineering Design: Algorithms and Examples, 2nd Edition, Prentice Hall India Learning Private Limited, 2012.
3. Xin-She Yang: Optimization Techniques and Applications with Examples, 1st Edition, Wiley, 2018.

Suggested Reference Book(s):

1. A. D. Belegundu and T. R. Chandrupatla: Optimization Concepts and Applications in Engineering, 2nd Edition, Cambridge University Press, 2011.
2. Xin-She Yang: Engineering Optimization: An Introduction with Metaheuristic Applications, 1st Edition, Wiley, 2010.

Other useful resource(s):

Link to NPTEL course contents:Optimization Methods: https://nptel.ac.in/courses/105108127/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes(3) -10 Attendance - 5

Course Outcomes (COs) contribution to the ProgrammeOutcomes (POs)

Course outcomes (Optimization Techniques in Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	1	2	1	1	1	2	2	1.67
CO-2	3	2	2	1	2	1	3	1	1	1	2	2	1.75
CO-3	3	3	2	2	3	2	3	1	1	1	3	3	2.25
CO-4	3	3	2	2	3	2	3	1	1	1	3	3	2.25
CO-5	3	3	3	3	3	2	3	1	2	1	3	3	2.50
Average	3	2.6	2.2	1.8	2.6	1.6	2.8	1	1.2	1	2.6	2.6	

Electrical Machines

COURSE CODE: 18B1WEC740

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

To prepare students to perform the analysis of any electromechanical system and empower them to understand the working of electrical equipment used in daily life.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The ability to formulate and then analyze the working of any electrical machine using mathematical model under loaded and unloaded conditions.	Familiarity
CO-2	The skill to analyze the response of any electrical machine.	Usage
CO-3	The ability to troubleshoot the operation of an electrical machine.	Usage
CO-4	The ability to select a suitable measuring instrument for a given application.	Assessment
CO-5	The ability to estimate and correct deviations in measurements due to the influence of the instrument and due to the accuracy of the instrument	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Basics of electrical machines: Electromagnetism; magnetic field; torque; electromechanical energy conversion principle, Review of magnetic circuits: Magnetic materials, BH characteristics, Magnetomotive Force (MMF); Magnetic Field Strength; Permeability, Reluctance, Permeance; Analogy between Electric and Magnetic Circuits.	2
2	Transformers: Principle of Operation, EMF Equation; Ideal Transformer, Conditions for Ideal Transformer, Transformation Ratio, Volt-Amperes, Impedance Transformation. Practical Transformer at No Load, Effect of Magnetization, Effect of Core Losses: (i) Hysteresis Loss, (ii) Eddy-Current Loss; Construction of Transformer, Core of Transformer: (ii) Core Type Transformer; (ii) Shell Type Transformer. Ideal Transformer on Load; Practical Transformer on Load : Effect of Winding Resistance, Effect of Flux Leakage; Equivalent Circuit of a Transformer, Phasor Diagram, Simplified Equivalent Circuit, Approximate Equivalent Circuit. Voltage Regulation of a Transformer, Approximate Voltage Drop, Exact Voltage Drop; Condition for Zero Regulation, Condition for Maximum Regulation. Efficiency of a Transformer; All-day Efficiency.	7
3	Synchronous Machines: Electro-Mechanical Energy-Conversion Machines: Power Considerations for a Generator and Motor; How a Generator Differs from a Motor; Type of Rotary Machines. General Characteristics of the Synchronous Machine; Synchronous Speed; Rotating Magnetic Flux due to Three-Phase Currents; EMF Equation. Synchronous Motors; Phasor Diagrams for Generator and Motor; Constant Speed Operation; Operation of a Synchronous Motor; Effect of Change in Mechanical Load, Effect of Change in Excitation, Synchronous Condenser.	7

4	Induction Motor : Principle of Working; Slip of Induction Motor; Construction of Induction Motor; Rotor EMF, Current and Power Factor. Torque-Slip Characteristics; Condition for Maximum Torque; Maximum Torque; Effect of Rotor Resistance on the Starting Torque.	4
5	DC Machines : Construction of a DC Machine; Armature Winding; EMF Equation for a DC Generator . Types of DC Machines; A DC Machine as Generator or Motor; Types of DC Generators; Losses in a DC Machine; Efficiency of a DC Generator; Condition for Maximum Efficiency. Characteristics of DC Generators; Open-Circuit Characteristic (OCC). DC Motors; Equivalent Circuit of a DC Motor; Speed Regulation of a DC Motor; Torque Developed by a DC Motor; Torque and Speed Characteristics of a DC Motor.	8
6	Fractional Horse Power Motors: Introduction; Single-Phase Motors, Double-Field Revolving Theory; Types of Single-Phase Motors. Stepper Motors: Types of Stepper Motors; Variable reactance (VR) stepper motors, Permanent magnet stepper motor, Hybrid motor. one-phase on Mode, two-phase on mode, half step mode, microstepping mode.	5
7	Measurement and Error: Definitions; Accuracy and Precision; Significant Figures; Gross errors; Limiting Errors.	1
8	Electrical Instruments: Essentials of an Instrument: (1) Deflecting Torque; (2) Controlling Torque; (3) Damping Torque. Permanent Magnet Moving Coil (PMMC) Instruments; Ammeters; (*Multi-Range Ammeter*); Universal Shunt for Extending Current Ranges; Voltmeters; (*Multi-Range Voltmeter, AC Voltage Measurement).* The Series-Type Ohmmeter; Meter Sensitivity; Loading Effect; Multimeter; Dynamometer Wattmeter; Single-Phase Induction Type Energy Meter.	4
9	Measurement of Non-electrical Quantities: Sensors and transducers, Strain gauge, LVDT, piezoelectric, inductive and capacitive transducers, Hall Effect transducer, light and temperature sensors, proximity sensors.	4
Total lectures		42

Suggested Text Book(s):

1. D C Kulshreshtha: Basic Electrical Engineering, 1st Edition, McGraw Hill Education, 2011.
2. Helfrick and Cooper: Modern Electronic Instrumentation and Measurement Techniques, 1st Edition, PHI, 1992.

Suggested Reference Book(s):

1. B.L. Theraja, A.K. Theraja: A Textbook of Electrical Technology: Basic Electrical Engineering Vol- I, 23rd Edition, S Chand and Company Ltd, 2015.
2. B.L. Theraja, A.K. Theraja: A Textbook of Electrical Technology Vol II: AC and DC Machines, 23rd Edition, S Chand and Company Ltd, 2015
3. V.N. Mittle, Arvind Mittal: Basic Electrical Engineering, 2nd Edition Tata McGraw Hill Publishing Co, 2015.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108106071/
2. Link to topics related to course:
   https://nptel.ac.in/courses/108106071/1-24
   https://nptel.ac.in/courses/108105017/6
   https://nptel.ac.in/courses/108105017/21
   https://nptel.ac.in/courses/108105017/24

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Electrical Machines)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	1	1	1	1	1	2	2	2	1.73
CO-2	3	2	2	2	2	2	2	2	2	2	2	2	2.00
CO-3	1	1	2	2	3	2	3	3	3	3	3	3	2.60
CO-4	2	3	2	2	2	2	3	3	3	3	3	3	2.58
CO-5	1	2	2	2	2	3	3	2	2	3	3	3	2.56
Average	2.00	2.20	2.20	2.00	2.00	2.00	2.40	2.20	2.20	2.60	2.60	2.60	

Biomedical Signal Processing

COURSE CODE: 18B1WEC741

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce different biomedical signals.
2. To apply different methods to analyze and filter the signals.
3. To detect events in signals used for diagnosis.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the origin of different biomedical signals.	Familiarity
CO-2	Able to filter out the noise and artifacts from the medical signals.	Usage
CO-3	Able to extract different events from the signals.	Usage
CO-4	Understand different waveform analyzing methods for medical signals.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Biomedical Signals:- Action potential of neurons, Electrocardiography, Electroencephalogram, Electromyography, Electroretinogram and Electrooculography.	10
2	Filtering for Removal of artefacts: Types of Noise, Power Line and high frequency noise interference, motion artefacts, Filters for removal of interference, Illustration of the Problem with Case Studies.	8
3	Detection of Events: Illustration of the Problem with Case Studies, Derivative based Approaches for QRS detection; Autocorrelation function and Cross- correlation functions for the detection of events in EEG.	8
4	Waveform Analysis: Morphological Analysis of waves, Envelope detection and Analysis; Analysis of activity using Root Mean Square value, Zero-crossing rate, Turns Count, and Form factor.	8
5	Frequency-domain Analysis: Spectral Analysis of biomedical signals, Estimation of PSD; Measures Derived from PSDs.	8
Total lectures		42

Suggested Text Book(s):

1. R. S Khandpur and Raghbir Khandpur: Biomedical Instrumentation, 2nd Ed., McGraw-Hill Education; , 2003.
2. Rangaraj M. Rangayyan, Biomedical Signal Analysis, 2nd Ed., Wiley,2015.

Suggested Reference Book(s):

1. Leslie Cromwell, Fred Weibell J, Erich Pfeiffer. A: Biomedical Instrumentation and Measurements, Prentice-Hall India, 2nd Edition, 1997.
2. John G. Webster: Medical Instrumentation application and design, John Wiley, 3rd Edition, 1997.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/108105101/

Approved in Academic Council held on 25.10.2018

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Biomedical Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	3	2	3	2	2	3	2	2	1	3	2.28
CO-2	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-3	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-4	3	3	3	3	3	1	1	2	2	2	1	3	2.25
Average	2.75	2.5	3	2.75	3	1.25	1.25	1.25	2	2	1	3	

Industrial Internet of Things

COURSE CODE: 18B1WEC839

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the concepts of Internet of Things.
2. To automate the industrial process through IoT applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To Understand the Characteristics of IoT.	Familiarity
CO-2	To provide the basic knowledge of Network & Communication Aspects of IoT.	Familiarity
CO-3	To Design IoT applications in different domain and be able to analyze their performance.	Usage
CO-4	To Implement basic IoT applications on embedded platform.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & Application Programming Interfaces (APIs).	6
2.	IoT & M2M: Machine to Machine, Difference between IoT and M2M, Software defined Network.	8
3	Network & Communication Aspects: Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.	8
4	Challenges in IoT: Design challenges, Development challenges, Security challenges, Other challenges.	8
6	Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT applications.	6
7	Developing IoTs: Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts.	6
	Total Lectures	42

Suggested Text Book(s):

1. Arshdeep Bahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach”,Universities Press, 1st Edition, 2015.
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 1st Edition, 2017.

Suggested Reference Book(s):

1. Antonio Capasso and Giacomo Veneri, “Hands-On Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0”, Pact Publishing Ltd, UK, 1st edition, 2018.
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley-Blackwell, 1st Edition, 2010.

Other useful resource(s):

Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs22/preview

Link to topics related to course: https://onlinecourses.nptel.ac.in/noc19_cs32/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Industrial Internet of Things)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	2	2	2	2	2	2.6
CO-4	3	3	3	3	3	2	3	3	3	3	3	3	2.9
Average	3	3	3	3	3	2.75	3	2.75	2.75	2.75	2.75	2.75	

Wireless Ad Hoc and Sensor Networks

COURSE CODE: 18B1WEC844

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the basic WSN technology and supporting protocols, with emphasis placed on standardization basic sensor systems and provide a survey of sensor technology.
2. Learn key routing and transport layer protocols for sensor networks, and design requirements.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of wireless sensor and ad-hoc network.	Familiarity
CO-2	To identify communication protocols employed in wireless sensor and ad hoc network.	Assessment
CO-3	To select the appropriate technology to implement a WSN.	Assessment
CO-4	To assess different communication protocols and their usefulness in different applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Wireless sensor and Ad Hoc Networks, Architecture, Self-organizing Behaviour, Practical Implementation Issues, Power Management.	8
2	Layered Protocols Architecture, Physical layer, WSN Coverage & Placement of wireless sensor nodes, Topology Management in Wireless Sensor	8
3	Data link layer, Network layer, Congestion and Flow Control	8
4	MAC and Routing Protocols, Application of MAC and Routing protocols, Cooperation in Ad Hoc Network, MANETs.	9
5	Multicasting in MANETs, Mobility Models, Transport Protocols for MANETs, Opportunistic Mobile Networks, UAV Networks	9
Total lectures		42

Suggested Text Book(s):

1. Savo G Glisic, "Advanced Wireless Networks 4G Technologies", 2nd Edition, John Wiley & Sons, 2006.
2. Yingshu Li, My T. Thai, "Wireless Sensor Networks and Applications". 1st Edition, Springer,2008.
3. Jonathan Loo et.al. , "Mobile Ad Hoc Networks current status and future trends" 1st Edition, CRC Press, 2016.

Suggested Reference Book(s):

1. Stefano Basagni , "Mobile Ad Hoc Networking", 2nd Edition, John Wiley & Sons, 2015,
2. Driss Benhaddou, "Wireless Sensor and Mobile Ad-Hoc Networks", 1st Edition, Springer,2015.
3. A.Goldsmith, "Wireless communication" 1St Edition, Cambridge University Press,2005.

Other useful resource(s):

Link to NPTEL course contents: https://swayam.gov.in/courses/4408-wireless-adhoc-and-sensor-networks

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Wireless Ad Hoc and Sensor Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	1.75
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	2
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	1.83
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	1.91
Average	2.5	2.25	2	1.75	2.25	1.75	1.5	1.5	1.5	2.25	1.5	1.75	

Satellite Communication

COURSE CODE: 18B1WEC841 COURSE

CREDITS: 3 CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of communications Course Objectives:

1. To acquire good knowledge about the components of a satellite communication system.
2. To analyze different methods of satellite access and the applications of satellites.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To obtain basic knowledge of satellite communication principles.	Familiarity
CO-2	To have a thorough understanding of orbital mechanics and launches for the satellite communication.	Familiarity
CO-3	To understand the basic knowledge of link design of a satellite system.	Assessment
CO-4	To provide better understanding of multiple access systems and earth station technology.	Assessment
CO-5	To prepare students with knowledge in satellite navigation and GPS and satellite packet communications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction : Origin of Satellite Communication, Historical Back-ground, Basic Concepts of Satellite Communication, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communication.	2
2	Orbital mechanics and launchers: Kepler's laws, Newton's law, Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance.	7
3	Satellite systems: Attitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, communication subsystems, Satellite antenna Equipment reliability and Space qualification.	6
4	Earth station technology and Link design: Introduction, Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods. Basic transmission theory, system noise temperature and G/T ratio, Design of down links, up link design, Design of satellite links for specified C/N, System design example.	6
5	Multiple Access: Frequency Division Multiple Access (FDMA) – Intermodulation Calculation of C/N, Time Division Multiple Access (TDMA) – Frame Structure, Burst Structure, Satellite Switched TDMA, On-board Processing, Demand Assignment Multiple Access (DAMA) — Types of Demand Assignment, Characteristics, CDMA Spread Spectrum Transmission and Reception.	9
6	Low earth orbit and geo-stationary satellite systems: Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations, System considerations, Operational NGSO constellation Designs	6
7	Satellite navigation and the global positioning system: Radio and Satellite Navigation, GPS Position Location principles, GPS Receivers and codes, Satellite signal acquisition, GPS Navigation Message, GPS signal levels, GPS receiver operation, GPS C/A code accuracy, Differential GPS.	6
Total lectures		42

Suggested Text Book(s):

1. Timothy Pratt, Charles Bostian and Jeremy Allnutt, "Satellite Communications", 2nd Edition , John Wiley & Sons, 2002.
2. Dennis Roddy, "Satellite Communication", 4th Edition, Mc Graw Hill International, 2006.

Suggested Reference Book(s):

1. M.Richharia, "Satellite Communication Systems-Design Principles", 1st Edition, Palgrave, Macmillan 2003.
2. Wilbur L. Pritchard, Robert A Nelson and Henri G.Suyderhoud, "Satellite Communications Engineering", 2nd Edition, Pearson Publications, 2003.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/syllabus/117105131/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Satellite Communications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	2	1	1	2	1	3	2.0
CO-3	3	3	3	3	3	2	1	1	2	2	2	2	2.3
CO-4	2	2	2	2	2	3	2	1	1	3	2	2	2.0
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.8
Average	2.4	2.4	2.4	2.4	2.2	2.2	1.4	1.0	1.2	2.2	4	2.20	

AVR Based Embedded System Design

COURSE CODE: 20B1WEC534
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisite: **C/C++ Programing.**

Course Objectives:

1. To develop an understanding of the AVR processors, instruction sets and addressing modes.
2. To develop the student's knowledge in various robot structures and their workspace.
3. To use the robotic system for logic building & programming and to solve many engineering problems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will be equipped with the automation and brief history of robots and their applications.	Familiarity
CO-2	Students will be able to learn basic principles of robotic technology, configurations, control and programming of robots.	Assessment
CO-3	Students will be equipped with the principles of various sensors, actuators and their applications in robots.	Assessment
CO-4	Students will be able to understand the concept of dynamics and control for a typical pick and place robot.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**AVR Microcontrollers:** Microcontrollers and Embedded Processors, Overview of AVR family, Pin diagram, Block Diagram, AVR Microcontroller architecture, Status registers, General purpose registers, Data Registers, Memory organization, PWM, ADC, EEPROM, Instruction set, I/O ports, Interrupt, On-Chip peripherals, Timer, Counter.	6
2	**Embedded C:** Introduction, Decimal, binary and HEX numbers in C language, Basic elements in C, Variable types, variable declaration, Operators, Decision making, Loops, Functions, Arrays, Pointers, Structurer. C pre-processor.	5
3	**AVR Programming:** AVR studio setup, AVR compiler, AVR data types, Addressing modes of AVR, DDRx, PORTx, PINx registers, AVR I/O Port Programming, Time delay loop, Look-up table, Bit addressability, HEX file configuration of I/O registers, Timer programming, Input capture and Wave Generator, PWM programming External Interrupt programming, ADC programming, EEPROM programming.	5
4	**Serial Communication:** USART, I2C, I2C bus protocol, TWI in AVR, I2C programming in AVR using C, SPI Protocol, SPI bus protocol, SPI programming in AVR, RF Module, RF Communication, GSM Module, GSMAT Command, AT Command, Interfacing of GSM Module with Microcontroller, Xbee Module, Xbee Communication, Configure Xbee module, Xbee Communication Between PC & Micrcontroller, Implement of Xbee Based	6

	Application.	
5	**Peripheral Interfacing:** Interfacing with Display devices, LED, LCD, Seven Segment Display, Interfacing Motors with Microcontroller, Interfacing Sensors, Interfacing programs.	**6**
Total lectures		**28**

Suggested Text books:

1. Steven F. Barrett, Steven Frank Barrett, "Embedded Systems Design with the Atmel AVR Microcontroller", Morgan & Claypool Publishers, 2009.
2. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, "The AVR Microcontroller and Embedded Systems Using Assembly and C", 1st Ed., PHI, 2010.
3. Dhananjay Gadre,, "Programming and Customizing the AVR Microcontroller", McGraw Hill Education, 2017.

Suggested Reference books:

1. Steven F. Barrett, Daniel J. Pack "Atmel AVR Microcontroller Primer: Programming and Interfacing" Morgan & Claypool Publishers, 2008.
2. D.K. Pratihar, "Fundamentals of Robotics", Narosa Publishing House, 1st Edition, 2017.

Weblink:

1. https://nptel.ac.in/courses/108/105/108105102/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (AVR Based Embedded System Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	1	1	2	3	3	**2.08**
CO-2	3	3	3	2	3	2	1	1	1	1	2	3	**2.08**
CO-3	3	3	3	3	3	3	2	1	3	2	2	3	**2.58**
CO-4	3	3	3	3	3	3	2	1	3	2	3	3	**2.27**
Average	**3.00**	**3.00**	**2.75**	**2.50**	**2.75**	**2.50**	**1.50**	**1.00**	**2.00**	**1.75**	**2.50**	**3.00**	

AVR Based Embedded System Design Lab

COURSE CODE: 20B1WEC571

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: **Introduction to programming, Digital Electronics Lab**

Course Objectives:

1. To teach and help students acquire new skills in an era of rapidly evolving technology in the field of robotics.
2. To create the next generation of embedded systems engineers with a practical outlook to help provide practical solutions to some of the real world problems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Identify different components of embedded systems and robotics using Firebird-V robotic research platform.	Familiarity
CO2	To develop embedded C/C++ programs in different embedded systems programming platforms and gain practical exposure to interface various IO devices with Firebird-V robot.	Assessment
CO3	To acquire hands-on learning and experience through appropriate Sensors and Machine vision system for a real-time operation.	Assessment
CO4	Develop an AVR microcontroller based robotic system, using embedded C language programming concepts for handling a real life task.	Usage

List of Experiments:

S.No	Description	Hours
1	Introduction to Firebird-V Robotics Research Platform. • Firebird V AVR Platform • Major Components of a Robot: Sensors, Actuators, Control, Power, Communication, Display etc. • AVR Programming Tools: ATMEL STUDIO 6	2
2	Basic IO Interfacing on Firebird-V • Input-Output Ports in ATmega2560 and associated registers • Buzzer Interfacing	2
3	Motion Control of Firebird-V Robot • Forward, backward, left and right motion • Direction control of DC motor	2
4	DC Motor Velocity Control Using Pulse Width Modulation (PWM) • Pulse width modulation, Duty cycle • Timer in AVR and their associated registers	2

	• PWM generation in Firebird-V	
5	Servo Motor Control Using Pulse Width Modulation (PWM) • Pulse width modulation, Duty cycle • Timer in AVR and their associated registers • PWM generation in Firebird-V	2
6	LCD Interfacing on Firebird V Robot • Understanding LCD and its initialization • Displaying text at different positions on the LCD and implementing a simple scrolling display.	2
7	Interrupts handling on Firebird-V Robot • Closed-loop programming • Sources of Interrupt on ATmega2560 • Interrupt handling programming	2
8	To perform Analog to Digital conversion (ADC) on Firebird-V Robot • Need for ADC, ADC of ATmega2560 • Coding ADC	2
9	To perform white line following on Firebird-V Robot • Principle of line following sensor • Location of line following sensor in firebird-V • Program to follow white line	2
10	PC Based Control Using Serial Communication on Firebird-V Robot • Robot control using RS232 serial port • Robot control using XBee wireless communication module	2
Total Lab hours		**20**

Suggested/Resources:

1. Steven F. Barrett, Steven Frank Barrett, "Embedded Systems Design with the Atmel AVR Microcontroller", Morgan & Claypool Publishers, 2009.
2. Dhananjay Gadre,, "Programming and Customizing the AVR Microcontroller", McGraw Hill Education, 2017.
3. Steven F. Barrett, Daniel J. Pack "Atmel AVR Microcontroller Primer: Programming and Interfacing" Morgan & Claypool Publishers, 2008.
4. Resource provided by e-Yantra link here: http://elsi.e-yantra.org/resources
5. Resource provided by Firebird VAtmega2560 link here: http://www.nexrobotics.com/robots.html

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	2	3	2	1	3	**2.33**
CO2	3	3	3	3	1	1	1	1	1	1	1	2	**1.75**
CO3	3	3	3	3	2	1	1	1	2	2	1	3	**2.08**
CO4	2	3	1	3	2	1	1	1	1	1	1	3	**1.67**
Average	**2.75**	**3.00**	**2.50**	**3.00**	**1.75**	**1.25**	**1.00**	**1.25**	**1.75**	**1.50**	**1.00**	**2.75**	

Machine Learning for Wireless Communication

COURSE CODE: 20B1WEC732

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of communication system

Course Objectives:

1. To understand the fundamentals of machine learning.
2. To understand the various technologies employed in wireless communication system.
3. Apply the machine learning in different field of engineering.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand the basics of machine learning	Familiarity
CO-2	Analyze the behavior of wireless channel	Assessment
CO-3	Able to understand various technology of wireless communication	Assessment
CO-4	Design and develop various machine learning algorithm in the field of wireless communication.	Usage

Course Contents:

Unit	Contents	Lectures required
1	ML overview, What is machine learning, How it works, Different types of Machine Learning, ML challenge, Supervised ML, Unsupervised learning, Deep reinforcement learning.	**8**
2	Data Scrubbing, Setting up Data, Regression Analysis, Clustering, Bias & Variance, Artificial Neural Networks, Decision Trees.	**8**
3	Overview of communication system, wireless channel fundamentals, Performance parameters of wireless channel.	**8**
4	Advanced Technology used in wireless communication**:** CRN, OFDM and MIMO	**10**
5	Application of Machine learning in recent technology of wireless communication, mini project work.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Wireless Communications – Principles and Practice; by Theodore S Rappaport, Pearson Education Pte. Ltd., Delhi
2. Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005
3. Machine Learning for future wireless communication by Fa Long Lo

Suggested Reference Book(s):

1. Fundamentals of Wireless Communication by Tse David and Viswanath Pramod, Cambridge University press, Cambridge
2. Mobile Communications; By: Schiller, Jochen H; Addison Wesley Longman Pte Ltd., Delhi

3. Machine Learning Paradigms for Next-Generation Wireless Networks

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Machine Learning for Wireless Communication)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

Signal Processing for Machine Learning

COURSE CODE: 20B1WEC733

COURSE CREDITS: 3

CORE/ELECTIVE: Open Elective

L-T-P: 3-0-0

Pre-requisite: Engineering Mathematics, MATLAB Programming/Python Programming/R programming,

Course Objectives:

1. This course is intended to teach the students of CSE/IT/ECE. This course is a blend of signal processing and machine learning.
2. It will provide the ability to students to understand the role of signal processing methods for machine learning.
3. To provide the knowledge of de-noising, feature extraction techniques for machine learning techniques.

Course Outcomes:

Course Outcomes ()		**Level of Attainment**
CO-1	Student will be familiar with the different type signal processing	Familiarity
CO-2	Student will able to understand the pre-processing and de-noising techniques	Assessment
CO-3	Student will able to understand the feature extraction techniques	Assessment
CO-4	Student will able to understand the machine learning techniques	Assessment
CO-5	Student will able to apply the signal processing and machine learning techniques for different applications.	Usage

Course Contents:

S. No.	**Contents**	**Contact Hours**
1	**Introduction of the signal processing.** 1-D signal processing: Analog signal processing, digital signal processing , statistical signal processing, acoustic signal processing, speech processing, bio-signal processing, genomics signal processing, multimedia signal processing, VLSI signal processing, Radar signal processing, and Music signal processing,2-D signal processing: image processing, and 3-D signal processing: video signal processing.	06
2	**Signal preprocessing/de-noising techniques** Filters, transforms, and filter banks	08
3	**Feature extraction techniques** DFT, DWT, CWT, STFT, WVD, and other spectral methods.	08
4	**Machine learning Techniques** Introduction to supervised, unsupervised, reinforcement learning, learning rule,	10

	and activation functions, artificial neural network, support vector machine.	
5.	**Applications** Hands on practice of the signal processing and machine learning based applications in genomics data analysis, respiratory sound analysis, vibration signal analysis, classification of disease signals, and image classification, etc.	10
	Total	**42**

Suggested Text Book(s):

1. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing", 4th Edition, Prentice Hall, 2007.

2. S.N. Sivanandam, S.N Deepa, "Principles of Soft Computing", 3rd Edition, Wiley, 2019.

3. Sejdic, E. and Falk, "Signal Processing and Machine Learning for Biomedical Big Data". CRC Press,2018.

Suggested Reference Book(s):

1. Advanced Machine Learning and Signal Processing, is part of the IBM Advanced Data Science Specialization

https://www.coursera.org/learn/advanced-machine-learning-signal-processing#syllabus

2. Machine learning for signal processing

http://home.iitk.ac.in/~vipular/stuff/2019_MLSP.html

3. Deep learning for signal processing

https://www.kdnuggets.com/2020/07/deep-learning-signal-processing.html

Other useful resource(s):

1. **Evaluation Scheme:**

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs/POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average

CO-1	3	3	2	2	2	3	3	2	3	3	3	3	2.666667
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	3	3	2	3	3	3	2.833333
CO-4	3	3	3	3	3	3	2	3	3	3	3	3	2.916667
Average	3	3	2.75	2.75	2.75	2.75	2.75	2.75	2.75	3	3	3	

Artificial intelligence Techniques for Genomics Signal Processing

COURSE CODE: 20B1WEC735

COURSE CREDITS: 3

CORE/ELECTIVE: Open Elective

L-T-P: 3-0-0

Pre-requisite: Engineering Mathematics, MATLAB Programming/Python Programming/R programming,

Course Objectives:

1. This course has been designed for the students of CSE/IT/ECE/BT & Bioinformatics.
2. It will provide the ability to students to extract the hidden information about the diseases and different functionalities in the living organism via the processing of the genomics data (It's a kind of Big Data) using Artificial intelligence and signal processing.
3. In this course basic introduction of genomics, numerical representation of the DNA sequences, preprocessing/de-noising and feature techniques, and applications of machine learning, deep learning and transfer learning will be discussed.
4. With completion of the course students may find the opportunities in the companies, which are working on the genomics data or Bioinformatics.

Course Outcomes:

Course Outcomes ()		**Level of Attainment**
CO-1	Student will be familiar with the genomics signal processing	Familiarity
CO-2	Student will able to understand the pre-processing and de-noising techniques	Assessment
CO-3	Student will able to understand the artificial neural network along with its training and testing.	Assessment
CO-4	Student will able to understand the deep learning techniques along with its implementation.	Assessment
CO-5	Student will able to apply the artificial intelligence techniques in genomics signal processing.	Usage

Course Contents:

S. No.	**Contents**	**Contact Hours**
1	**Genomics signal processing** Basics of genomics, genomics signal processing, Numerical mapping schemes for the DNA sequences. Hands on practice using MATLAB/Python/R	06
2	**Feature extraction techniques and de-noising techniques** DFT, DWT, CWT, STFT, WVD, and other spectral methods. Hands on practice using MATLAB/Python/R	08

3	**Artificial neural network** Introduction to supervised, unsupervised, reinforcement learning, learning rule, and activation functions, artificial neural networks. Training of ANN in MATLAB/Python/R	08
4	**Deep learning methods** Convolution neural network, LSTM, pre-trained networks and other networks, Hands on practice using MATLAB/Python/R	08
5.	**Applications of artificial intelligence techniques in genomics signal processing.** Hands on practice of artificial intelligence techniques in genomics signal processing applications using MATLAB programming/Python programming/R-programming.	12
	Total	**42**

Suggested Text Book/Study Material(s):

1. Dougherty ER, Shmulevich I, editors. **Genomic signal processing and statistics.**Hindawi Publishing Corporation; 2005.
2. Data Analytics in Bioinformatics: A Machine Learning Perspective. 2021.
3. Yu N, Li Z, Yu Z. "Survey on encoding schemes for genomic data representation and feature learning—from signal processing to machine learning", Big Data Mining and Analytics. 2018.
4. Min, Seonwoo, Byunghan Lee, and Sungroh Yoon. "Deep learning in bioinformatics." Briefings in bioinformatics 18, no. 5,2017.
5. Dias R, Torkamani A. **Artificial intelligence in clinical and genomic diagnostics**. Genome medicine. 2019.
6. Latest research paper from reputed journals

Suggested Reference Book(s):

1. Advanced Machine Learning and Signal Processing, is part of the IBM Advanced Data Science Specialization

   https://www.coursera.org/learn/advanced-machine-learning-signal-processing#syllabus
2. Machine learning for signal processing

   http://home.iitk.ac.in/~vipular/stuff/2019_MLSP.html
3. Deep learning for signal processing

   https://www.kdnuggets.com/2020/07/deep-learning-signal-processing.html
4. Rahman, M. Z. U., &Putluri, S. (2021). *Genomic Sequence Analysis for Exon Prediction Using Adaptive Signal Processing Algorithms*. CRC Press.
5. Shmulevich, I. and Dougherty, E.R., 2010. *Probabilistic Boolean networks: the modeling and control of gene regulatory networks*. Society for Industrial and Applied Mathematics.
6. Aparna G, Mary GA, Sumana G. Performance Analysis of Signal Processing Techniques in Bioinformatics for Medical Applications Using Machine Learning Concepts.
7. Shmulevich I, Dougherty ER. **Genomic signal processing**. Princeton University Press; 2014 Sep 8.
8. Rahman, M. Z. U., &Putluri, S. "Genomic Sequence Analysis for Exon Prediction Using Adaptive Signal Processing Algorithms". CRC Press.2021
9. Randhawa, G., Hill, K. & Kari, L. ML-DSP: Machine Learning with Digital Signal Processing for ultrafast, accurate, and scalable genome classification at all taxonomic levels. BMC Genomics, 2019
10. Introduction to genomic signal processing with control. CRC Press; 2018

11. Morales JA, Saldaña R, Santana-Castolo MH, Torres-Cerna CE, Borrayo E, Mendizabal-Ruiz AP, Vélez-Pérez HA, Mendizabal-Ruiz G. Deep Learning for the Classification of Genomic Signals. Mathematical Problems in Engineering. 2020

Other useful resource(s):

1. Genomic Signal Processing and Data Science
   http://users.ece.utexas.edu/~hvikalo/ee381v.html
2. Genomics Signal Processing
   https://alterlab.org/teaching/BME6770/Syllabus.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs/POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	3	3	2	3	3	3	3	2.666667
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	3	3	2	3	3	3	2.833333
CO-4	3	3	3	3	3	3	2	3	3	3	3	3	2.916667
Average	3	3	2.75	2.75	2.75	2.75	2.75	2.75	2.75	3	3	3	

Image Sensing and Reconstruction

COURSE CODE: 20B1WEC736

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are good programming skills, basic theory of signals and systems, signal processing and some university level mathematics.

Course Objectives:

1. To understand the basic concepts of image formation, filtering and reconstruction.
2. To study various mathematical algorithms that allow usto process and manipulate 2D image data.
3. To discuss the issues and challenges pertaining to real timeimaging.
4. To study and analyze various states - of - the - art imageenhancement algorithms.
5. Study of application domains: industrial and scientific imaging.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Analyze the need and foundation of digital image sensing and reconstruction	Familiarity
CO-2	Study of the mathematical algorithms for filtering the image data	Assessment
CO-3	Analysis of problemsand approaches in real time image processing.	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Fundamentals of Image Sensing:** Accessing Image Data, Image Types, Conceptualizing Images, Human Visual System, Simplified Imaging Model, Image Sampling and Quantization. CCD and CMOS Sensors.	8
2	**Image Transformations:**Gray Level Transformations, Image Histogram and Processing, Multispectral Transformations, Multi – Image Transformations, Image Interpolation and Warping.	8
3	**Spatial Domain Filtering:** Point Processing, Neighborhood Processing, 2D Convolution, Image Smoothing, Computation of First Derivative and Second Derivative, Non – Linear Filters, Gray Scale Morphological Operators.	7
4	**Frequency Domain Filtering:** Fourier Transform and Discrete Fourier Transform (DFT), Two Dimensional DFT, Low Pass filtering, High Pass Filtering, Band Pass Filtering, Homomorphic Filtering, Short Time	7

	Fourier Transform, Discrete Wavelet Transform.	
5	**Image Segmentation and Compression Techniques:** Edge Detection, Local and Global Thresholding, Adaptive Thresholding, Geometrical Processing, Watershed Algorithm, Basic Image Compression, Lossless and Lossy Compression, Image Compression Models.	**6**
6	**Applications of Image Sensing and Reconstruction:** Image Detection, Recognition and Verification, CNN for Image Recognition, Pattern Recognition and Motional Tracking, Real Time Imaging.	**6**
Total lectures		**42**

Suggested Text Book(s):

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing,Third Edition, Pearson Prentice Hall, 2008
2. Stan Birchfield, Image Processing and Analysis, CengageLearning India Private Limited, 2018

Suggested Reference Book(s):

1. D. K. Theckadath, Digital Image Processing using MATLABCoding, Third Edition, Tech - Max Publications, 2010.
2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice – Hall, 1989.

Other useful resource(s):

Link to topics related tocourse:

i. https://nptel.ac.in/courses/digital image processing
ii. www.tutorialspoint.com/digital image processing

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes (Image Sensing and Reconstruction)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average

CO-1	2	2	3	3	2	1	1	1	2	2	2	2	**2**
CO-2	2	3	3	3	2	1	1	1	2	2	1	2	**2**
CO-3	2	3	3	3	2	1	1	1	2	2	1	2	**2**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2**
Average	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	