Department of Electronics and Communication Engineering

JUIT Waknaghat

A meeting of Board of Studies of the Department of Electronics and Communication Engineering was held on 23.03.2019 at 09:30 AM in the Board Room.

The following members were present

1.	Prof. M.J. Nigam	Chairman
2.	Prof. Samir Dev Gupta	Dean A & R
3.	Prof. D. Ghosh	External Member
4.	Dr. Rajiv Kumar	Member
5.	Dr. Shruti Jain	Member Secretary
6.	Dr. Meenakshi Sood	Member
7.	Dr. Neeru Sharma	Member
8.	Dr. Shweta Pandit	Member
9.	Dr. Vikas Baghel	Member
10.	Prof. P. B. Barman	HOD, PMS Department
11.	Prof. Sunil Khah	Representative PMS Department
12.	Prof. Ashish Kumar	Representative Civil Engineering Department
13.	Dr. Anil Kant	Representative BT & BI Department
14.	Dr. Hemraj Saini	Representative CSE Department
15.	Dr. Neel Kanth	Representative Mathematics Department
16.	Dr. Sakshi Khanna	Representative HSS Department

Leave of absence

Leave of absence was granted to the following members by the Chairman Board of Studies:

1. Prof. C.C.Tripathi (External Member)
2. Dr. Balwinder Singh (External Member)

The Chairman welcomed all the members who were present for the meeting. The meeting thereafter deliberated on agenda items as had been approved by the Chairman.

Item No. 1 : Confirmation of minutes of Last Meeting of the Board of Studies held on 13.10.2018.

It was suggested by Prof. Samir Dev Gupta to make a list of PhD courses and syllabi.
Prof. P.B. Barman has informed that the mode of Engineering Physics II is 3-0-0 (L-T-P) and Engineering Physics Lab II is 0-0-2 (L-T-P).

Rest approved

Item No. 2: To consider the approval of new Electives for 160 credit curricula for B.Tech ECE (2018 batch onwards).

Prof. D Ghosh has suggested that based on GATE, GRE and other competitive examinations syllabus, Automatic Control System should be included as a core course. After rigorous discussion on this topic, board has suggested replacing "Electrical Machines and Instruments" subject with "Automatic Control System" and also replacing the laboratory courses. Some portion of the subject contents are being already covered in Electrical Sciences syllabus.

Changes have been incorporated. Rest recommended was approved.

Item No. 3 : To consider the approval of syllabi of Professional Electives as per 160 credit curricula for B.Tech. ECE (2018 batch onwards).

It was suggested by Prof. Samir Devgupta that there is overlapping in Microwave subjects. So board has suggested clubbing the syllabus of Microwave Components and Devices and Microwave Theory and Techniques into one course titled "Microwave Theory and Techniques". He also suggested re-checking of Radar Principles and Applications syllabus.
The new syllabus of Microwave Theory and Techniques and Radar Principles and Applications is reframed and provided in **Appendix I**. Rest syllabi of electives for 160 credit scheme were approved.
Course codes needs to be generated by Administration.

Item No. 4 : To consider the approval of change in Course titles of some approved electives as per 160 credit curricula for B. Tech ECE (2018 batch onwards).

As recommended was approved.

Item No. 5 : To consider the approval of Open Electives for 160 credit curricula (2018 batch onwards)

It was suggested by Prof. P.B Barman that two lectures per week for one Theory course are insufficient for students. Later board has suggested that out of four open electives: two open electives should run on 2-0-2 (L-T-P) scheme and two electives on 3-0-0 (L-T-P) scheme. As per the suggestions changes has been incorporated and provided in **Appendix II.**

The syllabi of all open electives have also been incorporated.
Course codes needs to be generated by Administration.

Item No 6: To consider the approval of B-Tech ECE Proficiency in "Communication and Signal Processing".

As recommended was approved

Item No.7: To consider the approval of courses for 160 credit Curricula of B-Tech ECE with additional certificate of Proficiency.

It was suggested by Board that there should be change in titles of some courses. As per the suggestions changes has been incorporated and provided in **Appendix III.**

Item No 8: To consider the approval of courses for 160 credit Curricula of B-Tech with additional certificate of Minor in ECE.

Board has suggested making electives of Minor structure simple so that Computer Science or Civil Engineering students can opt for the course.

As per the suggestions changes has been incorporated and provided in **Appendix IV.**

Item No. 9: To revise the syllabi of Lab courses for 2016 and 2017 batches

As recommended was approved

Item No. 10 : To revise the syllabi of Lab courses for 2018 batch (160 credit scheme)

As recommended was approved

Item No. 11 : To approve the MOOC course to be introduced during the Academic Session 2018-19 for all batches of ECE.

As recommended was approved

Item No. 12 : To consider the change in nomenclature for core courses of 160 credit scheme for 2018 batch.

As per the suggestions changes has been incorporated and provided in **Appendix V** and the new 160credit scheme for ECE department is provided in **Appendix VI.**

Item No. 13: Any other item with the permission of the Chair.

There is a change in nomenclature of Network Analysis and Synthesis to "Network Theory" for 2017 batch.

Open Elective floated for 5^{th} semester of 3 credits (3-0-0) for 2017 batch will be considered as Professional elective. The list of electives and their syllabi is provided in **Appendix VII**

The meeting concluded at 1145hrs with a vote of thanks by **Prof. M. J. Nigam,** Chairman Board of Studies.

(Prof. D.Ghosh)

Absent
(Prof. C.C. Tripathi)

Absent
(Dr. Balwinder Singh)

(Prof. M. J. Nigam)

(Prof. Samir DevGupta)

(Dr. Rajiv Kumar)

(Dr. Shruti Jain)

(Dr. Neeru Sharma)

(Dr. Meenakshi Sood)

(Dr. Shweta Pandit)

(Dr. Vikas Baghel)

(HOD, CSE Department)

(HOD, BT / BI Department)

(HOD, PMS Department)

(Prof. Sunil Khah)

(HOD, Mathematics Department)

(HOD, HSS Department)

(HOD, Civil Engineering Department)

Microwave Theory and Techniques

COURSE CODE:

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	

Radar Principles and Applications

COURSE CODE:

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	

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		Digital Systems	2	0	0	2	2
			Digital Systems Design Lab	0	0	2	1	2
2	Open Elective		Principles of Communication Systems	2	0	0	2	2
			Principles of Communication Systems Lab	0	0	2	1	2
3	Open Elective		Fundamentals of Digital Signal Processing and Applications	2	0	0	2	2
			Fundamentals of Digital Signal Processing Lab	0	0	2	1	2
						Total	3	4

OPEN ELECTIVE-III

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective		Principles of Wireless Communication	2	0	0	2	2
			Principles of Wireless Communication Lab	0	0	2	1	2
2	Open Elective		Automation and Robotics	2	0	0	2	2
			Automation and Robotics Lab	0	0	2	1	2
3	Open Elective		Software Defined Radio and Applications	2	0	0	2	2
			Software Defined Radio Lab	0	0	2	1	2
						Total	3	4

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OPEN ELECTIVE-IV								
S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective		Optimization Techniques in Engineering	3	0	0	3	3
2	Open Elective		Electrical Machines	3	0	0	3	3
3	Open Elective		Biomedical Signal Processing	3	0	0	3	3
						Total	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		Industrial Internet of Things	3	0	0	3	3
2	Open Elective		Wireless Ad Hoc and Sensor Networks	3	0	0	3	3
3	Open Elective		Satellite Communication	3	0	0	3	3
						Total	3	3

Digital Systems

COURSE CODE:

COURSE CREDITS: 2

CORE/ELECTIVE:

L-T-P: 2-0-0

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 systems.	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.	5
2	Sequential circuits: Quine McCluskey Method for Combinational Circuits, Finite state model – Basic definition, capabilities and limitation of finite state machines, state equivalence & machine minimization, simplification of incompletely specified machines.	8
3	Asynchronous Sequential Circuits: Introduction to asynchronous circuits, timing diagram, state diagram & flow tables, types of asynchronous circuits, ASM charts and their usage.	8
4	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.	9
Total lectures		30

Suggested Text Book(s):

1. W. I. Fletcher :An Engineering approach to Digital Design, PHI.
2. M.Morris Mano : Digital Design, 3rd edition, Pearson Education, 2007.
3. Michael D. Ciletti: Advanced Digital Design with Verilog HDL, PHI, 2005.

Suggested Reference Book(s):

1. Digital Systems Design using VHDL – Charles H Roth, CENGAGE Learning.
2. Switching and Finite Automata Theory by ZVI Kohavi, TMH.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/117105080/

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-2	2	3	3	3	3	1	1	1	2	2	1	2	2.1
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	2.1
CO-4	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	

Digital Systems Design Lab

COURSE CODE:

COURSE CREDITS: 1

CORE/ELECTIVE:

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To provide students basic experimental experiences in constructing digital circuits.
2. To measure the experimental data and analysis of the results.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To have an in depth knowledge of digital systems.	Familiarity
CO2	To design and simulate different digital circuits	Familiarity
CO3	To get acquainted with various sequential circuits.	Assessment
CO4	To learn about the different types of hazards encountered during the design of digital circuits	Usage

List of Experiments

S.No	Description	Hours
1	Design and Simulation of logic gates.	2
2	Design and Simulation of adders and subtractors.	2
3	Simulation and verification of Multiplexer, Demultiplexer, Decoder and Encoder.	2
4	To design a 4 bit Binary to Gray code Converter, 4 bit Gray to Binary code Converter, 3 bit Binary to Excess-3 code Converter.	2
5	Minimization of expressions using QM method.	2
6	Functional table verification of Latches: (i) SR-Latch with NOR Gates (ii) SR-Latch with NAND Gates (iii) SR-Latch with control input using NAND Gates (iv) D Latch (v) T Latch	2
7	Design and Simulation of Ring Counter and Johnson Counter.	2
8	Design and simulation of PIPO, PISO, SIPO, and SISO shift registers.	2
9	Design of Sequence Detector using Mealy Machines.	2
10	Design of Sequence Detector using Moore Machines.	2

11	Design of Finite State Machine.	2
12	Design of 4- Bit Multiplier, Divider.	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_ce33/ (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
Average	3	3	2.75	2.75	2.50	2.00	1.25	1.00	1.00	1.00	1.25	1.5	

Principles of Communication Systems

COURSE CODE:

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:

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:

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	6

	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.	
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:

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

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:

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/

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:

COURSE CREDITS: 01

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Understand the various techniques of practical wireless communication system.
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:

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: 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:

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	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	Introduction to Automation and Robotics: History of automation, Automation systems, Types of automation, Definition of robot, Types of robots, classification and usage, Terminology of robotics, Specifications of robot, Architecture of robotic systems	5
2	Controllers and Actuators: Basic Control System concepts and Models, Types of Controllers: Proportional, Integral, Derivative, PI, PD and PID controller, Actuators-Electric, Hydraulic, Pneumatic, Types of transmissions	6
3	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	7
4	Robot Arm Kinematics and Dynamics:Position and orientation of a rigid body, Homogeneous transformations, Forward kinematics, Inverse kinematics, Lagrange formulation of dynamics	6

5	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		30

Suggested Text Book(s):

6. J. J. Craig, "Introduction to Robotics- Mechanics and Control", Pearson,3rd Edition, 2009.
7. Spong and Vidyasagar, "Robot Dynamics and Control", Wiley Student Edition, John Wiley and Sons, 2013.
8. R. K. Mittal and I. J. Nagrath, "Robotics and Control", Tata McGraw Hill, New Delhi, 4th Reprint, 2005.

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.

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: 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 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 (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	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	2	2	3	3	2.58
Average	3	3	2.75	2.5	2.75	2.5	1.5	1	1.75	1.75	2.5	3	

Automation and Robotics Lab

COURSE CODE:

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Digital Electronics Lab

Course Objectives:

1. To teach and help students acquire new skills in an era of rapidly evolving technology in the field ofrobotics.
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 platform and AVR programming tools.	2
2	To perform basic IO Interfacing on Firebird-V e.g. Buzzer interfacing.	2
3	To perform forward, backward, left and right motion control of Firebird-V Robot.	2
4	To study and perform Timer in AVR and their associated Registers.	2
5	To perform DC Motor velocity control using Pulse Width Modulation (PWM) in Firebird-V.	2
6	To perform LCD interfacing on Firebird V Robot and displaying text at different positions on the LCD and implementing a simple scroll display.	3
7	To study sources of Interrupt on ATmega2560 and perform Interrupts handling on Firebird-V Robot.	3
8	To perform Analog to Digital conversion (ADC) on Firebird-V Robot.	3

9	To perform white line following on Firebird-V Robot.	3
10	To perform PC based control using serial communication on Firebird-V Robot using RS232 serial port.	2
11	To perform PC based control using serial communication on Firebird-V Robot using X-Bee wireless communication module.	2
12	To implement Valet Parking Robot: parking the Firebird-V robot at an appropriate vacant slot in a parking lot.	2
Total Lab hours		28

Suggested/Resources:

1. Resource provided by e-Yantra link here: http://elsi.e-yantra.org/resources
2. Resource provided by Firebird VAtmega2560 link here:http://www.nexrobotics.com/robots.htm
3. S.Ghoshal, "Embedded Systems & Robotics" – Projects using the 8051 Microcontroller",Cengage Learning, 2009.
4. R. K. Mittal and I. J. Nagrath, "Robotics and Control", Tata McGraw Hill, New Delhi, 4th Reprint, 2005.

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	2.5	3	1.75	1.25	1	1.25	1.75	1.5	1	2.75	

Software Defined Radio and Applications

COURSE CODE:

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.	Familarity
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

(84)

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:

COURSE CREDITS: 01

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:

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:

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:

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/

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:

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:

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN 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:

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	

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFICIENCY :
Communication & Signal Processing

S. No.	Category Code	Semester	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Proficiency I	5	Wireless & Ad hoc Networks	3	0	0	3	3
2	Lab	5	Wireless & Ad hoc Networks Lab	0	0	2	1	2
3	Proficiency II	6	Wavelets and Applications	3	0	0	3	3
4	Proficiency III	7	Design for Internet of Things	3	0	0	3	3
5	Proficiency IV	7	Pattern Analysis in Machine Intelligence	3	0	0	3	3
6	Lab	7	Machine Learning Lab	0	0	2	1	2
7	Proficiency V	8	Applied Medical Signal Processing	3	0	0	3	3
8	Proficiency VI	8	Adaptive Signal Processing and Machine Intelligence	3	0	0	3	3
						Total	20	22

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

MINOR in Electronics and Communication Engineering

S. No.	Category Code	Semester	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	3	Digital Electronics & Logic Design	3	1	0	4	4
2	Professional Core	3	Digital Electronics & Logic Design Lab	0	0	2	1	2
3	Professional Core	4	Analogue and Digital Communications	3	1	0	4	4
4	Professional Core	5	Microprocessor and Interfacing	3	0	0	3	3
5	Professional Core	5	Microprocessor and Interfacing Lab	0	0	2	1	2
6	Professional Core	6	Advance Communication Lab	0	0	2	1	2
7	Professional Elective	6	Intelligent Control Systems	3	0	0	3	3
8	Open Elective	7	Principles of Wireless Communication	3	0	0	3	3
						Total	20	23

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

CHANGE OF COURSE NAME (CORE) OF ECE DEPARTMENT- 160 CREDITS

S. No.	Category Code	Old Name	New Name
1	Professional Core	Analogue Electronics	Analog Integrated Circuits
2	Professional Core	Signals & Systems	Fundamentals of Signals & Systems
3	Professional Core	Analog and Digital Communication	Modern Analog and Digital Communication
4	Professional Core	Analogue Electronics Lab	Analog Integrated Circuits Lab
5	Professional Core	Signals & Systems Lab	Fundamentals of Signals & Systems Lab
6	Professional Core	Analog and Digital Communication Lab	Modern Analog and Digital Communication Lab
7	Professional Core	Digital Signal Processing	Principles of Digital Signal Processing
8	Professional Core	Digital Signal Processing Lab	Principles of Digital Signal Processing Lab
9	Professional Core	Electromagnetic Engineering	Electromagnetic Waves
10	Professional Core	VLSI Technology and Applications	VLSI Technology
11	Professional Core	VLSI Lab	VLSI Technology Lab

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2018 batch (160 CREDITS)

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	18B11CI111	Programming for Problem Solving	3	0	0	3	3
7	Engg Science	18B17GE173	Engineering Graphics **OR**	0	0	3	1.5	3
		18B17GE171	Workshop Practices					
8	Engg Science	18B17CI171	Programming for Problem Solving Lab	0	0	2	1	2
9		18B17GE172	Mandatory Induction Program	-	-	-	-	-
							17.5	22

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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COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2018 batch (160 CREDITS)

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	18B11MA311	Probability 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) 4rth 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	18B11MA411	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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COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2018 batch (160 CREDITS)

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	2	0	2	3	4
8	Open Elective		Open Elective-III / MOOCs	2	0	2	3	4
9	Professional Elective		Professional Elective-II	3	0	0	3	3
10			Industrial Training				0	0
							22	27

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COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2018 batch (160 CREDITS)

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		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		Project Part-II				8	8
							20	20

TOTAL CREDITS	160
TOTAL HOURS	185
HSS	12
Basic Science	24
Engg. Science	27
Professional Core	46
Professional Elective	21
Open Elective	15
Project	15

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

PROFESSIONAL ELECTIVES FOR 5th Semester

List of Professional Elective for 5th Semester ECE, 2016 batch

S.No.	Professional Electives
1	Applied Artificial Intelligence
2	Control systems
3	Microwave Components and Devices

Syllabi of Professional Elective for 5th Semester ECE, 2016 batch

Applied Artificial Intelligence

COURSE CODE:

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. Study of design of expert systems which exhibit intelligent behavior.
2. Study of design and development of products using Artificial Intelligence.
3. Participate in the design of systems that act intelligently and learn from experience.
4. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Basic methods and algorithms from area of artificial intelligence	Familiarity
CO-2	Identify problems where artificial intelligence techniques are applicable.	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):** Overview of AI, Philosophy of AI, AI Foundation and History, Applications of AI in modern world.	8
2	**Intelligent Agents:** Agents and Environments, 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, Knowledge and Reasoning:** Problem solving Agents, Formulating Problems, Searching for Solutions, Uninformed Search Strategies, Knowledge based agents, Knowledge Representation, Uncertain Knowledge and Reasoning	7
4	**Machine Learning**: Machine learning concepts, K-nearest neighbors and training-testingLogistic regression, Decision trees, Neural networks, Clustering, Association rules	7
5	**Reinforcement Learning:** Learning from Observations, 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:

i. https://nptel.ac.in/courses/106105077/
ii. https://nptel.ac.in/courses/106105079/
iii. 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 (Applied Artificial Intelligence)	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**	

Control Systems

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

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 understand stability of state space models and their controllability and observability in modern automation and control.

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 ability to formulate reduced models for complex systems.	Familiarity
CO-3	The skill to analyze the response of any LTI system.	Assessment
CO-4	The ability to design any system with desired specifications both in time and frequency domain.	Assessment
CO-5	The ability to derive, interpret and solve problems using modern state space control methods for continuous time and discrete time systems.	Usage
CO-6	The skill to apply advance control schemes for various applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Systems and Control:** Open loop and closed loop control systems, components of control system: sensors, actuators, controllers, process, modeling principles of physical systems: electrical, mechanical, thermal and pneumatic systems, effect of feedback on gain, stability, sensitivity and noise, characteristics of transfer function models: poles, zeros, stability and minimal realization, block diagram algebra, signal flow graphs, Mason's gain formula, conversion between block diagram and signal flow graph.	6
2	**Response Analysis:** Standard test input signals, transient and steady	8

	state response: first, second and higher order systems, system design specifications, error analysis: static and dynamic error coefficients, Effect of adding poles and zeroes, Correlation-ship between time and frequency domain specifications	
3	**Stability Analysis:** Absolute stability, relative stability, routh-hurwitz, root locus, bode plot, polar plot and Nyquist plot techniques, gain margin and phase margin, constant magnitude loci: M-circles, constant phase Loci: N-circles, nichol's chart. system identification: inverse bode plots. Effect of adding zero to the forward path, effect of adding pole to the forward path.	**8**
4	**Compensator Design:** System design specifications, design of compensating networks (Lead, Lag, Lag-Lead) for specified control system performance using root locus and bode plot, concepts and applications of P, PD, PI and PID controllers..	**6**
5	**Linear State Variable Models:** Concept of state, state space modeling: SISO and MIMO systems, useful transformations in state space analysis and design, various forms: physical variable form, phase variable form, Jordan canonical form, solution of state equations, computation of state transition matrix: Laplace method, power series method and Cayley Hamilton method, derivation of transfer function from State variable model, decomposition of transfer function: direct decomposition, cascade decomposition, parallel decomposition, characteristics of linear state variable models, natural and forced responses, determination of controllability and observability of a control system using Kalman and Gilbert tests..	**8**
6	**Advanced Control Schemes:** Control systems with multiple loops-cascade control, selective control systems: override control, split range control, feed-forward and ratio control, adaptive and inferential control systems.	**6**
Total lectures		**42**

Suggested Text Book(s):

1. Benjamin C. Kuo: Automatic Control Systems, 9th Ed., Prentice Hall of India, 2014.
2. Nagrath & Gopal: Control System Engineering, 6th Ed., New Age International Pvt Ltd, 2018.
3. Stephanopoulos, G.: Chemical Process Control, 1st Ed., Prentice Hall of India, 2008.

Suggested Reference Book(s):

1. K. Ogata: Modern Control Engineering, 5th Ed., Prentice Hall India Learning Private Limited, 2010.
2. Norman S. Nise: Control Systems Engineering, 6th Ed., John Wiley & Sons Inc, 2010.
3. Richard C Dorf, Robert H Bishop: Modern Control Systems, 12th Ed., Pearson Edu Pearson, 2014.

Other useful resource(s):

1. Link to NPTEL course contents: Control systems
   https://onlinecourses.nptel.ac.in/noc18_ee41/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 (3) - 10 Quizzes (3) - 10 Attendance - 5

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

Course outcomes (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	**1.67**
CO-2	3	2	1	3	2	1	1	1	1	1	1	2	**1.58**
CO-3	3	2	1	3	2	1	1	1	1	1	1	2	**1.58**
CO-4	3	3	2	1	2	1	1	1	1	1	1	2	**1.58**
CO-5	3	3	3	1	2	1	1	1	2	1	1	2	**1.75**
CO-6	3	2	2	2	3	1	1	1	1	1	1	2	**1.67**
Average	**3.00**	**2.33**	**1.83**	**2.00**	**2.17**	**1.00**	**1.17**	**1.00**	**1.17**	**1.00**	**1.00**	**2.00**	

Microwave Components and Devices

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Electromagnetic Engineering

Course Objectives:

3. To learn the basic operating principles of microwave components.
4. To have a strong foundations in microwave measurements.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the basic knowledge of microwave sources.	Familiarity
CO-2	To have a complete knowledge about the wave guide components and their applications in microwave systems.	Assessment
CO-3	To understand and gain knowledge of different active devices and their working principles.	Familiarity
CO-4	To understand and gain thorough knowledge of microwave measurements.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Microwave Sources:** Microwave transmission lines, Klystron amplifier design and operation, reflex klystron and TWT amplifier and its gain calculations.	10
2	**Microwave waveguides:** Parallel plate wave guides, rectangular wave-guides, cylindrical wave-guides, resonators.	10
3	**Microwave components:** Directional coupler, E-plane Tee, H-plane Tee, Magic Tee, Microwave circulators, Microwave isolators, Microwave attenuators, microwave phase shifters, microwave impedance matching circuits.	10

4	**Microwave Devices:** Principles of microwave transistor, microwave FET, Gunn oscillators, IMPATT diode, TRAPATT Diode, BARITT diode, PIN diode, Tunnel diode.	6
5	**Network analysis and Microwave Measurements:** Power measurement, frequency measurement, impedance measurement and VSWR measurement. Scattering parameters and SFG models	6
Total lectures		**42**

Suggested Text Book(s):

1. Samuel Y.Liao, " Micro wave Devices and Circuits", 3rd edition, Pearson education,2003.
2. R.E.Collin, "Foundations for microwave Engineering", 2nd edition,Tata Mc Graw Hill,1992.

Suggested Reference Book(s):

1. Annapurna Das,Sisir.K.Das,"Microwave Engineering",Tata McGraw Hill, 2000.
2. Pozar, David M. "Microwave engineering" John Wiley & Sons,2009.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108101112/
2. Link to topics related to course: https://nptel.ac.in/courses/108101112/1 to 12

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 Components and Devices)	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	1	**1.7**
CO-2	2	3	3	3	3	1	1	1	2	2	2	1	**2.0**
CO-3	2	2	2	2	3	1	1	1	2	2	2	1	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	1	**2.0**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1.0**	**1.0**	**1.0**	**2.0**	**2.25**	**2.0**	**1.0**	