SHIV NADAR UNIVERSITY
DELHI NCR

DEPARTMENT OF ELECTRICAL ENGINEERING

SCHOOL OF ENGINEERING (SoE)

UNDERGRADUATE (B.TECH.) PROSPECTUS

(2020-2021)

FOR

ELECTRONICS AND COMMUNICATION ENGINEERING (ECE)

AND

ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)

I. Overview of Department of Electrical Engineering

The Electrical Engineering (EE) department is part of the School of Engineering (SoE) at SNU. Its vision is to be a catalyst in imparting quality education and conducting valued research for the benefit of society. Historically, the field of electrical engineering is one of the most important engineering disciplines that have changed the course of the world. Some of our important areas of teaching are electrical machines and drives, power electronics, power systems, integrated circuits and systems, control systems, machine intelligence, communication systems and signal processing. Sufficient emphasis is given to practical teaching and hands-on learning. Relevant laboratories have been established to meet the requirements of teaching and research. The vision of the department is to establish itself as a center of excellence in terms of research and teaching in its chosen areas. We are committed to establishing human and material infrastructure towards this cause. The department has formed research groups in some of the key areas and is in the process of collaborating with various renowned institutions.

The undergraduate program is broad-based and founded on the pedagogy of learning by doing. The postgraduate programs are getting formulated and are intended to provide advanced degrees in contemporary areas of industrial relevance. They also provide platforms for research avenues. The department has a vibrant doctoral research program. The doctoral program aims to conduct research both in fundamental and applied areas for societal use. The programs intend to fill the dearth in the supply of highly skilled professionals. It will also enable the students to gain high-end skills for intellectually challenging careers in industry. Our aim is to invoke in our students a sense of curiosity to question and to motivate them to think deeply about theoretical and applied problems in technology for society's needs.

Presently the EE department offers the following programs: -

Undergraduate Programs:

(I) Bachelor of Technology in Electronics and Communication Engineering (B. Tech. in ECE) with the option of doing minor in any other stream of interest.

(II) Bachelor of Technology in Electrical and Electronics Engineering (B. Tech. in EEE) with the option of doing minor in any other stream of interest.

Master Programs:

(I) M. Tech in RF and Microwave Engineering.

Doctoral Programs:

(I) Ph.D. in Electrical Engineering / Electronics and Communication Engineering.

II. Credit Break-up of UG Curriculum in Electronics and Communication Engineering (ECE) & Electrical and Electronics Engineering (EEE) Courses

Overall Credit Distribution for ECE/EEE

S. No.	Category	ECE	EEE
1.	Core Common Curriculum (CCC)	18	18
2.	University Wide Elective (UWE)	18	18
3.	Additional CCC and/or UWE	6	6
4.	Basic Sciences (BS)	20	20
5.	Engineering Sciences (ES)	12	12
6.	Major Core	59	61
7.	Major Elective	15	15
8.	Major Project -1	6	6
9	Internship / Major Project - 2	6	6
Total Credits		**160**	**162**

Basic Sciences for ECE/EEE

S. No.	Course Title	L:T:P	Credits	Sem. Offered
1.	Physics-1	3-1-0	4	1
2.	Mathematics-1	3-1-0	4	1
3.	Mathematics-2	3-1-0	4	2
4.	Physics-2	3-1-1	5	2
5.	Mathematics-3	3-0-0	3	3
Total Credits			**20**	

Engineering Sciences for ECE/EEE

S. No.	Course Title	L:T:P	Credits	Sem. Offered
1.	Basics of Electrical & Electronic Circuits	3-1-1	5	1
2.	Introduction to Computing and Programming	3-0-1	4	1
3.	Introduction to Semiconductor Devices	3-0-0	3	2
Total Credits			**12**	

Major Electives for ECE/EEE

S. No.	Course Title	L:T: P	Credits
1.	Major Elective - I		3
2.	Major Elective - II		3
3.	Major Elective - III		3
4.	Major Elective - IV		3
5.	Major Elective-V		3
Total Credits			**15**

Core Projects

S. No.	Course Title	L:T:P	Credits	Sem. Offered
1.	Major Project-I	0-0-06	6	7
2.	Major Project-II	0-0-06	6	8
Total Credits			**12**	

Semester-wise Credit Distribution For EEE/ECE

S. No.	Category	Credits (ECE)	Credits (EEE)
1.	Semester I	20	20
2.	Semester II	20	20
3.	Semester III	21	21
4.	Semester IV	20	23
5.	Semester V	22	21
6.	Semester VI	24	24
7.	Semester VII	21	21
8.	Semester VIII	12	12
Total Credits		**160**	**162**

Detailed rules and regulations regarding B.Tech. Program in SNU can be found in UG handbook (available at: https://snulinks.snu.edu.in/snuPolicies/students/

III. Semester-wise Course Distribution for ECE/EEE

Semester-wise Course Distribution for ECE

First Semester

S. No.	Course Title	L:T: P	Credits
1	CCC-1	3-0-0	3
2	Mathematics-1	3-1-0	4
3	Physics-1	3-1-0	4
4	Basics of Electrical & Electronic Circuits	3-1-1	5
5	Introduction to Computing and Programming	3-0-1	4
Semester Credits			**20**

Second Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-2	3-0-0	3
2	Mathematics-2	3-1-0	4
3	Digital Electronics	3-1-1	5
4	Physics-2	3-1-1	5
5	Semiconductor Devices	3-0-0	3
Semester Credits			**20**

Third Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-3	3-0-0	3
2	Mathematics-3	3-0-0	3
3	Circuit Theory	3-0-0	3
4	Data Structures	3-0-1	4
5 6	Signals and Systems Electromechanics	3-1-0 3-0-1	4 4
Semester Credits			**21**

Fourth Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-4	3-0-0	3
2	UWE-1(DES211)	3-0-0	3
3	UWE-2	3-0-0	4
4	Electromagnetic Engineering	3-0-0	3
5	Analog Electronic Circuits	3-0-1	4
6	Communication Engineering	3-0-1	4
Semester Credits			**20**

Fifth Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-5	3-0-0	3
2	UWE-3	3-0-0	3
3	Control Systems	3-0-1	4
4	Digital Signal Processing	3-0-1	4
5	Power Electronics	3-0-1	4
6	Communication Networks	3-0-1	4
Semester Credits			**22**

Sixth Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-6	3-0-0	3
2	UWE-4		3
3	UWE-5		3
4	VLSI Technology and Design	3-0-1	4
5	Major Elective-1	3-0-0	3
6	Embedded Systems Hardware	3-0-1	4
7	Digital Communication	3-1-0	4
Semester Credits			**24**

Seventh Semester

S. No.	Course Title	L:T:P	Credits
1	UWE-6		3
2	Major Elective-2	3-0-0	3
3	Major Elective-3	3-0-0	3
4	Major Project-1	0-0-6	6
5	Additional CCC and / or UWE	3-0-0	6
Semester Credits			**21**

Eighth Semester

S. No.	Course Title	L:T:P	Credits
1	Internship / Major Project -2	0-0-6	6
2	Major Elective -4	3-0-0	3
3	Major Elective -5	3-0-0	3
Semester Credits			**12**

Semester-wise Course Distribution for EEE

First Semester

S. No.	Course Title	L:T: P	Credits
1	CCC-1	3-0-0	3
2	Mathematics-1	3-1-0	4
3	Physics-1	3-1-0	4
4	Basics of Electrical & Electronic Circuits	3-1-1	5
5	Introduction to Computing and Programming	3-0-1	4
Semester Credits			**20**

Second Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-2	3-0-0	3
2	Mathematics-2	3-1-0	4
3	Digital Electronics	3-1-1	5
4	Physics-2	3-1-1	5
5	Semiconductor Devices	3-0-0	3
Semester Credits			**20**

Third Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-3	3-0-0	3
2	Mathematics-3	3-0-0	3
3	Circuit Theory	3-0-0	3
4	Data Structures	3-0-1	4
5	Signals and Systems	3-1-0	4
6	Electric Machines-I	3-0-1	4
Semester Credits			**21**

Fourth Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-4	3-0-0	3
2	UWE-1 (DES211)	3-0-0	3
3	Measurement and Instrumentation	2-0-1	3
4	Electromagnetic Engineering	3-0-0	3
5	Analog Electronic Circuits	3-0-1	4
6	Electric Machines-II	3-0-1	4
7	Transmission & Distribution	3-0-0	3
Semester Credits			**23**

Fifth Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-5	3-0-0	3
2	UWE-2	3-0-0	3
3	Control Systems	3-0-1	4
4	Power Electronics	3-0-1	4
5	UWE -3	3-0-0	3
6	Digital Signal Processing	3-0-1	4
Semester Credits			**21**

Sixth Semester

S. No.	Course Title	L:T:P	Credits
1	CCC-6	3-0-0	3
2	UWE-4		3
3	UWE-5		3
4	Power Engineering	3-0-1	4
5	Electric Drives	3-0-1	4
6	Embedded Systems Hardware	3-0-1	4
7	Major Elective-1	3-0-0	3
Semester Credits			**24**

Seventh Semester

S. No.	Course Title	L:T:P	Credits
1	UWE-6		3
2	Major Elective-2	3-0-0	3
3	Major Elective-3	3-0-0	3
4	Major Project-1	0-0-6	6
5	Additional CCC and / or UWE	3-0-0	6
Semester Credits			**21**

Eighth Semester

S. No.	Course Title	L:T:P	Credits
1	Internship / Major Project -2	0-0-6	6
2	Major Elective -4	3-0-0	3
3	Major Elective -5	3-0-0	3
Semester Credits			**12**

IV. List of ‘Major Core’ & ‘Major Elective’ courses offered in Electrical Engineering Department

Major Core Courses		
S. No.	**Course code**	**Course name**
1	EED101	Introduction to Electrical Engineering
2	EED102	Introduction to Semiconductor Devices
3	EED103	Basics of Electrical & Electronics Circuits
4	EED201	Signals and Systems
5	EED 202	Circuit Theory
6	EED203	Electro Mechanics
7	EED204	Analog Electronic Circuits
8	EED205	Communication Engineering
9	EED 206	Digital Electronics
10	EED 207	Electric Machines-II
11	EED208	Measurement and Instrumentation
12	EED209	Electric Machines-I
13	EED301	Electromagnetic Engineering
14	EED302	Control Systems
15	EED303	Microprocessors and Microcontrollers
16	EED304	Communication Networks
17	EED305	Digital Signal Processing
18	EED306	Power Electronics
19	EED307	Power Engineering
20	EED308	Embedded Systems Hardware
21	EED309	Recent Trends In Electrical Engineering
22	EED401	VLSI Technology and Design
23	EED 402	Electric Drives
24	EED 497	Major Project -1
25	EED498	Internship/ Major Project-2

Major Elective Courses		
S. No.	**Course code**	**Course name**
1	EED 350	Digital communication
2	EED351	Semiconductor Devices
3	EED 352	Transmission and Distribution
4	EED 353	Protection and Switch Gear
5	EED 354	Microwave Engineering
6	EED 355	Analysis and Control of Special Electrical Machines
7	EED 356	High Voltage Engineering
8	EED 357	Satellite Communication
9	EED 358	Mobile & Wireless Communication
10	EED 359	Digital Design with FPGA
11	EED 360	Modern Control
12	EED361	Design of Analog CMOS Circuits
13	EED362	GSM, SS7 & IN Signaling Fundamentals
14	EED363	Applied Machine Learning
15	EED364	Graph Signal Processing and its applications
16	EED365	Advanced Electromagnetics
17	EED366	Design of Photovoltaic System
18	EED367	HVDC Transmission
19	EED368	Information Theory & coding
20	EED369	MEMS Technology & Devices
21	EED370	Switched Mode Power Converters
22	EED371	Photovoltaic Power Generation
23	EED372	Power System Operations & control
24	EED373	Antenna & Wave Propagation
25	EED374	Radar Engineering
26	EED375	Python & Perl Scrip. Lang. for Data Sci. & Automtn
27	EED376	Optical Fiber Communication
28	EED377	Special Topics in RF And Microwave Engg.
29	EED378	Intro. to VLSI & WBG Devices for Power Circuits
30	EED379	IOT –Arch., Comm., Technology & Applications
31	EED380	Applied Deep Learning
32	EED405	Automotive Electronics
33	EED406	AutoSAR

V. Brief description of courses offered in electrical engineering department

1. EED 101 (Introduction to Electrical Engineering) (L: T: P) - (3:1:1)

Circuit Analysis: Review of KCL and KVL, Basic Circuit Terminology-Node, loop, mesh, circuit, branch and path. Ideal sources, Source transformation, Star-Delta transformation. AC analysis - Phasor, complex impedance, complex power, power factor, power triangle, impedance triangle, series and parallel circuits.

Network Theorems: Network Theorems (A.C. and D.C. Circuits) - Mesh and Nodal analysis, Thevenin, Norton, Maximum Power transfer, Millman, Tellegen and Superposition theorem.

Resonance and Transient Analysis: Introduction to Resonance-series and parallel, half power frequency, resonant frequency, Bandwidth, Q factor. Transient Analysis-Step response, Forced response of RL, RC & RLC series circuits with Sinusoidal Excitation-Time Constant and Natural frequency of Oscillation- Laplace Transform applications.

Electronic Devices and Components: Review of Energy band diagram- Intrinsic and Extrinsic semiconductors- PN junction diodes and Zener diodes-characteristics, Diode Applications-Rectifiers, Clippers and Clampers. Transistors-PNP and NPN – operation, characteristics and applications, Biasing of Transistors. Operational Amplifiers- Introduction and Applications-Inverting, Non Inverting, Voltage follower, Integrator, differentiator and difference amplifier, summer, log and Antilog.

Three Phase Systems and Transformers: Introduction to three phase systems, power measurements in three phase systems. Transformer- Principle of operation, construction, phasor diagram of Ideal and practical transformer with load (R, L, C and their combinations) and no-load, equivalent circuit, efficiency and voltage regulation of single phase transformer, O.C. and S.C. tests. Introduction to D.C. Machines.

Recommended book(s):

1. Introductory Circuit Analysis, Robert L. Boylestad, Twelfth edition, Pearson, 2012.
2. Introduction to Electric Circuits, Richard C. Dorf and James A. Svoboda, Wiley India Private Limited, Sixth Edition, 2007.
3. Principles of Electric Circuits Conventional Current Version, Thomas L. Floyd, Pearson Education International, Eighth Edition, 2007.
4. Electronic Devices and Circuit Theory Introductory Circuit Analysis, Robert L. Boylestad and Louis Nashelsky, Pearson, Tenth Edition, 2007.

2. EED 102 (Introduction to Semiconductor Device) (L: T: P)-(3:0:0)

Basic Semiconductor Properties: Material properties, Crystal Structure , E-k Diagrams, intrinsic and extrinsic Semiconductors , Energy bands in semiconductors Non-Mathematical approach to crystal structure

Equilibrium Carrier Statistics: Density of states, Fermi function, Equilibrium carrier concentrations, Electron and Hole Concentrations, E-F Calculations

Charge Carriers in Semiconductors: Electrons and Holes, Temperature Dependence of Carrier Concentrations, Compensation and Space Charge Neutrality. Conductivity and Mobility.

Recombination- Generation Processes: Recombination-Generation Statistics, Surface recombination- generation (Non-mathematical approach for surface Carrier Transport: Drift. Diffusion. Equations of State

Physics of Semiconductor and Metal-Semiconductor junctions: p-n junction: p-n junction under applied zero bias, forward and reverse bias including breakdown, p-n junction capacitance, dynamic resistance, piecewise linear model, Schottky and Ohmic Contact.

Bipolar Junction Transistor: Basics of BJT structure, type and biasing, T-model and Ebers-mole model, current gain in BJT (alpha, Beta, Gamma), Capacitances in a BJT

Metal Oxide Semiconductor Field Effect Transistor: Basic field effect transistors. MOS Fundamentals, Physics of Ideal and Non-ideal MOSFET (Enhancement Mode).

LEDs and Solar Cells

Recommended book(s):

1. Solid State Electronic Devices, Streetman & Banerjee (Pearson).
2. Physics of semiconductor devices, S. M. Sze (Wiley-Interscience).
3. Semiconductor Device Fundamentals, Robert F. Pierret (Pearson).

3. EED 103 (Basics of Electrical & Electronic Circuits) (L:T:P)-(3:1:1)

Linear D-C Circuits: Kirchhoff's laws, Series & Parallel combinations of resistances, Voltage & Current divisions, Analysis of resistive circuits using Loop & Node equations – with independent sources only, and with both independent and controlled sources.

Useful Circuit Analysis Techniques: Superposition, Source transformations, Thevenin's equivalent, Norton's equivalent, Maximum Power transfer, Delta-wye conversions.

Time-domain Analysis of LTI Circuits: Natural & forced responses of basic RC & RL circuits, Natural & forced responses of Series & Parallel RLC circuits.
Sinusoidal Steady State Analysis of A-C Circuits: Notions of phasors, impedance, admittance & transfer function; Frequency response vs transient response; Responses of RC, RL & RLC circuits – series & parallel Resonance; Simple passive Filters & their Bode plots; Loop & Node Analysis of a-c circuits with independent & controlled sources.
Basic Amplifiers: Amplifier parameters & controlled source models; Basic Feedback theory - Open-loop Gain, Feedback factor & Closed-loop gain; Effect of feedback on Amplifier parameters; VCVS model of an OPAMP; Amplifiers using ideal OPAMP; Frequency response of basic OPAMP-based amplifiers.
Power Amplifier: Small-signal vs Large-signal behaviour of amplifiers; Power amplifier requirements – Power Output & Efficiency; Power amplifier using OPAMP and transistors.
Waveform Generators: Condition of harmonic oscillation; RC and LC oscillator circuits; Timer and Relaxation oscillator based on comparator and RC timing circuit; Square wave generator using 555 Timer and Digital inverters (TTL/CMOS); Crystal clock generator.
D-C Power Supply: Half-wave and Full-wave Rectifiers, Shunt Capacitor filter, Voltage Regulator, Regulated D-C Power Supply. Wave Shaping Circuits: Diode Clippers; Precision Clippers using Diode and Op-amp; Diode Clamp; Peak Detector and Peak Hold circuits; Sample and Hold circuit.

Recommended book(s):
1. Engineering Circuit Analysis, W. H. Hayt, J. E. Kemmerly & S. M. Durbin, Tata McGraw Hill.

4. EED 201 (Signals and Systems) (L: T: P) - (3:1:0)

Prerequisites- EED 101/ EED103 or Mathematics courses covering Laplace Transform, Differential Equations and Basic Calculus (Approval from Instructor required).

Signals: Classification and representation of signals and systems, Continuous time & Discrete time signals and systems, Impulse and Step response of a system, linear systems, linearity, time invariance, causality, signal properties -LTI systems, Convolution.
Fourier Series and Transform: Fourier series, Fourier transform and properties, relation between Fourier transform and Fourier series, Sampling and reconstruction, FFT, DIT FFT, DIF FFT Algorithm, Inverse DFT and Convolution using FFT.
Laplace transforms: Representation of signals using continuous time complex exponentials, relation of Laplace and Fourier transform, concept of ROC and transfer function- block diagram representation, Inverse Laplace transform, properties, analysis and characterization of LTI systems using Laplace transform.

Z transforms: Representation of signals using discrete time complex exponentials-properties, inverse Z transforms, ROC, Analysis and characterization of LTI systems using Z transforms, block diagram, transfer functions.
Random variable and Process: Introduction to random variable and random process, State space analysis,
Two Port Network: Introduction to Two port networks and parameters.

Recommended book(s):

1. Signals & Systems, A.V. Oppenheim, A. S. Willsky & S. H. Nawab, 2nd edition, PHI, 1997.
2. Principles of Linear Systems and Signals, B. P. Lathi, 2nd Ed., Oxford University Press.
3. Signals and Systems, S. Haykin & B. Van Veen, 2nd edition, John Wiley & sons, 2004.
4. Signals and Systems, Ziemer and Tranter, 4th edition, Pearson LPE.

5. EED 202 (Circuit Theory) (L: T: P)-(3:1:0)

Transient in Circuits: Solving first order transient circuits using differential equations. Second order differential equations
Transform Domain Analysis: Laplace transform method, Transfer functions, Analysis of electrical circuits using Laplace transform
Network Topology: Network Graph, incidence matrix, notions of Tree, Cut set and Tie Set, graph theoretic formulations of network equations.
Network Functions: Concept of poles and zeros, driving point and transfer functions
Two-Port Networks: Characteristics of linear time-invariant networks, relationships among different network parameters, interconnections of networks.
Active Circuits and Feedback

Recommended book(s):

1. Network Analyses, M. E. Van Valkenberg, PHI.
2. Networks and Systems, D. Roy Choudhury, New Age International Publisher.
3. Introduction to Electric Circuits, Richard C. Dorf and James A. Svoboda, John Wiley.

6. EED 203 (Electro-mechanics) (L: T: P) - (3:0:1)

Prerequisites: EED101 or EED103

Transformers: Different types of transformers and Applications, Transformer Construction, Core and Shell type of transformers, Core Materials and Laminated core, Cooling systems, Ideal

Transformer Fundamentals, Practical Transformer, Equivalent circuit of a transformer, testing of Transformers, Polarity Test, OC test , SC Test and Back to Back or Sumpner's Test.

DC Machines: Principles of Electromechanical energy conversion, Electrical and magnetic circuits. DC machine Constructional details, DC generator – Operation, types of generators, Characteristics, DC winding diagrams.

DC Motors: DC motor operation, characteristics, Principles of commutation and armature reaction, Starters, Testing of DC machines.

AC Machines: Three phase Induction Machines, Constructional details, Principle of operation, IM characteristics, Starting of IM, Testing of IM, Three phase Synchronous machines (SM), Constructional details, Principle of operation, SM characteristics, Starting of SM, Different types of SM.

FHP and special Machines: Single phase IM, Universal Machine, PM DC machine, Stepper motors.

Recommended book(s):

1. Electrical Machinery, Fitzgerald, McGraw-Hill, 6th Edition, 2010
2. Electrical machinery and transformers, Guru and Hiziroglu, Oxford, 2004
3. Principles of electrical machines and Power Electronics, P. C. Sen, John Wiley and sons
4. Electrical machines, Nagrath and Kothari, McGraw hill, 3rd edition. 2004
5. Electrical machines, P. S. Bimbhra, Khanna Publisher, 2004

7. EED 204 (Analog Electronic Circuits) (L: T: P): (3:0:1)

Prerequisites: EED101 or EED103

Review of BJT and MOSFET: Review of physical properties and basic I-V equations of BJT and MOSFET; Various biasing operating modes of BJT and MOSFET, Low frequency incremental equivalent circuits, Basic BJT and MOSFET inverters and their applications

Transistor Biasing schemes: Resistive Biasing and Current Mirror Biasing Small-signal Analysis of Amplifiers: Single-stage amplifiers-CE, CB and CC and their MOSFET counterparts

Multi-transistor Amplifiers: Darlington pair, Difference amplifier, Active load and Cascode amplifier;

High-frequency model and Frequency Response: High-frequency model and Frequency Response of different types of amplifiers;

Basic Operational Amplifier design: Frequency Response of Opamp and simple Opamp-based amplifiers;

Introduction to Analog to Digital Conversion and Vice Versa: Basic Concepts of Analog to Digital Conversion and Vice Versa, Concept of INL and DNL, Common Schemes ADC and DAC for e.g. Resistive and Current Source based DAC, FLASH and Successive approximation ADC.

Recommended book(s):

1. Microelectronic Circuits, Sedra and Smith.
2. Electronic devices and circuits, Jacob Millman & Christos C. Halkias.
3. OP Amp and linear Integrated Circuit, Ramakant A.Gayakwad.

8. EED 205 (Communication Engineering (L: T: P) - (3:0:1)

Prerequisites: EED201

Review of Fourier series and Transform. Hilbert transform. Band pass signal and system representation. Noise: Resistor noise, Noise temperature, Noise bandwidth, effective input noise temperature, Noise figure. Noise figure & equivalent noise temperature in cascaded circuits. Random process: stationary, power spectral density, Gaussian process, noise. AM, DSBSC, SSB, VSB; Signal representation, generation, and demodulation. FM: signal representation, generation, and demodulation. Super heterodyne receiver, Mixer. Phase recovery with PLL. Noise in AM/FM: AM receivers using coherent detection, AM receivers using envelope detection, FM receivers. Pulse Modulation: PPM, PWM, PAM. PCM: sampling, PAM sampling, quantization, PCM -TDM. Basics of TDMA, FDMA, CDMA & GSM.

Recommended book(s):

1. Communication systems, S. Haykins, Wiley.
2. Principles of communication systems, H.Taub and D.L. Shilling, TMH.
3. Modern digital and analog communication systems, B. P. Lathi, Oxford.
4. Communication Systems, R. Singh and S. Sapre, TMH.
5. Digital and Analog Communication Systems, Shanmugam, Wiley.

9. EED 206 (DIGITAL ELECTRONICS) (L: T: P)-(3:1:1)

Digital Processing of Information- Analog and Digital representations of information; Information processing steps – logic and arithmetic; Expressing a decision-making process as a sequence of basic logic operations.

Digital Logic – Basic logic gates – AND, OR, NOT, NOR, NAND, XOR; De Morgan's laws; Truth Table; Boolean functions; A logical problem stated as a Boolean function. Number Systems and Arithmetic- Positional number systems – Binary, Decimal, Octal, Hexadecimal; Signed number representations; Arithmetic operations.

Processor Architecture- Concept of a Programmable Arithmetic and Logic Unit (ALU); A Processor and its instruction set; Basic constituents of a processor – Programmable ALU, Register array and Program sequencer; A simple single-bus architecture; Data paths and their control for different Instructions.

Hardware Description Language– VLSI digital design flow; Need for HDL; Language reference manuals for Verilog – syntax and semantics; Verification and synthesis of HDL designs; High-level language to HDL conversion.
Combinational Circuit Design– Realisation of Boolean functions using gates; Karnaugh map; Simplification of Boolean functions, Combinational circuit design using multiplexers and gates; Tabular Method, Combinational circuit design using Verilog.
Sequential Circuit Design– Latches and Flip-flops; Ripple counters; Sequence generator using flip-flops; State Table and State Diagram; Synchronous counters; Shift Registers; Ring and MLS counters; Sequential circuit design using Verilog.

Recommended book(s):
1. Digital Design, M. Morris Mano & Michael D. Ciletti, 5th Edition (Pearson).

10. EED 207 (Electric Machines-II) (L: T: P)-(3:0:1)

Prerequisites: EED209

Basic concepts of rotating electrical machines: Electrical and mechanical degrees, flux per pole, frequency of induced emf, generated emf expression, short-pitced coil and full pitched coil, coil span factor (pitch factor) and distribution factor and their physical significance, rotating magnetic field, synchronous speed, mmf variation of concentrated and distributed winding along the air-gap, space harmonics in the mmf wave**.**
Three phase Induction motors: Construction, types, and working principle of a three phase induction motor (I.M.), concept of slip, rotor induced emf and its frequency, stator and rotor voltage equations, equivalent circuit diagram of a three phase I.M., phasor diagram of the I.M. under no-load and full load conditions, effect of the presence of the air-gap on the no-load power factor, power flow diagram of the I.M., Torque-slip characteristics of the I.M., effect of adding external resistance on the starting torque and the maximum torque of the motor, plugging operating on the motor, IM stability, no-load and blocked rotor tests on the I.M., starting methods on the I.M., power factor improvement of the I.M. by capacitor banks, effect of changing the voltage and frequency on the I.M. performance, high torque squirrel cage I.M., tooth/slot harmonics in the I.M., asynchronous crawling, synchronous crawling, and cogging phenomena.
Single phase Induction motors: Double revolving field theory, torque-slip characteristics of a single phase I.M., stator and rotor governing equations, equivalent circuit diagram of a single phase I.M., no-load and blocked rotor tests on the motor, starting methods of the motor; resistance split phase starting, capacitor split phase starting.
Three phase Synchronous machines: Types of synchronous machines, effect of resistive, inductive, and capacitive loads on the terminal voltage of a three phase synchronous generator, concept of synchronous reactance, emf method to draw the equivalent circuit diagram of the

cylindrical rotor synchronous generators, open-circuit and short-circuit characteristics, voltage regulation of the alternators, active and reactive power flow equations for the cylindrical rotor alternators, conditions for reactive power generation and absorption, effect of variation in the field current on the performance of alternators and synchronous motors (connected to the grid), V-curve for the alternators and synchronous motors, synchronous condensers, synchronization, starting methods of three phase synchronous motors, two reaction theory of salient pole type synchronous alternators, power-angle characteristics, damper winding and hunting phenomenon.

Recommended book(s):

1. Electrical Machinery P. S. Bhimbra, Khanna publishers, 2012.
2. Generalized Theory of Electrical Machines, P. S. Bhimbra. Khanna publishers, 1998.
3. Electrical Machinery, Fitzgerald and Kingsley, McGraw- Hill Higher education, 7th edition, 2013.
4. Electrical Machines, D. P. Kothari and I. J. Nagrath, McGraw- Hill Higher education, 4th edition, 2010.

11. EED 208 (Measurement and Instrumentation) (L: T: P)-(2:0:1)

Prerequisites: EED101 or *EED103*

DC and AC potentiometers, DC and AC bridges, measurement of low and high resistances, measurement of 'L' and 'C' , Sensitivity of bridge, electrostatic and electromagnetic interference-grounding methods;
Instrument specifications and error analysis; Principle of analog voltmeter, ammeters, multi meters, single and three-phase wattmeter's and energy meters, frequency meter and phase meter, Extension of Instrument range: CT and PT;
Basics of digital measurements: A/D and D/A converters, Sample and Hold circuits, Electronic voltmeter, precision rectifiers, true r.m.s. voltmeter, Elements of Digital Multi meter;
Cathode ray oscilloscope, Digital storage oscilloscope;
Hall Effect sensors, clamp-on meter; Temperature sensors: Thermistor, RTD, Thermocouples, Bimetallic strip, pyrometer, Linear and Rotary Displacement sensors: LVDT, Angular encoder, Resolver, Piezoelectric sensors: Piezoelectric effect, pressure and vibration measurement, Strain Gauges: Principle of operation and applications.

Recommended text book(s):

1. E.O. Doebelin, 'Measurement Systems – Application and Design', Tata McGraw Hill Publishing Company, 2003.
2. E.W. Golding and F.C. Widdis, 'Electrical Measurements and Measuring Instruments', 5th Edition, Wheeler Publishing House, Delhi
3. Melville B. Stout, 'Basic Electrical Measurements', Prentice Hall of India
4. A.K.Sawhney, 'A Course in Electrical and Electronics Measurements and Instruments', Dhanpat Rai and Sons, Delhi 2005.

12. EED209 (Electric Machines-I) (L: T: P) - (3:0:1)

Prerequisites: EED101 or EED103

Electromechanical Energy Conversion: Electromechanical Energy conversion – forces and torque in magnetic field systems – energy balance – energy and force in a singly excited magnetic field system, determination of magnetic force - co-energy – multi excited magnetic field systems.
Transformers: Different types of transformers and Applications, Transformer Construction, Core and Shell type of transformers, Core Materials and Laminated core, Cooling systems, Ideal Transformer Fundamentals, Practical Transformer, Equivalent circuit of a transformer, testing of Transformers, Polarity Test, OC test , SC Test and Back to Back or Sumpner's Test.
D.C. Generators & Armature Reaction: D.C. Generators – Principle of operation – Action of commutator – constructional features – armature windings – lap and wave windings – simplex and multiplex windings – use of laminated armature – E. M.F Equation – Problems. Armature reaction – Cross magnetizing and de-magnetizing AT/pole – compensating winding – commutation – reactance voltage – methods of improving commutation. Applications of DC generators in different types of industries
Types of D.C Generators & Load Characteristics: Methods of Excitation – separately excited and self- excited generators – build-up of E.M.F - critical field resistance and critical speed - causes for failure to self-excite and remedial measures. Load characteristics of shunt, series and compound generators – parallel operation of DC series generators – use of equalizer bar and cross connection of field windings – load sharing.
D.C. Motors & Speed Control Methods: D.C Motors – Principle of operation – Back E.M.F. - Torque equation – characteristics and application of shunt, series and compound motors – Armature reaction and commutation. Speed control of DC Motors**:** Armature voltage and field flux control methods. Ward-Leonard system. Principle of 3 point and 4 point starters – protective devices. Applications of DC motors in different types of industries. Testing of D.C. Machines: Losses – Constant & Variable losses – calculation of efficiency – condition for maximum efficiency. Methods of Testing – direct, indirect and regenerative testing – brake test – Swinburne's test – Hopkinson's test – Field's test – Retardation test – separation of stray losses in a DC motor test.

Recommended book(s):

1. Electrical Machinery, Fitzgerald, Mc Grawhill, 6th Edition, 2010
2. Electrical machinery and transformers, Guru and Hiziroglu, Oxford, 2004
3. Principles of electrical machines and Power Electronics - P.C.SEN, Jhon Wiley and sons
4. Electrical machines, Nagrath and Kothari, Mcg raw hill, 3rd edition. 2004
5. Electrical machines theory, operation, applications, adjustment and control, Charles I.Hubert,
6. Pearson Education, Second Edition, 2009
7. Analysis of electrical machinery and drive systems, IEEE Press, P.C.Krause, Second Edition
8. Stepping motors and their microprocessor controls, Takhashi Kenjo, Clarender press, 1984.
9. Electrical machines, P S Bimbhra, Khanna Publisher, 2004

13. EED301 (Electromagnetic Engineering) (L: T: P)-(3:0:0)

Prerequisites: PHY102

Fundamental Concepts: Review of vector algebra and calculus, coordinate transformations, Scalar and Vector fields, Vector calculus, Divergence, the Divergence Theorem, Curl and Stokes theorem.
Electrostatics: Coulomb's Law and concept of Electric Field, Electric field due to charge distribution, Gauss's law, Electric potential, Electric field in materials, Conductors and Dielectrics, Material polarization, Boundary conditions, Resistance and capacitance, Method of Images, Poisson's and Laplace's equations.
Magnetostatics: Bio-Savart law, Ampere's Law and its applications, Maxwell's equation for static EM fields, Magnetic materials, Boundary conditions, Inductor and inductance, magnetization, magnetic energy.
Maxwell's Equations: Faraday's law, Inconsistency of Amperes law, Continuity equation, Displacement current, Maxwell's equations, Boundary conditions, different forms of Maxwell's equations.
EM Wave Propagation: Wave propagation in free space, Conductors and dielectrics, Polarization, Plane wave propagation in conducting and non-conducting media, Phasor notation, Phase velocity, Group velocity; Reflection at the surface of the conductive medium, Surface Impedance, Depth of penetration, Poynting theorem, Poynting Vectors and power loss in a plane conductor.
Antenna and Radiation: Scalar and vector potentials. Radiation from a current filament, half-wave dipole and small loop antennas. Antenna characteristics, radiation pattern, radiation intensity, directivity and power gain., Effective area and Friis equation.
Transmission Line: Transmission line parameters and equations, characteristic impedance, open and short circuited lines, standing wave and reflection losses. Impedance matching, Smith Chart, Simple and double stub matching.
Electromagnetic Interference and Electromagnetic Compatibility: Introduction to Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC).

Recommended book(s):
1. Engineering Electromagnetics - William H. Hayt, Jr.
2. Elements of Electromagnetics- M. N. O. Sadiku, Oxford University Press.
3. Field and wave electromagnetics - D. K. Cheng, pearson.
4. Electromagnetic Waves & Radiation Systems, Jordon E C Balmain.
5. Electromagnetic Field Theory & Transmission Lines, G S N Raju, Pearson
6. Electromagnetics with Applications, Kraus & Fleisch, TMH.

14. EED 302 (Control Systems) (L: T: P) - (3-0-1)

Prerequisites: EED202, EED201

Introduction and Mathematical Modeling: Open-loop and Closed-loop Systems, Effect of feedback, Mathematical modelling of physical systems; Servomechanisms, Servomotors, Synchros, Block Diagram and Signal Flow representation and analysis.
Time - Domain Analysis: Standard Signals; Time-response of 1^{st} order and 2^{nd} order systems, Dynamic / Transient and Steady-State Response, Steady-State Errors: Error Constants, Type-0, Type-1, and Type-2 Systems, Effect of Poles and Zeroes on response characteristics; Dominant Poles, Design and Response of Controllers: P; PI; PD and PID.
Stability: Absolute and Relative Stability, Routh Stability Criterion: BIBO Systems; Necessary Conditions, Relative Stability Analysis, Root Locus Technique: Concept, Construction, and Rules of Root Loci, Effect of poles and zeros.
Frequency-Domain Analysis: Correlation between Time-Domain and Frequency-Domain Analysis, Polar Plot and Bode Plot: Properties and Constructions, Gain Margin and Phase Margin, Nyquist Plot: Nyquist Stability Criterion; Effect of Poles and Zeroes, Constant M and N Circles; Nichols Chart.
Compensation Networks: Effect and Need of Compensatory Networks, Types: Lead Compensator; Lag Compensator and Lag-Lead Compensator, PID and Modified PID Controllers, Introduction to Digital Controllers: PLC and PAC Type Controllers
State-Space Analysis: Conventional Control verses Modern Control Theory, Concept of State-Space Representation, Realizations of Transfer Functions; Solution of State-Space Equations; State Transition Matrix, Stability Criteria: Observability and Controllability of Linear Systems

Recommended books:
1. Control Systems: Principles and Design, M.Gopal, Tata McGraw Hill, 4^{th} Edition, 2012.
2. Control System Engineering, I.J. Nagrath and M. Gopal, New Age Int., 6^{th} ed., 2016.
3. Automatic Control Systems, Benjamin C. Kuo, PHI, 7^{th} ed., 2010.
4. Modern Control Engineering, Katsuhiko Ogata, PHI, 5^{th} ed., 2012.

15. EED 303 (Microprocessors and Microcontrollers) (L: T: P): 3:0:1

Prerequisites: *EED 206*

Evolution of Digital Design Methodology through SSI, MSI, LSI and VLSI technologies; Emergence of Programmable Digital Systems based on Standard Hardware; Microprocessor as the Basic Building Block for Digital design; Essential Ingredients of a Microprocessor; Datapath Design; Control Unit design; Microprogramming; Pipelining; Memory Organization – Cache and Virtual Memory; Input/Output Organization; Interrupts and DMA; Architecture and Programming of the 8051 Microcontroller. Experiments will include Microprocessor building blocks – both in

actual hardware and in verilog simulation; 8051 trainer kits and simulators along with basic hands-on training of MPU/MCU, programming and their use in real world problems.

Recommended book(s):

1. Microprocessor Architecture, Programming, and Applications with the 8085, R. Gaonkar, Penram.
2. The 8051 Microcontroller Architecture, Programming & Applications, K. J. Ayala, Penram.

16. EED304 / CSD 328 (Communication Networks) (L: T: P)-(3:0:1)

Prerequisites: Ability to program in C or JAVA

Introduction to communication networks. Switching: Circuit switching, Packet switching, Message switching, Cell switching, permanent virtual circuit, Switched virtual circuit. Transmission Medium: Copper cable, Shielded twisted pair, UTP, Coaxial cable, Optical fiber cable. Telephone communication. Data Communication: OSI layers. Data Link layer: HDLC, Multiple access control- ALOHO, Polling, CSMA/CD, Token passing. LAN: Ethernet- 10Base2, 10Base5, 10Base F, 100BaseT, Gigabit Ethernet, Token ring, FDDI, Repeater, Bridge, Router, Gateway. WAN: Packet switch network- X.25, Frame relay, ATM. Broadband Access Technology: ISDN, Cable modem, xDSL. Internet Protocol: TCP/IP, UDP, IPv4, IP.

Recommended book(s):

1. Data Communication and Networking, B. A. Forouzen, Tata McGrw Hill, 4th Ed., 2006.
2. Data and Computer communications, William Stallings, 8th Ed., Pearsons, Prentice Hall, 2007.
3. Data Communication and Networking-A practical approach, M. Moussavi, CENGAGE Learning, 2012.
4. Introduction to Telecommunications, Anu. A. Gokhle, 2nd Ed. Cengage Learning, 2005.
5. Telecommunications Essentials, L. Goleniewski, 2nd Ed. Pearson, 2006

17. EED 305 (Digital Signal Processing) (L: T: P)-(3:0:1)

Prerequisites: EED201

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals; State Space representations. Discrete systems: attributes, Z-Transform, Analysis of LSI systems, Frequency analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems. Design of FIR Digital filters: Window method, Eigen based methods, Park-McClellan's method. Design of IIR Digital Filters: All pass based design, Butterworth, Chebyshev and Elliptic

Approximations; Low pass, Band pass, Band stop and High pass filters, Matched filters, CIC filter design. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to Multirate signal processing. Application of DSP to Speech and Radar signal processing.

Recommended book(s):

1. Discrete Time Signal Processing, A. V. Oppenheim and Schafer, PrenticeHall, 1989.
2. Digital Signal Processing: Principles, Algorithms and Applications, John G. Proakis and D.G. Manolakis, Prentice Hall, 1997.
3. Theory and Application of Digital Signal Processing, L. R. Rabiner and B. Gold, Prentice Hall, 1992.
4. Introduction to Digital Signal Processing, J. R. Johnson, Prentice Hall, 1992.
5. Digital signal processing, a computer based approach, Sanjit K. Mitra, Tata McGraw Hill.

18. EED306 (Power Electronics) (L: T: P)-(3:0:1)

Prerequisites: EED101 or *EED103*

Power-Electronic Devices: Construction and characteristics of Power diode, Thyristor, TRIAC, MOSFET and IGBT. Rectifiers (AC to DC converters): Study of single phase AC to DC controlled rectifier, three phase AC to DC controlled rectifier, application of AC to DC rectifiers in HVDC transmission and DC motor control. Switched mode power supplies (DC to DC converters): Study of non-isolated buck, boost and buck-boost type DC to DC converters, Isolated DC to DC converters: forward converter and fly back converter. Inverters (DC to AC converters): DC to single phase AC conversion, DC to three phase AC conversion, Different types of pole voltages, PWM Inverter, PWM techniques – Sine wave PWM (SPWM), hysteresis control based PWM, variable-voltage variable-frequency inverter application in AC motor drive. AC to AC converters: phase angle control keeping frequency unchanged, AC chopper, cyclo-converter.

Recommended book(s):

1. Power electronics, C. W. Lander, Mc-Graw Hill.
2. Power Electronics: Circuits, Devices and Applications, 3rd Edition by M. H. Rashid, Pearson Publishers, India.
3. Power Electronics: Converters, Applications and Design by Ned Mohan, Undeland and Robbins, John Wiley & sons.

19. EED 307 (Power Engineering) (L: T: P)-(3:0:1)

Prerequisites: EED352

Load flow Studies (Steady state Analysis): Formation of Y_{bus} for load flow studies, Necessity of Power Flow Studies – Data for Power Flow Studies – Derivation of Static load flow equations – Load flow solutions using Gauss Seidel Method: Acceleration Factor, Load flow solution with and without PV buses, Algorithm and Flowchart. Numerical Load flow Solution for Simple Power Systems (Max.3Buses): Determination of Bus Voltages, Injected Active and Reactive Powers (Sample One Iteration only) and finding Line Flows/Losses for the given Bus Voltages. Newton Raphson Method in Rectangular and Polar Co-Ordinates Form: Load Flow Solution with or without PV Busses Derivation of Jacobian Elements, Algorithm and Flowchart. Decoupled and Fast Decoupled Methods. Comparison of Different Methods – DC load flow.

Short Circuit Analysis: Formation of Z_{Bus} Matrix; Partial network, Algorithm for the Modification of Z_{Bus} Matrix for addition element for the following cases: Addition of element from a new bus to reference, Addition of element from a new bus to an old bus, Addition of element between an old bus to reference and Addition of element between two old buses (Derivations and Numerical Problems). Modification of Z Bus for the changes in network (Problems), Per Unit System of Representation. Per Unit equivalent reactance network of a three phase Power System, Numerical Problems. Symmetrical fault Analysis: Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors, Numerical Problems.

Short Circuit Analysis-II (Transient analysis): Symmetrical Component Theory: Symmetrical Component Transformation, Positive, Negative and Zero sequence components: Voltages, Currents and Impedances.

Sequence Networks: Positive, Negative and Zero Sequence Networks, Unsymmetrical Fault Analysis: LG, LL, LLG faults with and without fault impedance, numerical problems.

Power System Steady State Stability Analysis: Elementary concepts of Steady State, Dynamic and Transient Stabilities. Description of Steady State Stability Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability and Methods to improve steady state stability.

Power System Transient State Stability Analysis: Derivation of Swing Equation. Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation. Solution of Swing Equation: Point by Point Method. Methods to improve Stability, Application of Auto Reclosing and Fast Operating Circuit Breakers.

Recommended book(s):

1. Power System Engineering, Nagrath and Kothari, McGraw Hill, 2rd edition, 2008.
2. Power System analysis, J. J. Grainjer, W. D. Stevension, Tata McGraw Hill, 2003.
3. Computer Methods in power system analysis, Stagg and El-Abaid, McGraw Hill.
4. Introduction to Power Systems, Mohamed E. El-Hawary, IEEE Press, 2008.
5. Power System Stability and Control, Prabha Kundur,, Tata McGraw Hill, 2010.

20. EED 308 (Embedded System Hardware) (L: T: P)-(3:0:1)

Prerequisites: *EED206*

Introduction to the embedded system: i) components of embedded system, ii) characteristics of embedded system, iii) challenges in embedded system design, and iv) architecture of a general embedded systems

Microprocessor: i) introduction, ii) generations of microprocessors, iii) classification of the microprocessor, iv) single bus microprocessor architecture, v) instruction set of single bus microprocessor, vi) introduction to 8085 microprocessor, vii) pinout and signals of 8085, viii) functional block diagram of 8085, ix) addressing modes and interrupts in 8085, and x) instruction sets and programming in 8085.

8051 microcontroller: i) features and introduction of 8051, ii) block diagram and pinouts, iii) programming model, iv) Internal RAM organization, v) interrupts, vi) C programming of 8051, and vii) interfacing some important peripherals to 8051.

Arduino: i) introduction to Arduino (development board and IDE), ii) programming to Arduino, and iii) interfacing some important peripherals to Arduino.

32 bit microcontroller: i) overview, ii) functional block diagram, iii) Integrated Development Environment, iv) General purpose input-output (GPIO), v) Analog interface, vi) Timers, vii) Hardware Abstraction Layer (HAL).

Communication Protocol: i) overview of Serial Peripheral Interface Protocol (SPI protocol), ii) overview of Inter –IC (I2C) communication protocol, iii) overview of Universal Asynchronous Receiver/Transmitter (UART) protocol, iv) overview of USB communication technology, and v) overview of RFID communication technology.

Hands on experience on simple embedded systems: i) ADC and DAC, ii) PID control, iii) sensors and actuators, iv) position and movement control, v) data communication interfaces, and vi) Internet of Things.

21. EED 350 (Digital Communication) (L: T: P): 3:0:0

Prerequisites: *EED 201*

Introduction and Overview of Digital Communication Systems and Principles, Model, Analog vs. Digital Communication, Sampling, Quantization, PCM. Concept of Probability and Random variable: characterization and Pdfs.

Geometric representation of Signal waveforms: Gram Schmidt procedure, Constellations.

Digital modulation and demodulation schemes: performance analysis and comparison, Synchronization and Channel equalization. Digital Transmission: ISI, Matched filter, Maximum

Likelihood detector, Transmitter, Receiver designs Channel capacity, Coding and Decoding, Source Coding, Information Measure. Introduction to Error control: Viterbi, Linear Block codes, Convolution Codes, Hamming, and Turbo codes.
Introduction to Multiple Access Communication, Spread spectrum communications, OFDM.

Recommended book(s):
1. Modern Digital and Analog Communication Systems, B. P. Lathi, 4th edition, Oxford University press, 2010.
2. Digital Communications: Fundamentals and Applications, B. Sklar, 2nd ed., Prentice Hall, 2001.
3. Digital Communications, John G. Proakis, 4th Edition, Mc-Graw Hill International.
5. Fundamentals of Digital Communication, U. Madhow, Cambridge University Press, 2008.
6. A Foundation in Digital Communication, Amos Lapidoth, Cambridge University Press, 2009.
7. Communication Systems, Simon Haykin, 4th Edition, Wiley India.
8. Principles of Digital Communication, R. G. Gallager, Cambridge University Press.

22. EED 352 (Power Generation, Transmission and Distribution) (L: T: P) - (3:0:0)

Prerequisites: EED103 and EED201

Electrical power Generation: Generation of electrical energy: Basic structure of power system; demand of electrical system – base load, peak load; controlling power balance between generator and load, advantages of interconnected system; Thermal power plant – general layout, turbines, alternators, excitation system, governing system, efficiency; Hydel power plant – typical layout, turbines, alternators; Nuclear power plant – principle of energy conversion, types of nuclear reactors; brief overview of renewable energy sources.
Introduction to Transmission and Distribution in electric power system: Structure of electric power system - different operating voltages of generation, transmission and distribution advantage of higher operating voltage for AC transmission. An introduction to EHV AC transmission, HVDC transmission and FACTs. Mechanical design of transmission line between towers – sag and tension calculations using approximate equations taking into account the effect of ice and wind.
Transmission Line Parameters: Parameters of resistance, inductance and capacitance calculations - single and three phase transmission lines - single and double circuits - solid, stranded and bundled conductors - symmetrical and unsymmetrical spacing – transposition of lines - concepts of GMR and GMD - skin and proximity effects - interference with neighboring communication circuits. Corona discharge characteristics – critical voltage and loss. (Simple diagrams of typical towers and conductors for 400, 220 and 110 kV operations)
Modelling and Performance of Transmission Lines: Transmission line classification - short line, medium line and long line - equivalent circuits – Ferranti effect - surge impedance, attenuation

constant and phase constant - voltage regulation and transmission efficiency - real and reactive power flow in lines – power circle diagrams – shunt and series compensation. An introduction to power angle diagram - surge-impedance loading, load ability limits based on thermal loading; angle and voltage stability considerations.

Insulators and Cables: Classification of insulators for transmission and distribution purpose – voltage distribution in insulator string and grading - improvement of string efficiency. Underground cables - constructional features of LT and HT cables – insulation resistance, capacitance, dielectric stress and grading – tan δ and power loss - thermal characteristics.

Substation, Grounding System and Distribution System: Classification, functions and major components of substations. Bus-bar arrangements - substation bus schemes - single bus, double bus with double breaker, double bus with single breaker, main and transfer bus, ring bus, breaker-and-a-half with two main buses, double bus-bar with bypass isolators. Importance of earthing in a substation. Qualitative treatment to neutral grounding and earthing practices in substations. Feeders, distributors and service mains. DC distributor – 2-wire and 3-wire, radial and ring main distribution. AC distribution – single phase and three phase 4-wire distribution.

Recommended book(s):

1. Electric Power Generation, Transmission and Distribution, S. N. Singh, Prentice-Hall, 2007.
2. Elements of Power System Analysis, W. D. Stevenson, McGraw-Hill, 4/e, 1982.
3. Modern Power System Analysis, D. P. Kothari and I. J. Nagrath, McGraw-Hill, 2006.
4. Electrical Power Systems, C. L. Wadhwa, New Age International Pvt., Ltd.
5. Power System Analysis, Hadi Sadat, Tata McGraw-Hill.

23. EED 353 (Protection and Switchgear) (L: T: P)-(3:0:0)

Prerequisites: EED307

Circuit breakers: Air circuit breakers, oil circuit breakers, vacuum circuit breakers, SF6 gas circuit breakers, transient recovery voltage (TRV), transient rate of rise of recovery voltage (TRRV), ratings of circuit breakers, arc interruption theories, capacitor switching, reactor switching.

Relays: Overcurrent protection; directional and non-directional overcurrent relays, differential protection, percentage differential protection scheme, protection of transformers, protection of generators, carrier aided protection of transmission lines, distance protection schemes; impedance relay, reactance relay, mho relay, their characteristics. Introduction to microprocessor based relays.

Recommended book(s):

1. Switchgear and Protection, S. S. Rao, Khanna Publishers.
2. Power system protection and switchgear, Badri Ram and D. N. Wishwakarma, McGraw Hill.
3. Electrical Transients in Power Systems by Allan Greenwood

24. EED 354 (Microwave Engineering) (L: T: P)-(3:0:1)

Prerequisites: EED301

Introduction of Microwaves and their applications.
Waveguides: Rectangular Waveguides, Solution of Wave equation in TE and TM modes. Power transmission and Power losses. Excitation of modes in Rectangular waveguides, circular waveguides: Basic idea of TE and TM modes, field patterns, TEM mode of propagation. **Waveguide Components:** Scattering matrix representation of networks, Rectangular cavity and circular cavity resonators. Waveguide Tees, Magic Tees. Hybrid rings. Waveguide corners, Bends and twists, Directional couplers, Circulators and isolators, Windows, Irises, tuning screws. **Measurement**: frequency, Wave length, VSWR, Impedance, power.
Microwave Tubes: Klystron, Reflex Klystron, Magnetron, TWT, BWO: Their schematic, Principle of operation, performance characteristics and application.
Semiconductor Devices: Construction, Operation and Practical applications of PIN diode, varactor and Tunnel diode, Gunn diode, IMPATT, TRAPTT diodes, Maser
MIC: Introduction to microstrip lines, Parallel Striplines, Coplanar striplines, Shielded striplines, Slot lines, Transitions, Bends and Discontinuities.

Recommended book(s):
1. Microwave Devices And Circuits, Samuel Y. Liao, Pearson
2. Microwave Engineering, Pozar, Wiley
3. Foundations For Microwave Engineering, R.E. Collin, Wiley
4. Microwave Engineering, M.L. Sisodiya, New Age

25. EED355 *(*Analysis and control of special electrical machines) (L: T: P) - (3:0:0)

Prerequisites: EED203 or EED207

Introduction to Special machines and their applications in different industries- Evaluation of electrical machines, electrical machine design fundamentals, three phase and single phase Induction machines, Synchronous machines- Synchronous generators and motors. Special machines- Design, constructional and control aspects of permanent magnet brushless DC motor (PM BLDC), permanent magnet synchronous motor (PMSM), switched reluctance motor (SRM) and Stepper motor.

Recommended book(s):
1. Permanent Magnet Synchronous and Brushless DC Motor Drives, R. Krishnan, CRC Press, Taylor & Francis Group, 2010.

2. Brushless Permanent-Magnet and Reluctance Motor Drives, T. J. E. Miller, Oxford University Press, 1989.
3. Permanent Magnet Motor Technology, Design and Applications, Jacek F. Gieras and Mitchell Wing, Second edition, Marcel Dekker INC, NY-2002.
4. Electronic Control of Switched Reluctance Machines, T. J. E. Miller, Newnes power engineering series.
5. Stepping Motors and Their Microprocessor Controls, Takashi Kenjo, Clarendonpress.
6. Permanent magnet brushless dc motor drives and controls, Chang-liang Xia, John Wiley & Sons-2012.

26. EED 356 (High Voltage Engineering) (L: T: P): (3:0:0)

Electric breakdown mechanisms in gaseous, liquid, and solid dielectrics, generation of high A.C. and D.C. voltages, generation of impulse voltages and currents, measurement of high voltages and currents, high voltage testing of electrical equipments, transients in power systems (lightning and switching induced transients), insulation coordination, partial discharge, tan delta measurement techniques. Electric filed analysis of high voltage cables.
Degree of uniformity for cylinder-cylinder, spherical-spherical, cylinder-plane, needle-plane electrode systems, numerical computation of the electric field intensity in homogenous and multi-dielectric isotropic materials by finite element method (FEM).
Extra-high voltage (EHV) and ultra-high voltage (UHV) transmission systems, mitigation of audible noise (AN), radio interference (RI), corona loss, and high voltage gradients.
Modelling and analysis of HVDC systems, modelling and analysis of flexible A.C. transmission systems (FACTS).

Recommended book(s):

1. High voltage engineering fundamentals, E. Kuffel, W. S. Zaengl, and J. Kuffel, Butterworth-Heinemann, Oxford, 2000.
2. High Voltage Engineering, M. S. Naidu and V. Kamaraju, TMH Publications, 2000.
3. Extra High Voltage AC Transmission Engineering, R. K. Begumudre, New Age Science Ltd., 2011.
4. HVDC Power Transmission Systems, K. R. Padiyar, New Age International Publishers, New Delhi 1990.
5. Understanding FACTS, N. G. Hingorani and L. Gyugyi, Standard Publishers, New Delhi, 2001.
6. Static Reactive Power Compensation, T. J. E. Miller, John Wiley & Sons, New York, 1982.

27. EED357 (Satellite Communication) (L: T: P)-(3:0:0)

Prerequisites: EED205

Introduction to satellite systems & application: History, evolution of satellites, evolution of launch vehicles. Satellite orbits: Orbital parameters, earth's azimuth & elevation angles. Satellite Sub systems: Mechanical subsystem, propulsion subsystem, thermal control subsystem, power supply sub system, Attitude & orbit control, Telemetry, tracking & command subsystem, Antenna subsystem, Payload. Communication Techniques: Type of the signals, Modulation techniques, multiplexing techniques, Multiple Access techniques- FDMA, SCPC, MCPC, TDMA, CDMA, SDMA. Satellite Link Design: Transmission equation, link design parameters, frequency considerations, propagation considerations, noise considerations, interferences, G/T ratio, Link budget, VSAT. Navigation satellites, Global Positioning System.

Recommended book(s):

1. Satellite Communication Systems Engineering, Wilbur L. Pritchard, H. G. Suyderhoud, Robert A.Nelson, Prentice Hall, New Jersey, 2006.
2. Satellite Communications, Timothy Pratt and Charles W.Bostain, John Wiley and Sons, 2003.
3. Satellite Communication, D. Roddy, McGraw Hill, 2006.
4. Digital Satellite Communication, Tri T Ha, McGraw Hill, 1990.
5. Design of Geosynchronous Spacecraft, B. N. Agarwal, Prentice Hall, 1993.

28. EED 358 (Wireless and Mobile Communications) (L: T: P) – (3:0:0)

Prerequisites: EED201 and EED205

Evolution of mobile communication systems. 1G, 2G, 2.5G & 3G, 4G, Beyond 4G systems.
Multiple Access: FDD, TDD, FDMA, TDMA, CDMA, SDMA, OFDM, MIMO.
Cellular Communication: Introduction, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage & channel capacity in cellular system
GSM: GSM standards and architecture, GSM Radio aspects, typical call flow sequences in GSM, security aspects. GPRS, UMTS.
CDMA standards: Spread spectrum, direct sequence and frequency hop spread spectrum, IS-95 CDMA architecture, forward link and reverse link. Infrastructure based and Adhoc networks, WLAN IEEE802.11a/b/g/n/ac. Bluetooth.

Recommended book(s):

1. Wireless Communications, T. S. Rappaport, PHI, 2002.

2. Mobile Cellular Telecommunications- Analog & Digital Systems, William C.Y. Lee, , McGraw Hill, 1995.
3. Mobile Communications, Pearson, Jochen Schiller, 2nd ed, 2009
4. Wireless Communications and networks, William Stalling, Prenyice hall of India, 2nd Ed., 2005.

29. EED-359 (Digital System Design with FPGAs) (L: T: P) - (3:0:1)

Prerequisites: *EED206*

Programmable logic devices such as field programmable gate arrays (FPGAs), have become a major component of digital system design these days. The Course starts with an Introduction to the scope of Reconfigurable platforms and applications along with a complete FPGA design flow. Then use of a hardware description language (HDL; in particular Verilog) for the specification, synthesis, simulation, and exploration of principles of register transfer level (RTL) designs. In this class the students learn how to write HDL models that can be automatically synthesized into integrated circuits using FPGAs. Details of techniques to resolve common pitfalls in designing with FPGAs and best practices incorporated in Industry will be dealt with few case studies. Laboratory and homework exercises include writing HDL models of combinational and sequential circuits, synthesizing models, performing simulation, writing test bench modules, and synthesizing designs to an FPGA. The course also contains lab work and is based on a sequence of Verilog design examples leading to a final group project.

Recommended book(s):

1. Fundamentals of Logic Design, Charles. H. Roth, 5th Ed., Cengage Learning, 2004.
2. Advanced Digital Design with the Verilog HDL, M.D. Ciletti, 2nd Edition.
3. Verilog Styles for Synthesis of Digital Systems, David R. Smith, Paul Franzon.
4. FPGA Design: Best Practices for Team-based Design, Philip Simpson, Springer 2010.
5. Digital Systems Design with FPGAs and CPLDs, Ian Grout, Springer 2008.
6. FPGA Prototyping using Verilog Examples – Xilinx Spartan-3 Version, Pong P. Chu, Wiley.
7. Verilog by Example – A Concise Introduction for FPGA Design, Readler.

30. EED 360 (Modern Control) (L: T: P) - (3:0:0)

Brief Review of Matrix Algebra (Notes), State Space Representation of the Control Systems (2.1-2.3, Examples), Dynamics of Linear Systems State Transition, Matrix, Laplace Transform, Transfer Functions, Companion Form, Jordan Form, Controllability and Observability Physics of the Concepts of Controllability and Observability, Algebraic Conditions (5.1-5.4, Examples),

Dynamic Response (State Feedback), Design of Regulators for Single Input, Single Output Systems, Multiple Input Systems, Placement of Closed Loop Poles (6.1-6.3, 6.5, Examples), Linear Observers Structure and Properties of Observers (7.1-7.3, Examples), Optimization (Notes), Optimal Control (Notes, book) (9.1-9.4, Examples), Robust Control System Design (4.10, Examples)

Recommended book(s):

1. Control Systems Design: An Introduction to State-Space Methods, Bernard Friedland, McGraw-Hill, 1986
2. Theory of Matrices, F. R. Gantmacher,
3. Introduction to Linear System Theory, C. T. Chen
4. Modern Control Engineering, R. Ogata

31. EED 361 (DESIGN OF ANALOG CMOS CIRCUITS) (L: T: P)-(3:0:0)

Prerequisites: EED204, EED202 and MOS Device fundamentals

CMOS Fundamentals: MOS Device Physics, Design of MOS switch, MOS diode/ active resistor. Amplifier Design: MOS amplifiers, Common-Source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascade stage.

Differential Amplifier: Differential amplifier, Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS load.

Bias Circuits and References: Passive and Active current mirrors, Bandgap References.

Frequency Response: Frequency response of CS stage, CD stage, CG stage, cascade stage, differential pair. Feedback Topologies, Operational amplifiers: one stage op-amp, two-stage CMOS op-amp, Gain Boosting, Stability and Frequency Compensation.

Recommended book(s):

1. Design of Analog CMOS Integrated circuits, Behzad Razavi.
2. CMOS Analog Circuit Design, Allen & Holberg.

32. EED 363 (Applied Machine Learning) (L: T: P)-(3:0:0)

Introduction: Machine Intelligence, Well-posed Machine Learning/Data Mining Problems, Data representation, Domain knowledge, Forms of Learning.

Supervised Learning: Learning from Observations, Generalization Performance, Heuristic Search in Inductive Learning, Cross-validation, Measures of assessing accuracy of Predictions.
Statistical Decision Making: Naive-Bayes Classifier, k-NN Classifier, Linear Regression, Logistic Regression.
Learning with Neural Networks: Neuron Models, Network Architectures, Perceptrons and Linear Classification using Regression Techniques, Linear Neuron and Widrow-Hoff Learning Rule, Back-propagation, Algorithm, Classification using Neural Networks.
Data Clustering: Overview of Basic Techniques, K-means Algorithm.
Decision-tree Learning: Measures of Impurity, ID3, C4.5 and CART Decision Trees, Pruning the Tree.

33. EED364 (Graph Signal Processing and its Application) (L: T: P)-(3:0:0)

Prerequisites: EED201

Introduction -Why Graph Signal Processing: concepts, applications and challenges, Introduction to graph concepts, Linear algebra review Spectral graph theory, Orthogonal transforms review Frequency interpretation, Nodal Theorems Graph filtering, Vertex and Spectral interpretations
Shift invariance, localization and uncertainty principles, Linear Algebra Review: spaces, inner products, orthogonality, bases and subspace
Eigenvalues and eigenvectors – Interpretation, Circular convolution Linear Operators based on Polynomials of Adjacency and Laplacian Matrices, Eigenvectors and Eigenvalues of graphs. Perron-Frobenius Theorem, Rayleigh's Quotient
Bipartite graphs: Graph Laplacian, Symmetric Normalized Laplacian, Random Walk Laplacian
Spectral decomposition of a graph signal: spectral filtering Interpretation
Nodal domains: Results on nodal domains, Vertex domain filtering Polynomials of Graph Laplacian and localized filtering, Discussion of IIR, FIR filtering on a graph-Time frequency localization for regular signals
Time frequency localization in Graphs Bounds on Graph Signal Localization, down sampling regular signals Motivation of down sampling on graphs, Results for bipartite graphs, Open questions.
Introduction to wavelets Two channel filter banks ,Lifting based solutions Time-frequency trade-off, time, frequency localization Multiresolution Analysis, Diffusion Wavelets, Diffusion Wavelets, Down sampling, Wavelets Multiresolution and graph approximation, Directed Graphs Construction of Continuous time wavelet transform, Spectral Graph Wavelets, Graph Filter banks.

Recommended book(s):

1. D. M. Cvetkovic, P. Rowlinson, and S. Simic, An introduction to the theory of graph spectra .Cambridge University Press Cambridge, 2010.
2. D. K. Hammond, P. Vandergheynst, and R. Gribonval. Wavelets on graphs via spectral graph theory. Applied and Computational Harmonic Analysis , 30(2):129--150, 2011.
3. P. Milanfar. A tour of modern image filtering: new insights and methods, both practical and theoretical. Signal Processing Magazine, IEEE , 30(1):106--128, 2013.
4. S. K. Narang and A. Ortega. Perfect reconstruction two-channel wavelet filter banks for graph structured data. Signal Processing, IEEE Transactions on , 60(6):2786--2799, 2012.

34. EED367 (HVDC Transmission) (L: T: P)-(3:0:0)

Prerequisites: EED306/ EED307/ EED352

Introduction to Line Commutated HVDC: HVDC applications, Comparison of AC and DC Transmission, Line-commutated HVDC components, LCC HVDC Topologies.

Six Pulse Diode and Thyristor Converter: Three phase uncontrolled bridge, Three phase Thyristor rectifier, Analysis of commutation overlap in Thyristor convertor, Active and reactive power in a three phase Thyristor converter, Inverter operation. Analysis of 12 Pulse converter.

Analysis of HVDC Converter: Equivalent circuit of rectifier bridge, Equivalent circuit of Inverter bridge, HVDC equivalent circuit.

Converter Control Characteristics: HVDC V-I operating diagram, HVDC power reversal, Constant extinction angle (CEA) control, Constant current (CC) control, modification of inverter characteristics.

HVDC Interaction with AC systems: Influence of converter extinction angle, Influence of reactive power compensation, power transfer between two AC systems, Systems dynamics with low short circuit ratio.

Fault Management and HVDC System Protection: DC line faults, overvoltage protection, AC line faults.

HVDC System Harmonics: Harmonic performance criteria, Harmonic limits, Thyristor converter harmonics, Harmonic filters.

VSC Converters: Voltage source converter (VSC) HVDC applications and topologies, performance analysis with LCC HVDC, Introduction to multilevel VSC converters.

35. EED368 (Information Theory & Coding) (L: T: P)-(3:0:0)

The concept of information and its efficient representation. Efficient representation of information leads to data compression. The concept of run length coding, the rate distortion function and the design of an optimal quantizer. Vector quantizer design. A brief introduction to image compression.

Introduction Channel models Channel Capacity Channel Coding, Information Capacity Theorem. The Shannon Limit, Random selection of codes. Block codes. Linear block codes. Encoding and decoding strategies. The notions of perfect codes, optimal linear codes, cyclic codes, and a sub-class of linear block codes Fire codes, Golay codes and Cyclic Redundancy Check (CRC) codes as specific examples of cyclic codes. BCH codes, convolution codes, trellis codes, Viterbi decoding technique, turbo codes and LDPC codes

Trellis Coded Modulation (TCM) talks about the combined coding and modulation schemes. TCM encoding and decoding are discussed. The reader also learns how to design TCM schemes for additive white Gaussian noise channels as well as fading channels.

Recommended book(s):

1. Ranjan Bose: Information theory, Coding and Cryptography Mc. GraW Hill,Third edition
2. Thomas Cover and Joy A Thomas: Elements of Information theory Wiley
3. Robert Ash: Information theory Dover books

36. EED369 (MEMS Technology and Devices) (L: T: P)-(3:0:0)

Overview of MEMS/NEMS; MEMS materials and Technologies: materials systems, micro-machining techniques; Actuation principles: Piezoelectric, electrostatic etc.; sensing mechanisms: piezo-resistive, capacitive, piezoelectric etc.; MEMS devices and applications: pressure sensors, accelerometers, Gyroscopes, RF MEMS: Switches, acoustic wave RF filters; Electronic Interface with sensors and actuators.

Recommended book(s):

1. Chang Liu, “Foundations of MEMS”, Prentice Hall (Pearson).
2. Stephen D. Senturia “Microsystem Design” Springer.
3. Gabriel M. Rebeiz “RF MEMS: Theory, Design, and Technology” Wiley.

37. EED371 (Photovoltaic Power Generation: Fundamentals and Applications) (L: T: P)-(3:0:0)

Introduction of Solar Cell: Renewable energy sources, Current status of PV power generation in India, Advantages and challenges of solar energy, Solar cell technology, P-N junction diode, Introduction to P-N junction in equilibrium and non-equilibrium conditions, P-N junction under illumination: solar cell, Generation of a photo voltage, Photo generated current, Current-voltage (I-V) equation of solar cell, I-V characteristics of solar cell.

Design of PV Cell, Module and Array: Short circuit current, Open circuit voltage, Fill factor, Efficiency, modelling of a PV cell, Effect of series and shunt resistances on efficiency, Effect of solar radiation and temperature on efficiency, modelling of a PV module and array

Solar Radiation: Extra-terrestrial solar radiation, Solar spectrum at the Earth's surface, Declination angle, Apparent motion of the sun and solar altitude, Angle of sunrays on solar collector, Sun tracking, Estimation of solar radiation empirically

Identification of Solar PV Module: PV parameters estimation of a single diode model (SDM) and double diode model (DDM) PV module, Conversion of PV module parameters to array parameters, Temperature and solar irradiation dependence PV parameters, Study of I-V and power-voltage (P-V) characteristics of a PV array under different environmental conditions using Matlab simulation

Maximum Power Point Tracking (MPPT) Methods of a PV Source: Fractional short-circuit current (FSCI) technique, Fractional open circuit voltage (FOCV) technique, Hill Climbing/ Perturb & Observed (PO), Incremental conductance, One cycle control (OCC) technique, Differention technique, Feedback voltage and current technique, Load current/Load voltage maximization technique, Fuzzy logic based MPPT technique, Artificial neural network based MPPT technique, Particle swarm optimization based MPPT technique, Gauss-Newton, Steepest-Decent, Levenberg-Marquardt

Partial Shading of a PV Array: Shading effect of a PV array, Mismatch loss, Different types of PV configuration to reduce mismatch loss, Effect of bypass diode in a PV array under shading conditions, Extraction of maximum power from a PV array under partial shading conditions

Power Electronics Application in PV System: DC to DC converters, Control of DC to DC converter, Input side reflected impedance of DC to DC converters, DC to AC converter (Inverter)

PV System with Storage: Cells and batteries, Lead acid cell, Nickel cadmium storage cell, Nickel metal hydride (NiMH) Cells, Lithium cells, Stand-alone PV system, Grid integrated PV system

Recommended book(s):

1. Solar Photovoltaics: Fundamentals, Technologies and Applications by Chetan Singh Solanki, PHI learning publication.
2. Solar Energy Fundamentals and Applications by Garg & Prakash, H. P. Garg, Tata McGraw-Hill Education.

3. Photovoltaic Systems: Analysis and Design by A. K. Mukerjee and Nivedita Thakur, PHI learning publication.
4. Wind and Solar Power Systems: Design, Analysis, and Operation by Mukund R. Patel, Taylor & Francis.

38. EED372 (Power System Operation and Control) (L: T: P)-(3:0:0)

Prerequisites: EED307, EED352

Economic Operation of Power System: Fundamental of power flow solutions, Power factor correction, Distribution of load between units within a plant, Distribution of load between plants, The transmission-loss equation, An interpretation of transformation C, Classical economic dispatch with losses, Automatic generation control, Unit commitment, Solving the unit commitment problems.

Load Frequency Control and Control Area Concept: Automatic load-frequency control of single area systems: Speed-governing system, Hydraulic valve actuator, Turbine-generator response, Static performance of speed governor, Closing the ALFC loop, Concept of control area, ALFC of multi-control area systems (Pool operation): The two area systems, Modelling the Tie-Line, Block diagram representation of two area system, Dynamic response of two area system, Supervisory control and data acquisition (SCADA).

Power System Stability Problems: Basic concepts and definitions, Rotor angle stability, Synchronous machine characteristics, Power versus angle relationship, Stability phenomena, Voltage stability and voltage collapse, Mid-term and long-term stability, Classification of stability.

Small Signal Stability: State space concepts, Basic linearization technique, Participation factors, Eigen properties of state matrix, Small signal stability of a single machine infinite bus system, Studies of parametric effect: Effect of loading, Effect of KA, Effect of type of load, Stability improvement by power system stabilizers. Design of power system stabilizers.

Transient Stability: Time domain simulations and direct stability analysis techniques (extended equal area criterion) Energy function methods: Physical and mathematical aspects of the problem, Lyapunov's method, Modelling issues, Energy function formulation, Potential Energy Boundary Surface (PEBS): Energy function of a single machine infinite bus system, equal area criterion and the energy function, Multi-machine PEBS.

Sub Synchronous Oscillations: Turbine generator torsional characteristics, Shaft system model, Torsional natural frequencies and mode shapes, Torsional interaction with power system controls: interaction with generator excitation controls, interaction with speed governors, interaction with nearby DC converters, Sub Synchronous Resonance (SSR): Characteristics of series capacitor - compensated transmission systems, Self – excitation due to induction generator effect, Torsional interaction resulting in SSR, Analytical methods, Counter measures to SSR problems.

Recommended book(s):

1. Power System Analysis- By John. J. Grainger & W. D. Stevenson, Jr., TMH, 2003 Edition, Fifteenth Reprint.
2. An Introduction to Electric Energy System Theory- By O. I. Elgerd, TMH, Second Edition.
3. Power System Stability and Control- By Prabha Kundur, Mc Graw Hill Education, 2016 Edition, Twentieth Reprint.
4. P. Sauer and M. Pai, "Power system dynamics and stability", Prentice Hall, 1998
5. Power Generation Operation and Control-By A. J. Wood and B. F. Wollenberg, John Wiley and Sons, 1996.
6. Power System Analysis Operation and Control- By A. Chakrabarti and S. Haldar, Third Edition, PHI Publications, 6th Reprint, 2010.

39. EED373 (Antenna & Wave propagation) (L: T: P)-(3:0:1)

Prerequisites: EED301

Fundamental Concepts: Concept of Radiation (physical meaning), Potential functions & Electromagnetic field, Network Theorems, Radiation Pattern, near-field and far-field regions, basic parameters of antenna (directivity, gain, beam-width, effective aperture, polarization, input impedance, radiation efficiency, radiation resistance and efficiency etc.), Friis transmission equation, Methods of Excitation.

Radiation from Wires and Loops: Infinitesimal dipole, finite-length dipole, dipoles for mobile communication, small circular loop.

Aperture Antennas: Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, Fourier Transformation in aperture antenna.

Travelling Wave antennas: Analysis and Design of Rhombic antennas and V antenna.

Broadband Antennas: Broadband concept, Log-periodic antennas, frequency independent antennas.

Reflector antennas: Parabolic reflectors and reflector optics.

Microstrip Antennas: Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular patch antennas.

Antenna Measurements: Antenna Radiation pattern measurements, Measurement of antenna beam width and gain, Polarization measurements. Measurement of radiation resistance, S parameter.

Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, Binomial arrays.

Wave Propagation: Propagation of radio waves, mode of propagation

Ground wave propagation- Attenuation characteristics for ground wave propagation, Calculation of field strength at a distance.

Sky wave propagation- . atmospheric effects, structure of ionosphere, and its effect on radio waves. Ray path, , ionospheric propagation, skip distance, virtual height, critical frequency, MUF, fading, diversity.

Space wave propagation - Reflection from ground for vertically and horizontally polarized waves. Reflection characteristics of earth. Resultant of direct and reflected ray at the receiver. Duct propagation.

Recommended book(s):

1. Antenna Theory Analysis and Design by Constantine A. Balanis
2. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2007
3. Antennas and Wave Propagation by J D Kraus
4. Antenna Theory and Design by Warren L Stutzman and Garry A Thiele
5. R.E.Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985
6. Antennas for All Applications by J D Kraus and Ronald J Marhefka
7. Antenna Theory and Design by Robert S Elliot
8. Microwave Antenna Theory and Design by Samuel Silver

40. EED 401 (VLSI Technology and Design) (L: T: P)-(3:0:1)

Prerequisites: *EED102, EED204 and EED206*

One of the main objectives of this course is to prepare students for senior year UG students in VLSI and Microelectronics area and for those who are planning for research/VLSI industry oriented career (MS/PhD and core semiconductor industries etc,).The broad topics that will be covered in this course: Introduction to VLSI, MOSFET basics, short channel MOS issues, CMOS basic flow, Layout and design rules, basic electrical parameters, Scaling rules, Design of digital and combinational blocks, emerging device technologies trends as per ITRS. Models for Digital Design: Miller Capacitance, The Digital MOSFET Model, Effective Switching Resistance of Long Channel MOSFET, Short-Channel MOSFET Effective Switching Resistance, Capacitive Effects. CMOS Technology: Static CMOS inverter, DC Characteristics, Noise Margins, Inverter Switching Point, Ideal Inverter VTC. Dynamic Characteristics of CMOS inverter: Computing the capacitance-propagation delay sizing inverter for performance optimization. Power consumption in CMOS logic gates: Pass Transistor Logic: MOSFET Pass Gate, Delay through a Pass Gate, The Transmission Gate (The TG) Sizing in pass transistor. Applications of the Transmission Gate as Path Selector and Static Circuits. Combinational mos logic circuits. Parallel Connection of MOSFETs, Series Connection of MOSFETs, NAND Gate, Quick Estimate of Delays, Number of Inputs, Complex CMOS Logic Gates, Cascode Voltage Switch Logic Dynamic CMOS design: Fundamentals of Dynamic Logic, Charge Leakage, Simulating Dynamic Circuits, Domino logic, Optimization of Domino logic, NPCMOS logic, Designing logic for reduced supply voltages. Design of Latch. LOW-POWER CMOS LOGIC CIRCUITS: Introduction, Overview of Power Consumption, Low-

Power Design Through Voltage Scaling, Estimation and Optimization of Switching Activity, Reduction of Switched Capacitance. Memory Design.

Recommended book(s):

1. Basic VLSI design, Douglas A. Pucknell, Kamran Eshraghian, Prentice Hall.
2. Fundamentals of Modern VLSI Devices, Y. Taur and T.H. Ning, Cambridge University Press.
3. Digital Integrated Circuits: A Design Perspective, Rabaey, Jan, Anantha Chandrakasan, and Bora Nikolic. 2nd ed., NJ: Prentice Hall, 2002.
4. One Major source of material will be recent and past articles from IEEE Transactions on Electron Devices, IEEE Electron Devices Letters, IEDM proceedings, etc.
5. FinFETs and Other Multi-Gate Transistors, Jean-Pierre Colinge (Ed.).
6. Sub-Threshold Design for Ultra Low-Power Systems, Alice Wang, Benton H. Calhoun and Anantha Chandrakasan, 2006.

41. EED 402 (Electric Drives) (L: T: P)-(3:0:1)

Prerequisites: EED203 and EED306

Introduction to Electric Drives: What is Electric Drive? What are its advantages? Different components of Electric Drive, Different types of Electric Drives.

Dynamics of Electric Drives: Fundamentals of speed-torque relations, multi-quadrant operation in speed-torque plane, Nature and classification of load torques, Calculation of time and energy spent in transient operations, steady state stability of drives.

Control of Electric Drives: Steady-state and transient operation of drives, speed and torque control, different kinds of closed loop control of electric drives, sensors required for closed loop speed control.

Selection of Motor and Drives: Different kinds of motors used in drives, motor power and duty cycle ratings, motors suitable for continuous or intermittent operation of drives.

DC Motor Drives: Overview of different types of dc motors and their torque-speed characteristics, starting and braking methods of dc motors, conventional speed control methods, modern speed control methods using power electronic converters, time and energy loss calculations during starting and braking of separately excited dc motor.

Induction Motor Drives: Overview of 3-phase Induction motor torque-speed characteristics, squirrel-cage and slip-ring induction motor, different types of starting and braking of induction motor, time and energy loss calculations in transient operation of induction motor, Speed control of 3-phase induction motor using conventional methods and using power electronic converters, V/f control and slip power recovery based control of induction motor speed and torque, torque-speed characteristics and speed control of single phase induction motor.

Synchronous Motor Drives: Overview of synchronous motor operation and speed control. Brushless DC motor, Switched Reluctance Motor &Stepper Motor Drives: Construction, operation and control of brushless dc motor, switched reluctance motor and stepper motor.

Recommended book(s):

1. Fundamentals of Electrical Drives by G. K. Dubey CRC Press.
2. Power Electronics and Motor Drives: Advances and Trends, Elsevier/Academic Press, 2006

42. EED405 (Automotive Electronics and AUTOSAR) (L: T: P)-(3:0:0)

Prerequisites: KPIT- PACE programed for selected students in KPIT Company

Automotive systems, Design Cycle and Automotive Industry Overview, Automotive systems- Overview of automotive industry, leading players, automotive supply chain, global challenges, Introduction to modern automotive systems and need of electronics in automobiles, Automotive transmissions; Transmission fundamentals, Types- MT, AT, CVT and DCT (dual Clutch Transmission), Vehicle Braking Fundamentals; Vehicle dynamics during braking, Hydraulic brake system components, Introduction to ABS, Steering Control- Fundamentals, Electric Power steering, Overview of Hybrid Vehicles- ECU Design- V- model development, Components of ECU, Examples of ECU on Chassis, Infotainment, body electronics and cluster.
Automotive Sensors and Actuators: Accelerometer Sensors, Wheel Speed Sensors, Brake pressure sensors, seat occupancy sensors, engine speed, steering wheel angle, vehicle speed sensor, Throttle position sensor, temperature sensor, mass air flow rate sensor etc., Actuators- Solenoids, Various types of electric motors, and piezo electric force generators Example- Relays, Solenoids and motors, sensors in airbag systems, Chassis control system, Automatic transmission system.

Microcontrollers/Microprocessors in automotive domain, Communication Protocols, Infotainment Systems: Microcontrollers/Microprocessors in Automotive domain, Critical review of Microprocessor, Microcontroller and DSP development (emphasis on ports, timers/ Counters, interrupts, Watchdog timers, PWM) Criteria to choose right microcontroller/ Processor, Automotive grade processors- Renesas, Quorivva, Infineon, Development of control algorithms for different automotive systems. Communication Protocols: CAN, LIN, Flex RAY, MOST, Ethernet, D2B and DSI, Communication Interface with ECU's , Interfacing techniques and interfacing with infotainment systems, Infotainment Systems: Application of Telematics in Automotive domain, GPS and GPRS (GPS navigation, integrated hands-free cell phones, wireless safety communications and automatic driving assistance systems all are covered under the *telematics* umbrella).

Automotive Control System and model based Development: Control System Approach in Automotive: Digital and analog control methods, modelling of linear system, System responses, Model based Development: MATLAB, SIMULINK, SIMSCAPE Tool boxes.

Safety Systems in Automobiles and Diagnostic Systems: Active Safety Systems- ABS, TCS, ESP, Passive Systems- Airbag Systems, Advance driver assistance system, Examples of ADAS- Collision Warning, Automatic Cruise Control, Head light control, Connected cars technology towards Autonomous vehicles etc., Functional Safety, Diagnostics – OBD , Off board Diagnostics etc.

AUTOSAR fundamentals: Introduction and Overview of AUTOSAR, AUTOSAR RTE and SWE, AUTOSAR Diagnostics, AUTOSAR Integration methodology, AUTOSAR Network management, operating System and partial networking, MCAL , ETHERNE

Recommended book(s):

1. AUTOSAR Consortium Webpage.
2. Automobile Electrical and Electronic Systems, Tom Denton, Elsevier, 2004.
3. KPIT System, FDP programme lecture notes.

43. EED 406 (AUTOSAR) (L: T: P) - (3:0:0)

Prerequisites: *EED405*

Introduction and Overview of AUTOSAR: Architecture-Methodologies-Application Interfaces.
AUTOSAR RTE and SWC: Introduction, RTE entities, Communication Models, Modes, Calibration, RTE Generation.
AUTOSAR Diagnostics: Terms and definition, Overview of DCM, DEM, FiM, fault handling in AOTUSAR, software reprogramming in AUTOSAR ECU.
AUTOSAR Integration methodology: Integration, Build Process, Compilation, Linking.
AUTOSAR Network management: OSEK Network Management, AUTOSAR Network Management, Nm Interface, CAN Network Management.
AUTOSAR OS: OS position, OS interaction – Timing and Protection Overview – Interrupt – Memory Protection.
AUTOSAR Partial Network Concept: Energy Management Introduction, Partial Networking, partial Networking restrictions.
MCAL: Introduction, module groups, drivers, initialization order.
ETHERNET – AUTOSAR Ethernet communication stack.

Recommended book(s):

1. AUTOSAR Manual.

VI. Faculty and their areas of specialization

1. **Dr. Dinkar Prasad, (Ph.D., IIT Kharagpur) - Associate Director (Academics) & HoD**

   Dr. Dinkar Prasad has more than 30 years of professional experience, divided almost equally between Industrial and Teaching experience. He joined Shiv Nadar University in 2013. Previously he taught at IIT Bombay and IIT Kharagpur and served with industries like, 'Tata Motors' and 'Emerson Network Power'. His research interests lie in the field of Power Electronics and Electrical Machine Drives. He has considerable experience in "Design of Power-electronic converters for variety of industrial applications". He has been granted two Indian patents while some more are pending with Indian patent offices.

2. **Dr. M. Gopal, (Ph.D. BITS, Pilani) - Professor and Director Emeritus**

   Dr. M. Gopal is a Professor of Electrical Engineering and Director Emeritus, School of Engineering. Dr. Gopal joined SNU after a long and stellar career at Indian Institute of Technology which included heading the Department of Electrical Engineering at IIT Delhi. His teaching and research stints span three decades at the IITs and nearly five years at SNU. He is a globally known academician with excellent credentials as author, teacher, researcher, and administrator His areas of research include Control Systems and Machine Learning. Dr. Gopal is the author/co-author of five books on Control Engineering. His book on Applied Machine Learning is in Press.

3. **Dr. Ranendra Narayan Biswas, (Ph.D., University of California, Berkeley) - Visiting Professor**

   Prof. RN Biswas has been serving SNU as a Visiting Professor. He is one of the finest academicians and has a glorious past. He joined IIT Kanpur in 1967 as an Assistant Professor and was elevated to the rank of Professor in 1977. He held several administrative positions in IIT Kanpur. He also served as director of CEERI, Pilani and founding director of Usha Martin Academy of Communication Technology (in collaboration with IIT Madras). He worked as Distinguished Professor in DIICT Gandhinagar and as Visiting Professor in IIIT Hyderabad, NIIT- Neemrana and IIIT Delhi. Prof. R N Biswas is known for his exemplary teaching both in and outside the classroom. He has nearly 50 years of teaching and research experience in electronic circuits, telecommunication

systems, communication networks, microprocessor architecture and systems. He has served in numerous national committees and boards as expert.

4. **Dr. M P Dave, (Ph.D., Roorkee University & Dr-Ing. Ruhr Univ, West Germany) - Visiting Professor**

   Prof. M.P.Dave is serving SNU as a visiting Professor. He is a distinguished teacher and researcher and has over 50 years of experience. Prof. M. P. Dave taught at IIT Roorkee for several decades. He was HoD at IIT Roorkee for one term and Group Leader of Power System for almost 20 years. After retirement from IIT, Roorkee he served as Visiting Professor at IIT Delhi and A. K. Garg Engineering College, Ghaziabad. He is senior member of IEEE and Fellow of I.E.(I). His areas of specializations include Power System Dynamics, Control System, and Electric Drives. He has more than 65 publications and has guided seven Ph.D. students at IIT Roorkee. Presently he is guiding four Ph.D. students from various Universities. He has wide administrative experience as Member of University Senate and Syndicate at IIT Roorkee, Convener of board of Studied at U.P. Technical University, Maha Maya Technical University and a nominated member of Academic Council of Maha Maya University etc..

5. **Dr. Prem Chand Jain, (Ph.D., BITS Pilani) - Visiting Professor**

   Prof. P. C. Jain obtained his BE, ME, and Ph.D degrees in 1968, 1972, 1979 respectively. He served with CEERI, Pilani for nearly three decades and retired in 1998 as Deputy Director. Later he served in senior positions in industries and institutes like Himachal Futuristic Comm. Ltd. (Gurgaon), S.T. Microelectronics (G.Noida), C-DAC (Noida). He is with SNU since 2013. During his 43 years of rich experience in research and teaching he guided more than 40 B.Tech & M.Tech. projects. He also guided 2 Ph.D students at BITS and C-DAC. He has 135 research papers in various International/National Journals/Conferences. He is Life Fellow of IETE, BES, and CSI. He was given 'IETE-Prof. S. N. Mitra memorial award' and 'IETE-K. S. Krishnan memorial award' in 1996 and 1997 respectively. He is a regular reviewer of IEEE Transaction journals.

6. **Dr. Vijay Kumar Chakka**, (**Ph.D., NIT Trichy) -Professor**

   Dr. Vijay Chakka has more than twenty years of teaching and research experience. He has guided more than 40 M.Tech. students at NIT Trichy and DAIICT Gandhinagar, and 3Ph.D students at

DAIICT Gandhinagar. He is a Senior Member of IEEE and reviewer of IEEE Communication journals and IEEE sponsored conferences on communications like ICC and GLOBECOM etc. He is also Book reviewer for McGraw-Hill International, Tata-McGraw-Hill, etc. in the area of communication and signal processing. He is also Doctoral committee member and PhD thesis examiner for several universities (like NIT Surat, DAIICT, Nirma University, Anna University, Manipal University, etc.)

7. **Dr. G Naveen Babu**, **(Ph.D., JPIIT Noida) -Associate Professor**

Dr. G. Naveen Babu obtained his BE, ME and PhD degrees in 2002, 2004 and 2013 respectively. After seven years of teaching and research he joined Shiv Nadar University in 2011. He was among the initial team of founding faculty of the University. For nearly three years he served as Coordinator of Electronics & Communication Engineering and Electrical & Electronics Engineering in SNU. In 2014, he moved to the University of Alberta, Canada, to pursue post-doctoral research in the field of Microwave Tubes. He joined back SNU after completing his Postdoctoral tenure with the Department of Electrical and Computer Engineering, University of Alberta, Edmonton, Canada.

8. **Dr. Sonal Singhal**, **(Ph.D., IIT Roorkee) –Associate Professor**

Dr. Sonal has been working in the area of VLSI design and fabrication. Her research interests include topics like design of novel semiconductor electronic and optoelectronic devices, VLSI Technology & design, network realization in HDL. Dr. Singhal's interest also includes MEMS Technology based design. Dr. Singhal has several publications to her credit in Journals like IETE, Current Nano Science, Science Direct, Springer and JAP etc.

9. **Dr. Atul Vir Singh, (Ph.D., IIT Delhi) - Associate Professor**

Dr. Atul Vir Singh joined Shiv Nadar University in May, 2012. He is working in the area of Micro-Electro-Mechanical-Systems (MEMS) technologies. He has extensive experience in MEMS processing techniques (surface and bulk micro-machining, anodic bonding, etch-stop, etc.) used to fabricate these devices. In order to promote MEMS research, he is interested in developing a MEMS design and fabrication facility for post graduate and research students.

10. **Dr. Madhur Deo Upadhayay, (Ph.D., IIT Delhi) -Associate Professor**

Dr. Madhur Deo Upadhayay has done teaching and research for more than a decade. He joined SNU in August 2013 as Assistant Professor. His research interests are Microwave devices (Active & passive) and antennas. He also worked as Departmental UG-Coordinator. He is a member of IEEE and reviewer for several IEEE journals and conferences.

11. **Dr. Amitabh Chatterjee (Ph.D., University of California, Santa Barbara)) –Associate Professor**

Dr. Chatterjee received the Integrated M.Tech. degree from IIT Bombay, Mumbai, India, in 1996, and the Ph.D. degree in ESD and high-current phenomenon from the University of California at Santa Barbara, Santa Barbara, CA, USA.,He was a Senior Scientist with the Raja Ramanna Center for Advanced Technology, Indore, India, after receiving the M.Tech. degree. He was a Fellow Researcher demonstrating all silicon off-chip signal transmissions with Vanderbilt University, Nashville, TN, USA. Since 2020, he has been a faculty member with Shiv Nadar University with TCAD-based research interests in establishing models in high-current phenomenon in silicon and WBG devices, THz generation, and sensors. His current research interests include modeling, reliability, and physics of devices, TCAD-based device engineering, and identifying bipolar processes.

12. **Dr. Amit Bakshi, (Ph.D., IIT Bombay) - Assistant Professor**

Dr. Amit Bakshi has joined SNU in January 2014 as an Assistant Professor in the Electrical Engineering Department. His main research interests are analysis of low frequency electromagnetic devices and short circuit mechanical strength analysis of power transformers. Dr. Amit has several publications in IEEE Transactions on Power Delivery.

13. **Dr. Himanshu SekharSahu, (Ph.D., IIT Guwahati)-Assistant Professor**

Dr. Sahu has completed B.E. in Electrical and Electronics Engineering from B.P.U.T. Rourkela, Odisha in 2006 and his M.Tech in Power System Engineering from Veer Surendra Sai University of Technolgy, Burla, Odisha in 2010. He has completed his Ph.D. in the specialization "Solar Power Generation and Its Integration with the Grid" from Indian Institute of Technology Guwahati in 2017. He had worked as an Institute Post-Doctorate Fellow in Department of Electrical

Engineering at Indian Institute of Technology Madras from September 2017 to July 2018. His research interests are integration of renewable energy sources with the grid, photovoltaic power system, and power quality issues.

14. Dr. Jitendra Prajapati, (Ph.D., IIT Guwahati) - Assistant Professor

Dr. Jitendra Prajapati has joined SNU in January 2019 as an Assistant Professor in the Electrical Engineering Department. His main research interests are Terahertz Radiation, Terahertz Antennas, Photoconductive and Photo-mixing Antennas, Tera-Hertz Applications, Terahertz Sensing.. Dr. Jitendra has several publications in IEEE Transactions and conferences.

15. Dr. Upendra Pandey, (Ph.D., University of Calabria, Italy) - Assistant Professor

Dr. Upendra earned his Ph.D. in Science and Technology of Mesosphase and Molecular Materials from the University of Calabria, Italy. He obtained his M.Tech. degree in Opto-electronics from Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, Madhya Pradesh, India. Post his Ph.D., Upendra was a Post-Doctoral Fellow for one year at University of Calabria, Italy. Later, in January 2013 he moved to University of St. Andrews, Scotland, United Kingdom as a Post-Doctoral Fellow to join Organic Semiconductor Centre to carry out his research work on different Novel Organic Semiconductors for their Organic Electronic Application with emphasis on Solar Cell. In October 2013, Upendra moved from St. Andrews to join Interdisciplinary Centre for Energy Research at the Indian Institute of Science, Bangalore as DST Inspire faculty fellow to work on Organic and Perovskite solar cells in October 2013 where he worked till April 15, 2019. At IISc. He joined Shiv Nadar University in 2019 and currently working as an Assistant Professor.

16. Dr. Rohit Singh, (Ph.D., IIT Indore) - Assistant Professor

Dr. Rohit Singh obtained his M.Tech degree in Electronics & Communication Engineering from Shiv Nadar University in 2014 and Ph.D. in Electrical Engineering from IIT Indore in 2018. His research interest is to develop cost-effective compound semiconductor-based heterostructures for HFET applications to be utilized in air and water pollutant detection.

17. Dr. Kamal Singh, (Ph.D., IIT Bombay) - Assistant Professor

Dr. Kamal Singh is with the Electrical Engineering Department of Shiv Nadar University since September 2019. Before that, he was a graduate student in the Department of Electrical Engineering at the IIT Bombay, India. He is interested in the fundamental aspects of wireless communication systems such as capacity, rate and power allocation laws under practical constraints etc. Multi-user communication models are very common and pose interesting and challenging problems. Currently, he is investigating a particular wireless multi-user channel known as mutiple access channel (MAC) with the objective of finding good communication schemes for ergodic fading conditions with distributed CSIT assumptions for both scalar and multi-antenna configurations at the transmitters and the common receiver.

18. Mr. Aakash Sinha, (MS, Carnegie Mellon University, USA) -Assistant Professor of Practice

Mr. Aakash Sinha joined SNU in July 2017 as Assistant Professor. He is B.E. from Delhi College of Engineering (2001), MS Robotics, Carnegie Mellon Univ., USA (2004) and has earned Certification in Entrepreneurship, Stanford Business School (2013). Before joining SNU he worked as Research Scientist- Lockheed Martin and as Chief Intelligent Vehicles Engineer- iRobot Corporation. He is also founder of Omnipresent Robot Tech. His research interests are Robotics, Drones, Driverless Cars and Machine Learning.

VII. Contact details of Faculty, lab staff and Ph.D. students

a) List of Faculty

S. No.	Name	Email id	Location/Extension
1	Prof. Dinkar Prasad	dp362@snu.edu.in	D334Q/ 447
2	Prof. Madan Gopal	mgopal@snu.edu.in	D036O/ 830
3	Prof. R. N. Biswas	ranendra.biswas@snu.edu.in	D132G/ 367
4	Prof. Madhukar P. Dave	mp.dave@snu.edu.in	D236L/773
5	Prof. Premchand Jain	premchand.jain@snu.edu.in	D236M/ 212
6	Prof. Vijay Kumar Chakka	vijay.chakka@snu.edu.in	C318E/ 713

7	Dr. G Naveen Babu	naveen.babu@snu.edu.in	B220F/ 142
8	Dr. Sonal Singhal	sonal.singhal@snu.edu.in	D132M/ 114
9	Dr. Atul Vir singh	atul.singh@snu.edu.in	D236D/ 204
10	Dr. Madhur Deo Upadhayay	mu689@snu.edu.in	C322B/ 297
11	Dr. Amitabh Chatterjee	amitabh.chatterjee@snu.edu.in	C219M/190
12	Dr. Amit Bakshi	amit.bakshi@snu.edu.in	C212B/ 714
13	Dr. Himanshu Sahu	himanshu.sahu@snu.edu.in	D236A/325
14	Dr. Jitendra Prajapati	jitendra.prajapati@snu.edu.in	C322G/663
15	Dr. Upendra Pandey	upendra.pandey@snu.edu.in	D236Q/690
16	Dr. Rohit Singh	rohit.singh@snu.edu.in	C320A/235
17	Dr. Kamal Singh	kamal.singh@snu.edu.in	C121A/476
18	Dr. Aakash Sinha	Aakash.sinha@ snu.edu.in	D236C/682

b) List of laboratory and supporting staff

S. No.	Name	Email id	Location/Extension
1	Mr. Devendra Kataria	devendra.kataria@snu.edu.in	D013/895
2	Ms. Priyanka Verma	priyanka.verma@snu.edu.in	D130/428
3	Ms. Shivani Rajput	Shivani.Rajput@snu.edu.in	D215/304
4	Mr. Mohan Kumar	mohan.kumar@snu.edu.in	C303/443
5	Mr. Bhuvnesh Kumar	bhuvnesh.kumar@snu.edu.in	C209/C217/352/472
6	Mr. Aswani Kumar	ak626@snu.edu.in	C102/6676
7	Mr. Durvesh Kumar	durvesh.kumar@snu.edu.in	C205/6704
8	Mr. Bhoopendra Singh	bs385@snu.edu.in	C201/6863
9	Mr. Rajvir Singh	rs240@snu.edu.in	C206/6815
10	Mr. Vakil Khan	vakil.khan@snu.edu.in	C105/6772

c) List of current PhD Students

S .No.	Name	Email id	Location/Extension
1	Ashish Kushwaha	ak999@snu.edu.in	D013/ 895

2	Goli Srikanth	gs499@snu.edu.in	D215/ 304
3	Harikesh Singh Rawat	hr529@snu.edu.in	D017/ 6713
4	Shaik Basheeruddinshah	bs600@snu.edu.in	D215/ 304
5	Shailendra Kumar Singh	ss523@snu.edu.in	C209/ 352
6	Vinay Sharma	vs816@snu.edu.in	C209/ 352
7	Narendra Shukla	ns997@snu.edu.in	C303/ 443
8	Kotha Venugopalachary	vk227@snu.edu.in	D215/ 304
9	Shaik Jani Babu	sb638@snu.edu.in	D215/ 304
10	Manali Saini	ms905@snu.edu.in	D215/304
11	An Belin Felicsona	af368@snu.edu.in	C209/352
12	Priyanka Mathur	pm133@snu.edu.in	D215/304
13	Rupali Barnwal	rb945@snu.edu.in	D015/6713
14	Irala Kumar	ik356@snu.edu.in	C206/6815
15	Deepak Yadav	dy331@snu.edu.in	C209/ 352
16	Himani Verma	hv790@snu.edu.in	D215/304
17	Jyothishree Pillai	jp698@snu.edu.in	C209/ 352
18	Kirshan Kumar Gautam	kg982@snu.edu.in	C106/6783
19	Shivam Tripathi	st934@snu.edu.in	D015/6713
20	Kajal Yadav	ky397	A206/A208/6816
21	Kiran G	kg611	C-105/6772

VIII. List of Laboratories in Electrical Engineering Dept.

S. No	**Name of Laboratory**	**Location/Contact person**
1	Electrical Machine Lab	D-013/ Devendra Kataria/895
2	Power Electronics Lab	C-106/ Devendra Kataria/6783
3	Energy Lab	D-015/ Devendra Kataria/6713
4	Project Lab	C-102/ Aswani Kumar/6676
5	Embedded Electronics Lab	C-105/ Vakil Khan/6772
6	Communication Lab	C-217/ Bhuvnesh Kumar/ 472

7	Digital Signal Processing Lab	D-215/ Shivani Rajput/ 304
8	Microwave Engineering Lab	C-209/ Bhuvnesh Kumar/352
9	Electronics Lab 2	C-205/Durvesh Kumar/ 6704
10	Electronics Lab 1	C-201/ Bhupendra Singh/ 6863
11	Measurement & Instrumentation Lab	C-206/ Rajveer Singh/ 6815
12	Microelectronics Lab	C-303/Mohan Kumar/ 443

IX. Graduate Program details

Department of Electrical Engineering offers 2 years Master program (M. Tech in RF and Microwave Engineering) and Doctoral research program (in Electrical Engineering and Electronics and Communication Engineering).

Details about M. Tech program can be found at:

https://ee.snu.edu.in/graduate/masters

Details about Ph.D. program can be found at:

https://ee.snu.edu.in/graduate/doctoral