4th Year 1st Semester

Sl. No	Course Code	Course Title	Hours/Week		Credit
			Theory	Practical/ Sessional	
1	EEE 4100*	Project & Thesis		3	1.5
2	EEE 4101	Digital Signal Processing	3		3
3	EEE 4102	Digital Signal Processing Sessional		3	1.5
4	EEE 4103	Control System	3		3
5	EEE 4104	Control System Sessional		3	1.5
6	EEE 4105	VLSI Circuits and Design	3		3
7	EEE 4106	VLSI Circuits and Design Sessional		3	1.5
8	EEE 4111**	Renewable Energy	3		3
9	EEE 4113**	High Voltage Engineering			
10	EEE 4115**	Optoelectronics	3		3
11	EEE 4117**	Mobile Cellular Communication	3		
12	EEE 4119**	Biomedical Engineering	3		
			15	**12**	**21.00**

*the course will be evaluated at the end of 4th year 2nd semester along with EEE 4200.
**Students can choose two courses according to their interest. If the students' choice differs, then offering of the courses will depend on number of students and availability of faculties.

Core Courses

1. EEE 4100 Project and Thesis

Contact hours/week: 3, Credit: 1.5

2. EEE 4101 Digital Signal Processing

Contact hours/week: 3, Credits: 3

Introduction to digital signal processing: sampling, quantization and signal reconstruction. Analysis of discrete-time system in the time domain: impulse response model, difference equation model.
Correlation: power signal, energy signal, applications. Z-transform and analysis of LTI systems.
Frequency analysis of discrete-time signals: discrete Fourier series and discrete-time Fourier transform (DTFT). Frequency analysis of LTI systems. Discrete Fourier transform (DFT) and Fast Fourier transform (FFT). Minimum phase, maximum phase and all pass systems. Calculation of spectrum of discrete-time signals.
Digital filter design: linear phase filters, specifications, design using window, optimal methods; IIR filters: specifications, design using impulse invariant, bi-linear z- transformation, least-square methods.

3. EEE 4102 Digital Signal Processing Sessional

Contact hours/week: 3, Credit: 1.5

In this course students will perform experiments to verify practically the theories and concepts learned in EEE 4101.

4. EEE 4103 Control System

Contact hours/week: 3, Credit: 3

Review of Laplace transform, Initial and Final value theorems,
Transfer Functions: Open-loop stability, Poles, Zeros, Time response, Transients, Steady-state, Block diagrams and signal flow diagram
Feedback principles: Open versus Closed-loop control, High gain control, Inversion;
State variables: Signal flow diagram to state variables, transfer function to state variable and state variable to transfer function,
Stability of closed-loop systems: Routh's method, Root locus, PID control: Structure, Design using root locus, Pole assignment: Sylvester's theorem, PI and PID synthesis using pole assignment,
Frequency Response: Nyquist plot, Bode diagram, Nyquist stability theorem, Stability margins, Closed-loop sensitivity functions, Model errors, Robust stability,
Controller design using frequency response: Proportional control, Lead-lag control, PID control,
Digital control systems: introduction, sampled data systems, stability analysis in Z-domain.

5. EEE 4104 Control System Sessional

Contact hours/week: 3, Credit: 1.5

In this course students will perform experiments to verify practically the theories and concepts learned in EEE 4103.

6. EEE 4105 VLSI Circuits and Design

Contact hours/week: 3, Credit: 3

IC trends, technology and design approaches.
MOS device: structure, operation, threshold voltage and characteristics.
Ratioed circuits: NMOS inverter with resistive and transistor load, Pseudo NMOS inverter.
Ratioless circuits: CMOS inverters: operation, transfer characteristics, design for equal rise and fall time, propagation delay, rise time, fall time and power consumption estimation. NMOS pass transistor and CMOS pass gate circuits. Buffer chain design to drive large capacitive load.
Integrated circuit fabrication technology: photolithography, CMOS process flow, design rules. Estimation of resistance and capacitance from layout. Layout matching. Stick diagram and area estimation from stick diagram.
Reliability issues: Latch-up, electromigration. Basic logic gates in CMOS. Synthesis of arbitrary combinational logic in CMOS, pseudo-NMOS, dynamic CMOS, clocked CMOS and CMOS domino logic.
Structured design: Parity generator, bus arbitration logic, multiplexers based design, programmable logic array (PLA) design.
Clocked sequential circuit design: two phase clocking, dynamic shift register. CMOS latches and flip flops. Subsystem design: 4-bit arithmetic processor: bus architectures, shifter, design of a general purpose ALU.
Memory elements design: System timing consideration, three transistors and one transistor dynamic memory cell. Pseudo-static RAM/register cell. 4 transistors dynamic and 32 transistors static CMOS memory cell. 4x4 bit register array and 132 bit static CMOS memory array.
Finite State Machine design: Design of Moore Type and Mealy type FSM using Verilog. Testing VLSI circuits.

7. EEE 4106 VLSI Circuits and Design Sessional
Contact hours/week: 3, Credit: 1.5

In this course students will perform experiments to verify practically the theories and concepts learned in EEE 4105.

Elective Courses

8. **EEE 4111 Renewable Energy
Contact hours/week: 3, Credit: 3

Renewable energy sources: Solar, wind, mini-hydro, geothermal, biomass, wave and tides. **Solar Photovoltaic**: Characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, sun tracking systems, Maximum Power Point Tracking (MPPT): chopper, inverter. Sizing the PV panel and battery pack in stand-alone PV applications. Modern solar energy applications (residential, electric vehicle, naval, and space). Solar power plants connected to grid.
Solar thermal: principles of concentration, solar tower, parabolic dish, receiver, storage, steam turbine and generator.
Wind turbines: Wind turbine types and their comparison, power limitation, Betz's law; Control mechanism: pitch, yaw, speed. Couplings between the turbine and the electric generator, Wind turbine generator - DC, synchronous, self-excited induction generator and doubly fed induction generator.
Grid interconnection: active and reactive power control. Biomass and biogas electricity generation.

9. **EEE 4103 High Voltage Engineering
Contact hours/week: 3, Credit: 3

Ionization and decay process: Townsend's first and second ionization coefficient. Electric breakdown in gases. Townsend's criterion for spark breakdown. Sparking potential. Penning effect. Corona discharges, power loss calculation. Breakdown of solid and liquid dielectrics.
Generation of high voltage: Alternating voltage, transformer cascade. Series resonant circuit for high voltage ac testing. Test of dc and ac cable.
Transient Voltage: Impulse wave shape. Impulse voltage generator and its mathematical analysis. Design consideration of impulse generators. Triggering of impulse generators. DC voltage doubler and cascade circuits. Electrostatic generator, voltage stabilization. Measurement of high voltage. Electrostatic voltmeter, sphere gap. Potential divider. High Voltage testing of power system equipment. Oil testing. Design consideration of transmission line based on direct stroke. High voltage transient in transmission line. High voltage lightning arrester. Insulation co-ordination.

10. **EEE 4115 Optoelectronics
Contact hours/week: 3, Credit: 3

Optical properties in semiconductor: Direct and indirect band-gap materials, basic transitions in semiconductors, radiative and nonradiative recombination, optical absorption, photo-generated excess carriers, minority carrier life time, luminescence and quantum efficiency in radiation. Properties of light: Particle and wave nature of light, polarization, interference, diffraction and blackbody radiation.
Light emitting diode (LED): Principles, materials for visible and infrared LED, internal and external efficiency, loss mechanism, structure and coupling to optical fibers. Double-Heterostructure (DH) LEDs, Characteristics, Surface and Edge emitting LEDs.

Stimulated emission and light amplification: Spontaneous and stimulated emission, Einstein relations, population inversion, absorption of radiation, optical feedback and threshold conditions. Semiconductor Lasers: Population inversion in degenerate semiconductors, laser cavity, operating wavelength, threshold current density, power output, elementary laser diode characteristics, heterojunction lasers, optical and electrical confinement. single frequency solid state lasers-distributed Bragg reflector (DBR), distributed feedback (DFB) laser. Introduction to quantum well lasers. Introduction to quantum well lasers, Vertical Cavity Surface Emitting Lasers (VCSELs), optical laser amplifiers.

Photo-detectors: Photoconductors, junction photo-detectors, PIN detectors, avalanche photodiodes, hetero-junction photodiodes, Schottky photo-diodes and phototransistors. Noise in photodetectors. PIN and APD. Photo-detector design issues.

Solar cells: Solar energy and spectrum, silicon and Schottky solar cells. Modulation of light: Phase and amplitude modulation, electro-optic effect, acousto-optic effect and magneto-optic devices. Introduction to integrated optics.

11. **EEE 4117 Mobile Cellular Communication

Contact hours/week: 3, Credit: 3

Introduction: Concept, evolution and fundamentals. Analog and digital cellular systems. **Cellular Radio System**: Frequency reuse, co-channel interference, cell splitting and components.

Mobile radio propagation: Propagation characteristics, models for radio propagation antenna at cell site and mobile antenna. Frequency Management and Channel Assignment: Fundamentals, spectrum utilization, fundamentals of channel assignment, fixed channel assignment, non-fixed channel assignment, traffic and channel assignment.

Handoffs and Dropped Calls: Reasons and types, forced handoffs, mobile assisted handoffs and dropped call rate. Diversity Techniques: Concept of diversity branch and signal paths, carrier to noise and carrier to interference ratio performance.

Digital cellular systems: Global system for mobile, time division multiple access and code division multiple access.

12. **EEE 4119 Biomedical Engineering

Contact hours/week: 3, Credit: 3

Origin and major types of biological signals: Human body: cells and physiological systems, bioelectric potential, bio-potential electrodes and amplifiers, blood pressure, flow, volume and sound, electrocardiogram, electromyogram, electroencephalogram, phonocardiogram, vector cardiogram. Interpretation of bio-signals. Noise in bio-signals.

Measurement of bio-signals: transducers, amplifiers and filters. Measurement and detection of blood pressure.

Blood flow measurement: plethysmograph and electromagnetic flow meter. Measurement of respiratory volumes and flow, related devices.

Xray-Tomograph: positron emission tomography and computed tomography. Magnetic resonance imaging. Ultrasonogram. Patient monitoring system and medical telemetry. **Therapeutic devices**: cardiac pacemakers and defibrillators. Electrical safety in bio instrumentations and sensing.