ELECTRICAL ENGINEERING OPTIONAL

Syllabus

Paper 1 :

1. Circuits—Theory:
Circuit components; network graphs; KCL, KVL; Circuit analysis methods: nodal analysis, mesh analysis; basic network theorems and applications; transient analysis: RL, RC and RLC circuits; sinusoidal steady state analysis; resonant circuits; coupled circuits; balanced 3-phase circuits. Two-port networks.

2. Signals and Systems:

- Representation of continuous-time and discrete-time signals and systems; LTI systems; convolution; impulse response; time-domain analysis of LTI systems based on convolution and differential/difference equations.
- Fourier transform, Laplace transform, Z-transform, Transfer function.
- Sampling and recovery of signals DFT, FFT Processing of analog signals through discrete-time systems.

3. E.M. Theory:

- Maxwell's equations, wave propagation in bounded media.
- Boundary conditions, reflection and refraction of plane waves.
- Transmission lines: travelling and standing waves, impedance matching, Smith chart.

4. Analog Electronics:

- Characteristics and equivalent circuits (large and small-signal) of Diode, BJT, JFET and MOSFET.
- Diode circuits: Clipping, clamping, rectifier.
- Biasing and bias stability.
- FET amplifiers.
- Current mirror; Amplifiers: single and multi-stage, differential, operational feedback and power.
- Analysis of amplifiers; frequency-response of amplifiers.
- OPAMP circuits.
- Filters; sinusoidal oscillators: criterion for oscillation; single-transistor and OPAMP configurations.
- Function generators and wave-shaping circuits.
- Linear and switching power supplies.

5. Digital Electronics:

- Boolean algebra; minimisation of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders.
- Sequential circuits: latches and flip-flops, counters and shift-registers.
- Comparators, timers, multivibrators.
- Sample and hold circuits, ADCs and DACs. Semiconductor memories.
- Logic implementation using programmable devices (ROM, PLA, FPGA).

6. Energy Conversion:

- Principles of electromechanical energy conversion: Torque and emf in rotating machines.
- DC machines: characteristics and performance analysis; starting and speed control of motors.
- Transformers: principles of operation and analysis; regulation, efficiency; 3-phase transformers.
- 3-phase induction machines and synchronous machines: characteristics and performance analysis; speed control.

7. Power Electronics and Electric Drives:
Semiconductor power devices: diode, transistor, thyristor, triac, GTO and MOSFET-static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters: fully-controlled and half-controlled; principles of thyristor choppers and inverters; DC-DC converters; Switch mode inverter; basic concepts of speed control of dc and ac motor drives applications of variable-speed drives.

8. Analog Communication:
- Random variables: continuous, discrete; probability, probability functions.
- Statistical averages; probability models; Random signals and noise: white noise, noise equivalent bandwidth; signal transmission with noise; signal to noise ratio.
- Linear CW modulation: Amplitude modulation: DSB, DSB-SC and SSB.
- Modulators and Demodulators; Phase and Frequency modulation: PM & FM signals; narrows band FM; generation & detection of FM and PM, Deemphasis, Preemphasis.
- CW modulation system : Superheterodyne receivers, AM receivers, communication receivers, FM receivers, phase locked loop, SSB receiver Signal to noise ratio calculation or AM and FM receivers.

Paper 2 :

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1. Control Systems:
- Elements of control systems; block-diagram representations; open-loop & closed-loop systems; principles and applications of feed-back.
- Control system components.
- LTI systems: time-domain and transform-domain analysis.
- Stability : Routh Hurwitz criterion, root-loci, Bode-plots and polar plots, Nyquist's criterion; Design of lead-lad compensators.
- Proportional, PI, PID controllers.
- State-variable representation and analysis of control systems.

2. Microprocessors and Microcomputers:
PC organisation; CPU, instruction set, register set timing diagram, programming, interrupts, memory interfacing, I/O interfacing, programmable peripheral devices.

3. Measurement and Instrumentation:
- Error analysis; measurement of current voltage, power, energy, power-factor, resistance, inductance, capacitance and frequency; bridge measurements.
- Signal conditioning circuit; Electronic measuring instruments: multimeter, CRO, digital voltmeter, frequency counter, Q-metre, spectrum-analyser, distoration-meter.
- Transducers : thermocouple, thermistor, LVDT, strain-gauge, piezo-electric crystal.

4. Power Systems: Analysis and Control:
- Steady-state performance of overhead transmission lines and cables; principles of active and reactive power transfer and distribution; per-unit quantities; bus admittance and impedance matrices;

load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults.
- Concepts of system stability: swing curves and equal area criterion.
- Static VAR system. Basic concepts of HVDC transmission.

5. Power System Protection:
- Principles of overcurrent, differential and distance protection.
- Concept of solid state relays.
- Circuit breakers.
- Computer aided protection: introduction; line, bus, generator, transformer protection; numeric relays and application of DSP to protection.

6. Digital Communication:
- Pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM), Digital modulation and demodulation schemes: amplitude, phase and frequency keying schemes (ASK, PSK, FSK).
- Error control coding: error detection and correction, linear block codes, convolution codes. Information measure and source coding.
- Data networks, 7-layer architecture.