

ELECTRICAL ENGINEERING

(Paper II)

Time Allowed : Three Hours
Maximum Marks : 300

QUESTION PAPER SPECIFIC INSTRUCTIONS

(Please read each of the following instructions carefully before attempting questions)

There are EIGHT questions divided in two Sections.

Candidate has to attempt FIVE questions in all.

Question Nos. 1 and 5 are compulsory and out of the remaining, any THREE are to be attempted choosing at least ONE question from each Section.

The number of marks carried by a question/part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Word limit in questions, wherever specified, should be adhered to.

SECTION 'A'

1. Answer any three of the following:

3 × 20 = 60

- (a) “A second order closed loop system is stable, if the open loop system has all its poles in RHS of s-plane”: Use Nyquist Criterion to justify your answer.
- (b) “Thermistors have a Negative-Temperature-Coefficient”. If this is correct discuss Explain their working, construction and applications. Compare resistance-temperature characteristic of a typical thermister and platinum.
- (c) For overhead transmission lines, shunt admittance is mainly capacitive susceptance ($j\omega LC$). Comment.
- (d) ‘Huffman coding is done to increase the rate of information bits to make them approach the rate of binary digits while in parity-check coding rate of binary digits is increased to make the information transmission more reliable’ Comment.

2. (a) What do you mean by a state transition Matrix? State and explain properties of state transition Matrix. A process control system is described by the state model:

$$\dot{X} = \begin{bmatrix} -1 & -0.5 \\ 0 & 1 \end{bmatrix} X + \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} u$$

$Y = \begin{bmatrix} 1 & 0 \end{bmatrix} X$ and $X_0 = 0$ Use Laplace Transform method to obtain state transition matrix $\phi(t)$ for the system.

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- (b) An 11-kV, 25-MVA, 3-phase, star-connected alternator was subjected to three different types of fault at its terminals. The fault currents were: 5610 A for 3-phase fault 6760 A for line-to-line fault and 8630 A for single line-to-ground fault. If the alternator neutral is solidly grounded, find the p.u. values of the three sequence reactances of the alternator. Assume that the resistances of windings are negligible.

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- (c) State and explain principle of Magnetio Hydro Dynamics (MHD) generation, Draw a block diagram of close cycle MHD system and explain operation of the system. State the advantages of MHD generation over other methods of electric generation. An ideal MHD generator using gas as working fluid has the following data:

Electrode Area	0.2 m ²
Distance between electrodes	24 cm
Magnetic Flux density	1 Wb/m ²
Conductivity of gas	50 Siemens/m
Gas velocity	1800 m/s

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Find: (i) Output voltage, power and efficiency at a loading factor of 0.7. (ii) Open circuit voltage and short circuit current. (iii) Maximum power output.

3. (a) How are diodes realized in integrated circuits using transistor structures? Describe and compare the three most popular diode structures with diagrams. 20
- (b) A power system is supplied by only two plants, both of which are operating on economic despatch. At the bus of plant 1, the incremental cost is Rs. 275/-per MWh and at plant 2 is Rs. 300/- per MWh. Which plant has the higher penalty factor? What is the penalty factor of plant 1 if the cost per hour of increasing the load on the system of 1 MW is Rs. 341/-? 20
- (c) (i) Show how three distance relays should be connected to current and potential transformers of a 3-phase transmission line in order that the protective system has the same sensitivity for all types of multiphase faults. What will be the response of this protective system to single-phase earth faults? (ii) What is the effect of fault impedance on the performance of distance protection? Suggest a method for overcoming this effect. 20
4. (a) Differentiate between Instruction Cycle (IC) and Machine Cycle (MC), Explain all the basic Machine Cycles of 8085 microprocessor. Explain difference between a FETCH cycle and an INTA signal. 20
- (b) What is meant by eccentricity, semi-major axis, apogee and perigee? The cosmos 1675 satellite has an apogee height of 39, 342 kms and a perigee height of 613 kms. Determine the semi-major axis, and the eccentricity of its orbit. Assume the mean earth radius of 6371 kms. 20
- (c) Summarize the attractive attributes and limitations of phased array radar. 20

SECTION 'B'

5. Answer any three of the following

3 × 20 = 60

- (a) “Measurement of Hall-Coefficient reveals the sign of charge carriers, thus giving type of conductivity and the concentration of charge carriers”, Explain the ‘Hall-Effect in D-type [?] semiconductors. Hence define Hall-Coefficient.
- (b) “Bridges can be used for the determination of frequency in terms of values of various bridge elements”. If this is correct draw the bridge and derive condition for balance. Why and how are two resistances and capacitances made equal? Can this bridge be used for measurement of capacitance?
- (c) HVDC transmission is economically superior to HVAC transmission in respect of transmitted power and line losses. Comment. Assume equal conductor resistance for the two transmission systems.
- (d) In a single mode fibre the waveguide dispersion can cancel the material dispersion making intra modal dispersion zero over a small range of wavelength. Comment. The wavelength range is around 1.3 μm .
6. (a) Discuss the phenomenon of superconductivity. What is ‘critical-field’ in a superconductor? How it is affected by temperature? Write the functional relationship. Write application of a superconductor as an electrical switching element. 20
- (b) In a TDM digital communication system 774 voice samples (using 8 [?] bits/sample) and 36 control bytes are multiplexed in one frame. If the sampling rate for voice signals is 8000 sample/sec. calculate (i) frame duration in sec, (ii) bit rate of the system, (iii) if the upstream signal is higher in frequency than this bit rate (calculated in part ii) by 1 ppm, calculate the number of frames after which one negative stuffing byte will be provided. 20
- (c) Discuss how a CW radar extracts the Doppler frequency shift from a moving target with the stationary clutter echoes rejected. 20

7. (a) Discuss the processes involved in realizing the epitaxial growth, masking and etching for the fabrication of integrated circuits. 20
- (b) What are the considerations for choice of the differentiating and the integrating circuit used for separating the H and V sync pulses? Discuss with schematic and waveforms; how is ripple reduced at the integrating circuit. 20
- (c) Consider a Fabry Perot Laser diode made of InGaAsP with refractive index = 3.5. If the gain profile is $g(\lambda) = g_0 e^{-(\lambda - \lambda_0)^2 / \sigma^2}$ [?] (i) With $g_0 = 1500 \text{ m}^{-1}$, $\sigma = 10 \text{ nm}$ and distributive cavity loss, $\alpha = 1000 \text{ m}^{-1}$ find the lower limit of cavity length for lasing. (ii) If the cavity length, $L = 2000 \text{ }\mu\text{m}$, $\alpha = 500 \text{ m}^{-1}$ and $\lambda_0 = 1.5 \text{ }\mu\text{m}$, find the number of longitudinal modes in the output of the laser. 20
8. (a) Draw a schematic block diagram of a microprocessor based system for over-current protection. Describe the operation of the system. With the help of a flow chart or otherwise explain associated system software. 20
- (b) (i) What is load frequency control and why it is used? (ii) A 100 MVA synchronous generator is operating on full load at a frequency of 50 Hz. The load is suddenly reduced to 65 MW. Due to time lag in governor system, the steam valve begins to close after 0.5 second. Determine the change in frequency that occurs in this period of time. Assume $H = 5 \text{ MJ/MVA}$ of generator capacity. 20
- (c) In a 132-kV, 3-phase earthed-neutral transmission circuit, a 3-phase solid fault occurred at some distance from the circuit breaker in substation. The power factor of the faulted section of the circuit (between the breaker and the fault) was 0.3, the recovery voltage was 0.95 of the full rated value, the breaking current was symmetrical and the restriking voltage transient had a natural frequency of 16 kHz. Compute the average value of the rate-of-rise of restriking voltage (RRRV). 20