

ELECTRICAL ENGINEERING (Paper II)

Time Allowed : Three Hours

Maximum Marks : 250

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.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

SECTION 'A'

1. (a) For the block diagram shown in the figure given below, obtain $C(s)/R(s)$ using block diagram reduction technique:
 [Figure: Block diagram: $R(s) \rightarrow$ block $1/s \rightarrow$ summing junction 1 (this signal enters with $+$) $\rightarrow$ block $1/s \rightarrow$ summing junction 2 (this signal enters with $+$) $\rightarrow C(s)$. A feedforward line drops from the underside of the first $1/s$ block, runs along the bottom and enters summing junction 1 from below (no sign printed) and summing junction 2 from below (sign $+$)] 10
- (b) A system input (x)-output (y) is described by the relation

$$d^2y/dt^2 + 8dy/dt + ky = 50x(t)$$
 Evaluate the response $y(t)$ and its maximum value for an input $x(t) = 2.5u(t)$, $u(t)$ is a unit step function. Given $k=25$. 10
- (c) Name the different types of CROs and mention their applications. Find the velocity of electrons that have been accelerated through a potential of 2000 V in a CRO. 10
- (d) Explain the working of an LVDT with a Bourdon tube for the measurement of pressure. 10
- (e) Discussing the issues in memory addressing, explain the five addressing modes used in 8085. 10
2. (a) State the Nyquist stability criterion. Draw the complete Nyquist plot and therefrom check the stability of the closed-loop system whose open-loop transfer function is $G(s)H(s) = (K(s+4))/(s^2(s+1))$. 20
- (b) What is pipelining? Explain how it improves the performance of a processor. Discuss how BRANCH like instructions can be handled in a pipelined system. A machine language program has N instructions, each having m parts. Suppose each part can be executed in one cycle and there is no BRANCH like instruction in the program. How much time does a processor (i) with pipelining and (ii) without pipelining take to execute the program? 20
- (c) Explain the working of a successive-approximation type digital voltmeter using a block diagram. 10
3. (a) The transfer function of a control system is given by

$$Y(s)/U(s) = (s^2 + 3s + 4)/(s^3 + 2s^2 + 3s + 2)$$
 Derive the state model of the system in controllable phase variable form. Comment on the observability. What is the value of the smallest time constant of the system? 20

- (b) Explain the direct connection method of measurement of Q of a coil. Name the sources of error in such measurements. Compute the value of self-capacitance and inductance of a coil when the following measurements are made: At frequency 2 MHz, the tuning capacitor is set at 450 pF. When the frequency is measured to 5 MHz, the tuning capacitor is tuned at 60 pF. 20
- (c) What is 8255A PPI? Discuss its blocks—output ports and control logic. Write the instructions to load 65 H in register C and 92 H in accumulator A. Display the number of 65 H and 92 H at PORT 0 and PORT 1 respectively. 10
4. (a)(i) Briefly discuss the functional classification of the instruction set, explaining role and format of instructions from each category—data transfer, arithmetic/logic, branch and control. 10
- (a)(ii) Discuss the role and purpose of the three buses—address, data and control. Explain how they connect microprocessor CPU to ROM, RAM and I/O for data transfer. 10
- (b) What are the sources of errors in an electro-dynamometer type wattmeter? A dynamometer type wattmeter connected normally to read power in a 1-phase circuit indicates the value P_1 . A second reading P_2 is obtained when a capacitor of reactance equal to the pressure coil resistance is connected in series with the pressure coil. Show that the phase angle of the load can be obtained from the expression $\tan\phi = 1 - 2P_2/P_1$. 20
- (c) The open-loop transfer function of a unity feedback control system is given by

$$G(s) = K / (s(1 + 0.2s)(1 + 0.05s))$$
Determine the value of K so that the gain margin is 20 db. 10

SECTION 'B'

5. (a) An 11 kV, 50 MVA, 3-phase solidly grounded generator has fault currents at its terminals for different types of faults as follows: $I_{LLL} = 1870$ A, $I_{LL} = 2590$ A, $I_{LG} = 4130$ A. Determine p.u. values of sequence reactances of the generator. 10
- (b) A transmission line of inductance 0.1 H and resistance of 5 ohms is applied with a voltage $v = 100\sin(\omega t + \alpha)$, α represents the instant on voltage wave when short circuit occurs. What should be the instant of short circuit so that DC offset current is (i) zero and (ii) maximum? Assume supply frequency as 50 Hz. 10
- (c) Explain the advantages of numerical relays. 10
- (d) Explain the role of Protocol Data Unit (PDU) in communication within seven layers of OSI-ISO model. 10
- (e) Differentiate between the problems of error detection and correction. How many check/parity bits are required to correct a single error in a message of m bits? 10
6. (a) A synchronous generator is feeding 250 MW to a large 50 Hz power system network over a double-circuit line. The maximum steady-state power that can be transmitted over line with both the circuits in operation is 500 MW and is 350 MW with one circuit in operation. A solid 3-phase fault occurring at network end of one of the lines causes it to trip. Estimate critical clearing angle in which circuit breaker must trip so that synchronism is not lost. What further information is needed to estimate critical clearing time? 20
- (b) Obtain three zone settings for (i) a reactance relay and (ii) a mho relay of 60° from the following data: CT: 400/1 A, PT: 132 kV/110 V. Impedance for the first section is $(2.5 + j5)$ ohms (primary) and that of second section is $(3.5 + j7)$ ohms (primary). The first zone covers 80% of the first section, the second zone covers the first section plus 30% of the second section and the third zone covers the first section plus 120% of the second section. 20

- (c) Differentiate between the Pulse Code Modulation (PCM) and Delta Modulation (DM) explaining why DM is considered as a better alternative to PCM. How does the choice of the two parameters—quantization level (δ) and sampling interval T_s affect the performance-noise and accuracy/data rate? 10
7. (a)(i) Determine the equivalent $ABCD$ constants of Network-1 connected in tandem with Network-2 as shown in the figure given below:
 [Figure: Two two-port networks in tandem (each in a dashed box). Network-1 (A_1, B_1, C_1, D_1): a series impedance $Z=20\angle 30^\circ \Omega$ in the top line; input voltage V_1 and input current I_1 at the left; output current I and voltage V at the junction. Network-2 (A_2, B_2, C_2, D_2): a shunt impedance $Z_p=50\angle -45^\circ \Omega$ across the line; output voltage V_2 and output current I_2 at the right] 10
- (a)(ii) A transmission line has its electrical length of 5 electrical degrees. Find its physical length. The frequency of supply is 50 Hz. Express the physical length in terms of wavelength of the line. 10
- (b)(i) Draw the waveforms showing modulation of the binary signal 0011010010 using ASK, FSK and PSK. 10
- (b)(ii) What is Quadrature Phase Shift Keying (QPSK)? How does it help to improve the data transmission rate? 10
- (c) Draw the block diagram and explain various components involved in digital signal processing for a numerical relay. 10
8. (a) A system consists of two plants (plants 1 and 2) connected by a tie-line and load is located at plant 2. When 100 MW is transmitted from plant 1, a loss of 10 MW takes place on the tie-line. Determine the generation schedule at both the plants and the power received by the load when λ for the system is ₹ 25 per MW-hr and fuel inputs to the two plants are given by
- $$F_1 = 0.015P_1^2 + 17P_1 + 50 \text{ ₹/hr}$$
- $$F_2 = 0.03P_2^2 + 19P_2 + 30 \text{ ₹/hr}$$
- 20
- (b)(i) What are the advantages and limitations of air-blast circuit breaker? 10
- (b)(ii) It is required to install a circuit breaker for a 3-phase, 50 Hz, 220 kV, 500 MVA substation. Select the suitable circuit breaker along its specifications. 10
- (c) Describe the Cyclic Redundancy Check (CRC) scheme for error detection. Explain how the Frame Check Sequence (FCS) and divisor/pattern are chosen. Given a message $M=1010001101$ (10 bits), pattern $P=110101$ (6 bits), illustrate how FCS can be calculated. 10