

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. Answer all of the following:

10×5=50

- (a) An approximate Bode plot of magnitude for a system was obtained and is shown below. Identify the system in terms of minimum phase transfer function.

[Figure: Asymptotic Bode magnitude plot, vertical axis M_{dB} (ticks -20, 20, 40, 60 and 66), horizontal axis $\log \omega$ (ticks 0.1, 1.0, 10, 100, 1000). The plot starts at 66 dB at $\omega=0.1$ and falls at -20 dB/dec to $\omega=1.0$; it is then flat (0 dB/dec) from $\omega=1.0$ to $\omega=10$ (dashed horizontal line marks this level, drawn between 40 and 60, value not labelled); from $\omega=10$ to $\omega=100$ it falls at -20 dB/dec (dashed horizontal line marks the level reached at $\omega=100$, drawn between 20 and 40, value not labelled); beyond $\omega=100$ it falls at -40 dB/dec, crossing 0 dB between 100 and 1000 and continuing below -20 dB. Dashed vertical lines at $\omega = 1.0, 10$ and 100.]

- (b)(i) Write the various interrupts available in the microprocessor 8085 in the order of decreasing priority.
- (b)(ii) Specify multiplexed and non-multiplexed bus lines in 8085 microprocessor.
- (c) Explain the function of piezoelectric crystal as transducer. Specify its use in (i) Kitchen lighter (ii) Ultrasound diagnostic equipments (iii) Industrial cleaning machines.
- (d) Draw the typical characteristics of an IDMT Relay and explain how to use these curves.
- (e) Using symmetrical component theory for analysing an unbalanced fault, show that under certain circumstances, it is possible that the fault current for a S-L-G fault can exceed the fault current for a 3-phase fault in the same system.

2. (a) What is the effect of introducing derivative control action on the response of a system? A system has open-loop transfer function given by

$$G(s) = 10 / ((s+1)(s+4))$$

Evaluate the parameters of a PD controller with this system with unity feedback so that the closed loop system has poles located at $-3 \pm j4$. Indicate the nature of closed loop time response to unit step input change.

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- (b) For a 2-bus system shown below, derive expressions for Real Power and Reactive Power at receiving end and sending end.

[Figure: Single-line diagram: an a.c. generator ($\sim$) connected to the sending-end bus, voltage $|V_S| \angle \delta$, sending-end power $S_S = P_S + jQ_S$; a transmission line with constants A, B, C, D connects it to the receiving-end bus, voltage $|V_R| \angle 0$, which feeds a Load (arrow) with $S_R = P_R + jQ_R$.]

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- (c) An IDMT Relay has a current setting of 150% and has a time multiple setting of 0.5. The relay is connected in a circuit through a C.T. having a ratio of 500 : 5 amps. Calculate the time of operation of the relay if the circuit carries a fault current of 6,000 A. Use the table given below:

P.S.M.	2	3.6	5	8	10	15	20
Time in seconds for T.M.S. of 1.0	10	6	3.9	3.15	2.8	2.2	2.1

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3. (a) Draw the approximate time response of an underdamped second order system subjected to unit step input disturbance in desired value for the following cases of complex conjugate poles: (i) with constant real part (ii) with constant imaginary part (iii) with constant damping ratio. In each case consider at least 2 sets of values and mention the most important feature of the response. 20
- (b) (i) Draw the equivalent of a medium length transmission line using π -model. (ii) Assume that the receiving end is supplying a lagging power factor load. Draw the Phasor diagram showing all voltages and currents. (iii) Derive the A, B, C and D constants of this line in terms of line parameters Z and Y. 20
- (c) Explain what is meant by Bewley-Lattice diagram. What is the use of this diagram? 10
4. (a) Describe with a block diagram the Ramp type analog-to-digital conversion. Also draw the block diagram of Ramp type digital voltmeter. 20
- (b) Describe the various addressing modes in the microprocessor 8085. Give suitable examples for each addressing mode. 10
- (c) A sinusoidal signal is transmitted using P.C.M. The output signal to quantization noise is required to be 55.8 dB. Find the minimum number of quantization levels. Derive the equation used. 20

SECTION 'B'

5. Answer all of the following:

10×5=50

- (a) A plant has open-loop transfer function

$$G(s) = \frac{2}{s(1+0.1s)(1+0.5s)}$$
Determine the complete stability information of the unity feedback closed loop system by sketching Nyquist path and Nyquist plot.
- (b) Derive an expression for the Bandwidth of 'P.C.M.' system.
- (c) A channel with bit rate, $R_b = 36$ kbps is available for 'P.C.M.' voice transmission. Find the appropriate values of binary digits N, the number of quantization levels (M) and the sampling rate (f_s), assuming $f_m = 3.2$ kHz.
- (d) Explain the importance of adding impedance in the neutral path of an alternator.
- (e) An analog transducer with a 0 – 10 V input is able to distinguish a change of 1 mV in its signal. Calculate (i) its resolution (ii) the minimum number of bits of ADC so that the digital output has almost the same resolution as transducer. Also calculate the (iii) quantization interval and (iv) number of decision levels.

6. (a)(i) LVDT with bellow is used for measuring the pressure. Draw the circuit diagram of LVDT-bellow system. 6
- (a)(ii) The sensitivity of LVDT-bellow system is 40 V per mm. The bellows are deflected by 0.15 mm by a pressure of 1.0×10^6 N per m^2 . Determine the pressure when the output voltage of LVDT is 3.9 V. 14

- (b) Explain: (i) Direct addressing (ii) Register indirect addressing (iii) Immediate addressing (iv) Register addressing. 20
- (c) The parity check matrix $\bar{H}$ of a linear (7, 4) block code is given by

$$\bar{H} = \begin{bmatrix} 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 & 1 \end{bmatrix}$$

Determine the coded word for the data 0101. 10
7. (a) For a position control system as shown in the figure below, determine the range of compensator gain K and the location of zero in left half for which the system is stable.
[Figure: Unity negative feedback block diagram: input R(s) (Desired position) enters a summing junction with sign +; the summing junction output feeds the Compensator block $(K(s+a))/((s+1))$ in cascade with the Plant block $1/(s(s+2)(s+3))$, whose output is Y(s) (Actual position); Y(s) is fed back directly (unity) to the summing junction with sign -.] 20
- (b) Explain hardware single stepping used in 8085 microprocessor. 20
- (c) Derive the expression for maximum signal to quantization noise ratio for sinusoidal message input when waveform coding is done by D.M. under no-slope overload condition. 10
8. (a)(i) A system is modelled in state-space form as

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -7 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

 $C = [3 \ 4 \ 0]$. Draw the signal flow graph and obtain the transfer function. 10
- (a)(ii) Define state controllability of a system. Apply the controllability test to determine the controllability of a system modelled by the state-space model as

$$\dot{X} = \begin{bmatrix} -2 & -2 & 0 \\ 0 & 0 & 1 \\ 0 & -3 & -4 \end{bmatrix} X + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

 $y = [1 \ 1 \ 0]X$. 10
- (b) In a 220 kV, 50 c/s power system, the reactance and capacitance upto the circuit breaker are 8 ohms and 0.025 μF respectively. A resistance of 600 ohms is connected across the circuit breaker contacts. Determine the following: (i) Natural frequency of oscillation (ii) Damped frequency of oscillation (iii) Value of Critical Resistance which will give no transient oscillations (iv) The value of resistance which when connected across circuit breaker contacts will give damped frequency of oscillation of one-fourth of the natural frequency of oscillation. 20
- (c) Show how unit protection principle can be employed in balanced voltage system. 10