

S

A-GTD-O-FDAA

ELECTRICAL ENGINEERING

Paper—I

(Conventional)

Time Allowed : Three Hours

Maximum Marks : 200

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions :

Candidates should attempt FIVE questions in all.

Question No. 1 is compulsory.

Out of the remaining SIX questions attempt any FOUR questions.

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

Answers must be written in ENGLISH only.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary, and indicate the same clearly.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

Attempts of questions shall be counted in chronological 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 answer book must be clearly struck off.

1. (a) Determine the Thevenin Resistance for the circuit shown in Fig. 1(a). 10

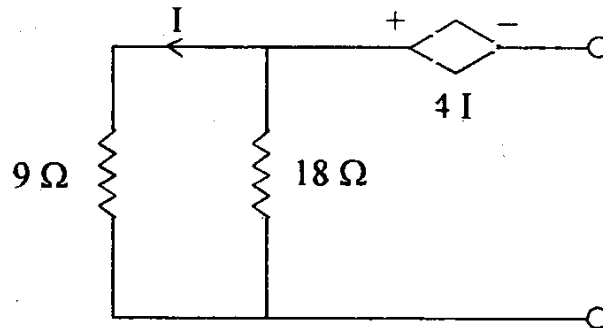


Fig. 1(a)

- (b) Determine current I through the $10\ \Omega$ resistances shown in Fig. 1(b) below : 10

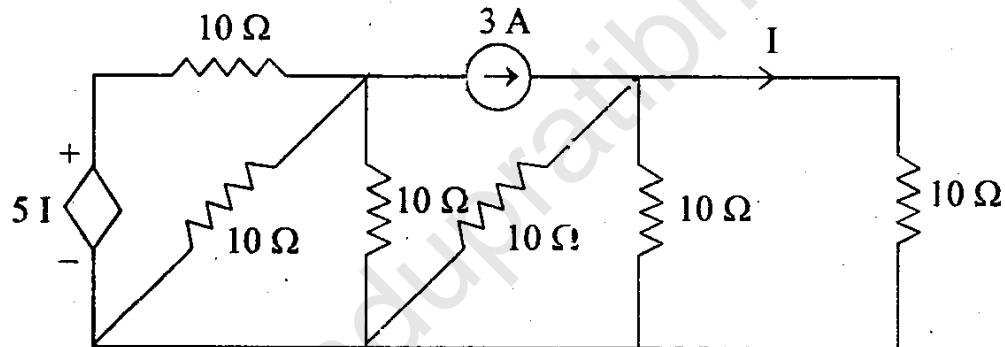


Fig. 1(b)

- (c) A PMMC instrument has full scale deflection current of $1\ \text{mA}$ and internal resistance of $50\ \Omega$. How this can be converted into an $1\ \text{A}$ ammeter and $100\ \text{V}$ voltmeter ? How the above instrument can be converted to read ac voltages ? 10
- (d) What are different types of Electrical resistance strain gauges ? Strain gauge with gauge factor of 2 is fastened to a metallic member subjected to a stress of $1000\ \text{kg/cm}^2$. The modulus of elasticity of metal is $2 \times 10^6\ \text{kg/cm}^2$. Calculate percentage change in resistance of the strain gauge. What is the value of Poisson's ratio ? 10

- (e) A wattmeter is connected as indicated in the following Fig. 1(e).

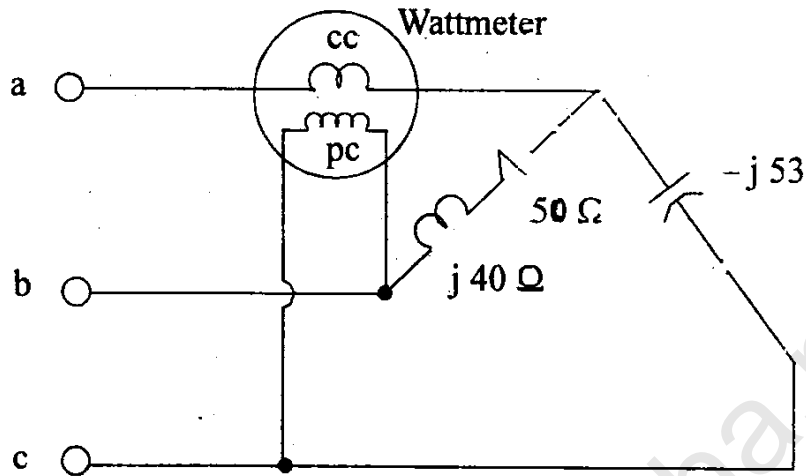


Fig. 1(e)

Calculate the wattmeter reading, assuming, 3 phase, 400 volts, 50 Hz balanced supply, with phase sequence abc. 10

- (f) Consider the feedback control system shown in Figure given below :

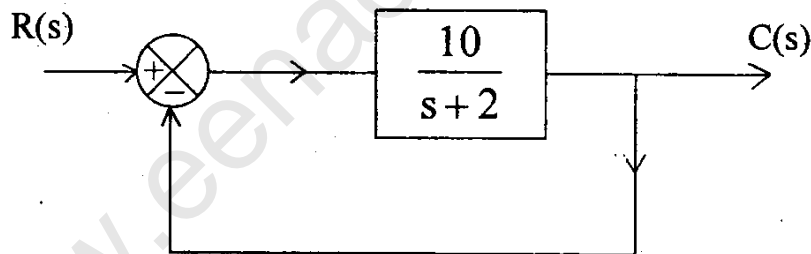


Fig. 1(f)

The above system is subjected to unit impulse input.

- (i) Obtain the expression for $c(t)$ and time constant.
- (ii) If the feedback loop is opened, what would be $c(t)$ and the associated time constant ?
- (iii) In which of the above two cases, the response would be faster ? 10

(g) For the feedback control system shown below,

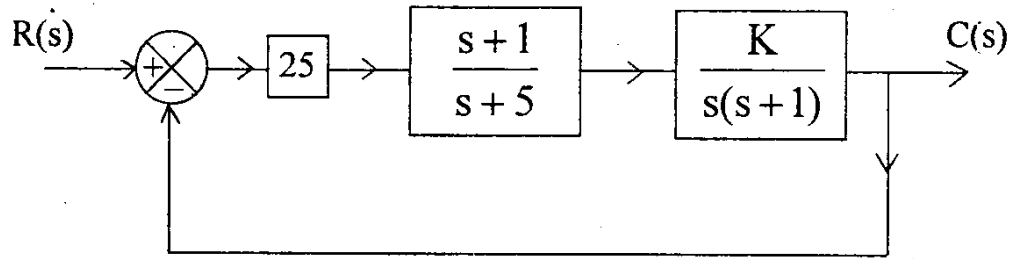


Fig. 1(g)

determine the sensitivity of closed loop transfer function with variation in parameter 'K' at $\omega = 1.5$ rad/sec. Assume, the normal process parameter value of K is 1. 10

(h) List at least two essential properties of each material that are necessary for construction of medium rating power transformer. 10

2. (a) Two mutually coupled identical coils are connected in series having self inductance $L = 4$ mH and mutual inductance $M = 2$ mH, what is the maximum ratio of two possible values of effective inductances ?

Determine the coefficient of coupling between the two coils. 10

(b) The following readings were observed when measuring a voltage.

S. No.	1	2	3	4	5	6	7	8
Volts	532	548	543	535	546	531	543	536

Calculate :

- (i) Average deviation
- (ii) Standard deviation
- (iii) Probable error of one reading. 10

- (c) Determine the E field using Gauss's law caused by a spherical cloud of electron with a volume charge density

$$P_v(r, \theta, \phi) = P_o \frac{r}{a} ; 0 < r < a$$
$$= 0 ; a \leq r < \infty. \quad 10$$

3. (a) Determine the value of the variable resistor R in Fig. 3(a) such that maximum power is absorbed by 2 ohm resistor. 10

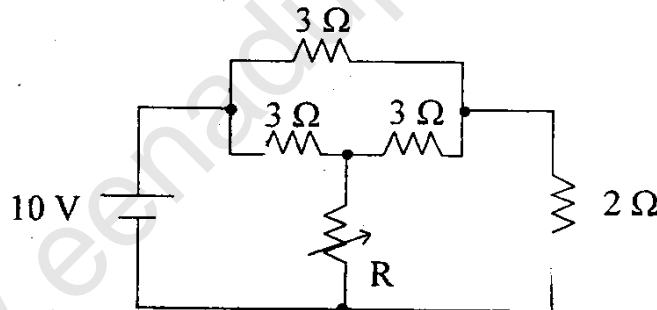


Fig. 3(a)

- (b) A current of $-8 + 6\sqrt{2} \sin(\omega t + 30^\circ)$ amperes is passed through a centre zero PMMC meter and moving iron meter. What would be their readings? 10

- (c) If we consider yz-plane of a Cartesian co-ordinate system as an interface between two dielectric

mediums having $\epsilon_1 = 5 \epsilon_0$ ($x > 0$) and $\epsilon_2 = 3 \epsilon_0$ ($x < 0$), then find the expressions for D_1 and E_1 in medium 1 and D_2 in medium 2 with known electric field in medium 2 is $\bar{E}_2 = 10\bar{i}_x + 20\bar{i}_z$.

10

4. (a) A two port network follows the following voltage-current relations :

$$I_1 = 2V_1 - V_2$$

$$2I_2 = -2V_1 + 4V_2$$

Determine z-parameters of the network and its T-equivalent circuit.

10

- (b) The field of a dc servomotor is separately excited by means of a dc amplifier of gain $K_A = 90$. A voltage proportional to field current is now feedback negatively to the amplifier input as indicated in following figure. Determine the value of K so that field time constant is reduced to 4 millisecond.

10

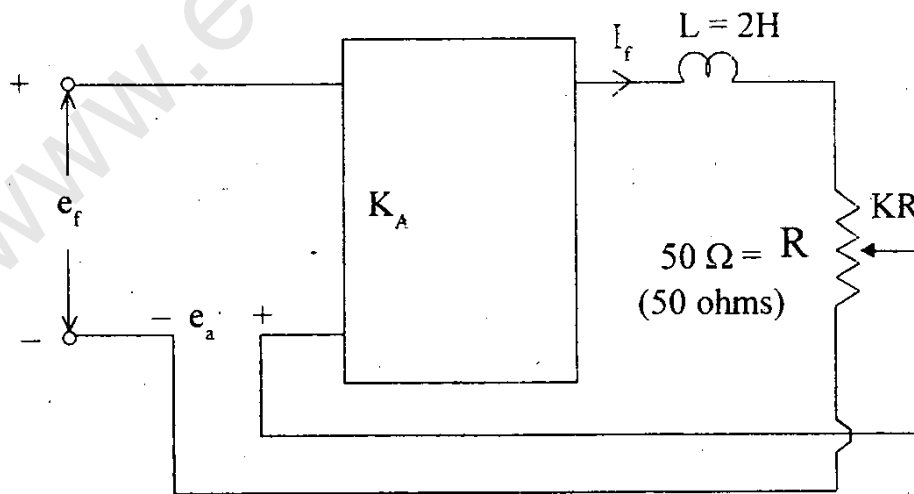


Fig. 4(b)

- (c) Explain the behavior of ferromagnetic materials above and below the Curie temperature. 10
5. (a) Show that the voltage V across R shown in Fig. 5(a) is independent of R at radian frequency ω of voltage source when $\omega^2 L_1 C_1 = \omega^2 L_2 C_2 = 1$. Find also the expression of this voltage. 10

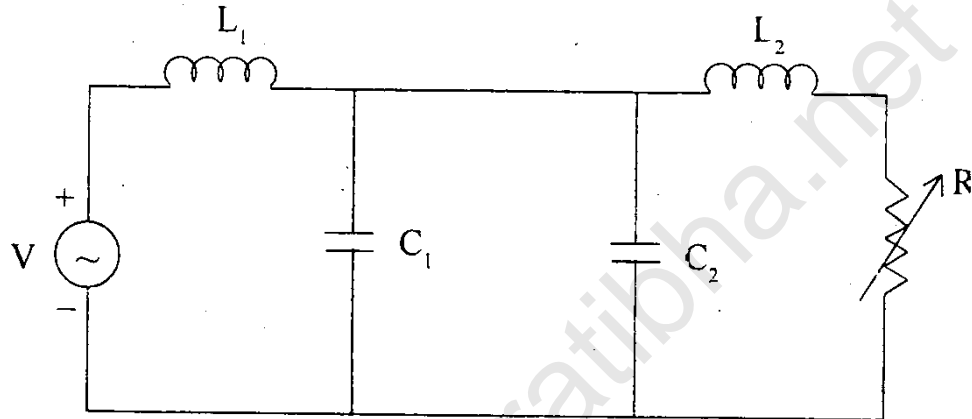


Fig. 5(a)

- (b) A unity feedback control system is characterised by openloop transfer function

$$G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$$

Using Routh's criteria, determine the value of gain 'K' for which system will be limitedly stable? Also, determine the closed loop poles for this value of 'K'. 10

- (c) What is the term $\sigma/\omega\epsilon$ called in the study of EM waves? Find general expression of attenuation constant α and relate with skin depth δ . Prove that the skin depth δ is independent of frequency when $\sigma/\omega\epsilon \ll 1$ (poor conductor) and decreases with frequency when $\sigma/\omega\epsilon \gg 1$ (good conductor). 10

6. (a) Find all the four canonical forms of the impedance $z(s) = s + 1$. State if you observe some speciality in these realisations. 10
- (b) The system is described by $G(s) = \frac{K(s^2 + 6s + 10)}{s^2 + 2s + 10}$, $H(s) = 1$. Obtain $K = 0$, $K = \infty$ points in root-loci. Show that the root-loci are arcs of a circle centred at origin with radius equal to $\sqrt{10}$. 10
- (c) How the four quantities E, D, H and B are related to each other in static and time varying fields? Name the relation as laws. Give the value of divergence and curl of each quantity. 10
7. (a) Determine overall z-parameters when two identical 2-port networks with $z_{11} = z_{12} = z_{21} = z_{22} = 2\Omega$ are connected in cascade. 10
- (b) The block diagram of the system is shown in Fig. 7(b) given below :

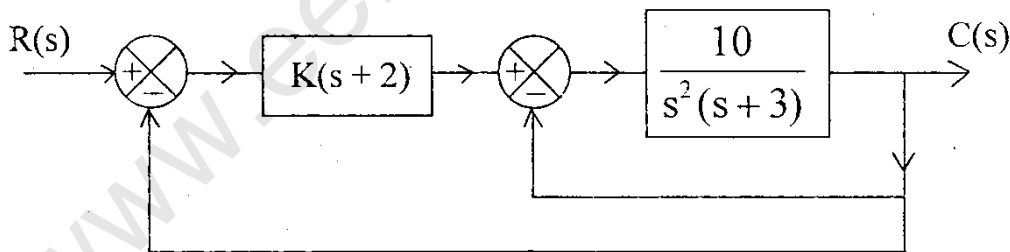


Fig. 7(b)

Obtain the phase crossover frequency. 10

- (c) What is the difference between the coaxial cable used for power line and the one used in an electronic circuit? Derive an expression of capacitance for such a cable per unit length. 10

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