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Question Paper Code : 51006

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Second Semester

Electrical and Electronics Engineering

EE 3251 — ELECTRIC CIRCUIT ANALYSIS

(Common to : Electronics and Instrumentation Engineering/Instrumentation and Control Engineering)

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Determine the voltage across 20 ohm resistor of the network shown in Fig. 1, [Fig. 1: 5 V source with 10 ohm directly across it; 8 ohm along the top to the right side; 20 ohm connected diagonally from the top-left node to the bottom-right corner; 12 ohm on the right side]
2. A 60-W incandescent bulb operates at 120 V. How many electrons and coulombs flow through the bulb in one day?
3. Write the condition for maximum power transfer in alternating current circuits, if the load consists of a purely variable resistance.
4. State Norton's theorem.
5. Define time constant of RL circuit.
6. In a series RLC circuit if $R = 10\ \Omega$, $L = 5\text{H}$ and $C = 2\text{mF}$, find Neper frequency and resonant frequency.
7. Two coupled coils with the self inductances 50 mH and 200 mH have a coupling coefficient of 0.5. Find the value of its mutual inductance.
8. Write the formula for calculating Q-factor of a parallel resonant circuit.
9. Two wattmeter method is used for power measurement in a three phase circuit. If the power factor is unity, what could be its effect on wattmeter readings?
10. Write two important advantages of 3 phase systems.

PART B — (5 × 13 = 65 marks)

11. (a) Using nodal analysis, determine the voltages at each node of the circuit shown in Fig. 11(a). [Fig. 11(a): 10 V source in series with 10 ohm to node 1; 5 ohm from node 1 to ground; two 3 ohm resistors in parallel between node 1 and node 2; 5 A current source into node 2; 2 ohm between node 2 and node 3; 1 ohm and 6 ohm from node 3 to ground]

Or

- (b) For the circuit in Fig. 11(b), Find the branch currents I_1 , I_2 , I_3 using mesh analysis. [Fig. 11(b): 15 V source on the left; 5 ohm (current I_1) along the top to a middle node; middle branch of 10 ohm in series with a 10 V source (current I_3 downward); 6 ohm (current I_2) along the top to the right; 4 ohm on the right side; mesh currents i_1 and i_2]
12. (a) Obtain the Norton equivalent for the circuit shown in Fig. 12(a) and hence determine the current through the load resistance. [Fig. 12(a): battery $B_1 = 28$ V with $R_1 = 4$ ohm to the middle node; load $R_2 = 2$ ohm from the middle node to the bottom line; $R_3 = 1$ ohm from the middle node to battery $B_2 = 7$ V]

Or

- (b) Calculate I_0 in the circuit shown in Fig. 12(b). [Fig. 12(b): 24 V source delivering I_0 ; left leg of 20 ohm over 10 ohm and right leg of 60 ohm over 50 ohm, both tops joined to the source; 40 ohm between the midpoints of the two legs; 20 ohm along the bottom between the lower ends of the legs]
13. (a) Find $i(t)$ in the circuit shown in Fig. 13(a) for $t > 0$. Assume that the switch has been closed for a long time. [Fig. 13(a): 10 V source, 2 ohm and 3 ohm in series with a $\frac{1}{3}$ H inductor carrying i ; the switch, which operates at $t = 0$, is connected across the 3 ohm resistor]

Or

- (b) A series RC circuit consists of resistor of 10 ohm and capacitor of 0.1 F connected to a constant voltage of 20 V through a switch S. Assume that the switch is closed at $t = 0$, obtain the current equation and determine the voltages across the resistor and capacitor.
14. (a) A voltage $v(t) = 10 \sin \omega t$ is applied to a series RLC circuit. At resonant frequency of the circuit, the maximum voltage across the capacitor is found to be 500 V. Also the bandwidth is 400 rad/sec and impedance at resonance is 100 ohm. Find the resonant frequency. Also find the values of L and C of the circuit.

Or

- (b) A coil having a resistance of 10 ohm and an inductance of 125 mH is connected in series with a 60 microF capacitor across a 120 V supply. At what frequency does resonance occur? Find the current flowing at the resonant frequency.
15. (a) A star-connected system has a balanced voltage of 440 V, the load impedances are $Z_1 = (3 + j2)$ ohm, $Z_2 = (4 + j5)$ ohm and $Z_3 = (6 + j3)$ ohm. Determine the phase voltages for a unbalanced star-connected load.

Or

- (b) An unbalanced four-wire, star-connected load has a balanced voltage of 400V, the loads are $Z_1 = (4 + j8)$ ohm, $Z_2 = (3 + j4)$ ohm and $Z_3 = (15 + j20)$ ohm. Calculate the line currents, current in the neutral wire and the total power.

PART C — (1 × 15 = 15 marks)

16. (a) Find the equivalent resistance across the terminals A and B of the network shown in Fig. 16(a), using star-delta transformation. [Fig. 16(a): outer triangle with A at bottom-left and B at bottom-right; 1 ohm from A to the top vertex, 1 ohm from the top vertex to B, 1 ohm directly from A to B; inside, 2 ohm from the top vertex to a centre node, 3 ohm from the centre node to an inner left node and 4 ohm from the centre node to an inner right node; 5 ohm between the inner left and inner right nodes; 2 ohm from A to the inner left node and 2 ohm from the inner right node to B]

Or

- (b) Find the currents I_1 , I_2 , I_3 for the circuit shown in Fig. 16(b). [Fig. 16(b): 24 V source feeding a bridge network of $R_1 = 150$ ohm and $R_2 = 50$ ohm (upper arms), $R_4 = 300$ ohm and $R_5 = 250$ ohm (lower arms) and $R_3 = 100$ ohm across the middle; mesh currents I_1 (upper bridge loop), I_2 (lower bridge loop) and I_3 (source loop)]
