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Question Paper Code : 30146

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

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. Find "Req" for the circuit shown in Figure 1. [Fig. 1: three 30 ohm resistors drawn in a row between the two Req terminals; a wire joins the left end of the first resistor to the junction of the second and third, and another wire joins the junction of the first and second to the right end of the third]
2. Identify the leading vector and the leading angle from the phasor diagram as shown in Figure 2. [Fig. 2: two phasors A (pointing up-right) and B (pointing up-left) with 60° between them]
3. Find the value of 'T' in the circuit shown in Figure 3. [Fig. 3: 5 V source, 3 A current source and 5 ohm resistor all in series]
4. Find the value of 'Rth' for the circuit shown in Figure 4. Assume maximum power is transferred to the load. [Fig. 4: Thevenin's source in series with Rth feeding a load of $3 + j4$ ohm]
5. Find the time constant for RL and RC series circuit. Assume the circuit is excited with D.C source.
6. A capacitor 'C' is initially charged to a value 'Vc' when it is connected to a D.C. voltage source of value 'Vo'. Calculate Vc(t).
7. In a RLC series circuit, write the expression of the frequency at which the voltage across the capacitor is maximum.
8. Find the expression for the total inductance of the circuit as shown in Figure 5. [Fig. 5: coils LA and LB connected in series with mutual inductance M between them; dot at the left end of LA; current i]
9. What are the advantages of three phase system?
10. In a two wattmeter measurement system, identify the value of power factor angle for which one of the wattmeter will show zero reading?

PART B — (5 × 13 = 65 marks)

11. (a) Find the value of 'Vo' in the circuit shown in Figure 6. [Fig. 6: current sources 3 A, 2 A and 1 A (all upward) connected to three top nodes joined by 3 ohm (between the 3 A and 2 A nodes) and 2 ohm (between the 2 A and 1 A nodes); 1 ohm from the 1 A node to a 4 ohm resistor on the right; a 1.5 ohm resistor across the top from the left node to the right node, with Vo marked across it]

Or

- (b) Find the range of 'Rin' for the circuit shown in Figure 7. [Fig. 7: ladder network seen from the input terminals (Rin): 1 ohm shunt, 2 ohm series, 3 ohm shunt, 4 ohm series, and a variable resistor R as the final shunt]
12. (a) Find the Norton's equivalent across the terminals 'a' and 'b' for the circuit shown in Figure 8. [Fig. 8: 5 ohm in series with a 2 V source, in parallel with a 5 A current source (downward) and a 2 ohm resistor, connected to terminals a and b]

Or

- (b) Find 'v' using superposition theorem for the circuit shown in Figure 9. [Fig. 9: 4 V source in series with 3 ohm (voltage v across it) to a node; 2 A current source from ground into that node; 2 ohm to a second node; 5 ohm from the second node to ground; 1 ohm from the second node to a dependent voltage source 2v]
13. (a) In the circuit shown in Figure 10, the battery voltage is applied for a steady state period. Obtain the complete expression for the current after closing the switch 'K'. [Fig. 10: battery E = 10 V in series with R1 = 1 ohm, R2 = 2 ohm and L = 1 H; switch K connected across R2]

Or

- (b) A capacitor of 5 microfarad is being charged to 10 V is connected to a resistance of 10 kohm and is allowed to discharge through it by closing a switch 'K'. Find the expression of discharging current.
14. (a) Determine the relationship between the resonance frequency and the half power frequencies of a series resonating circuit.

Or

- (b) Following data refers to two coupled coils 1 and 2 (Figure 11). $\Phi_{11} = 0.5$ mWb, $\Phi_{12} = 0.3$ mWb, $N_1 = 100$ turns, $N_2 = 500$ turns; $i_1 = 1$ A. Find coefficient of coupling, inductances L1, L2 and M. [Fig. 11: two coupled coils of N1 and N2 turns on a common core, current i1 in coil 1, leakage flux Φ_{11} and mutual flux Φ_{12}]
15. (a) A balanced three phase star connected load is connected across a 11 kV, 50 Hz, three phase supply. If the load consumes 150 kW and takes a leading current of 100 A, find the circuit constants of the load on per phase basis.

Or

- (b) Three identical resistances are connected in a star fashion, against a balanced three phase voltage supply. If one of the resistances is removed, calculate the reduction in power.

PART C — (1 × 15 = 15 marks)

16. (a) In the circuit shown in Figure 12, value of all the resistances is 1 ohm Calculate R_{AB} . [Fig. 12: symmetrical network of 1 ohm resistors forming three nested rectangles joined at their corners by diagonal resistors, with terminal A at the centre (where the inner diagonal resistors cross) and terminal B at the middle of the bottom side of the outer rectangle]

Or

- (b) Find the value of 'RL' (Figure 13) so that the efficiency of the circuit becomes 50%. [Fig. 13: 12 A current source in parallel with 10 ohm (current I_x downward); dependent voltage source $5I_x$ (- + from left to right) in the top line; 3 A current source and load RL in parallel on the right]
