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**Question Paper Code : 40976**

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024.

Second Semester

Electronics and Communication Engineering

**EC 3251 — CIRCUIT ANALYSIS**

(Common to : Electronics and Telecommunication Engineering)

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

**PART A — (10 × 2 = 20 marks)**

1. Recall current division law and Voltage division law.
2. Find the current  $I$  for the circuit as shown in Fig.1 [Fig.1: from terminal A, current  $I$  flows through 1 ohm, a 10 V source (+ on the left), 2 ohm, a 20 V source (+ at top), 5 ohm and a 6 V source (+ on the left) to terminal B, all in series]
3. Find the equivalent resistance of the circuit shown in Fig.2 [Fig.2: bridge between terminals A (top node) and B (bottom node): 30 ohm from top to left node, 60 ohm from top to right node, 75 ohm from left node to bottom, 15 ohm from right node to bottom, 90 ohm between left and right nodes]
4. Determine the Norton's equivalent circuit at terminals AB for the circuit shown in Fig.3 [Fig.3: 20 V battery on the left in series with 10 ohm to the middle node; 5 ohm from the middle node to a 10 V battery on the right; terminal A at the middle node and terminal B on the bottom line]
5. A resistor having a resistance of 10 ohm and an unknown capacitor are in series. The voltage across the resistor is  $V_R = 40 \sin(1000t + 45^\circ)$ . If the current leads the applied voltage by  $45^\circ$ , what is the unknown capacitance?
6. In a pure inductive circuit, will the current lead or lag the voltage. Draw its phasor diagram.
7. Determine the value of  $L$  and  $C_2$  for the circuit shown in fig.4. It has to pass a 5000Hz wave and block a 7000 Hz wave. [Fig.4: between two terminals,  $L$  in series with  $C_1 = 0.5 \mu\text{F}$ , in parallel with  $C_2$ ]
8. What is the time constant of a series R-L circuit having  $R = 2 \text{ ohm}$ ,  $L = 10\text{H}$ ?
9. For the shown in Fig.5, draw any two tree structures [Fig.5: oriented graph with outer nodes 1, 2, 3 and a centre node; branch a from 1 to 2, b from 2 to 3, f from 3 to 1, c from 1 to centre, d from centre to 3, e from 2 to centre]

10. Two coupled coils having self-inductance  $L_1 = 50\text{mH}$  and  $L_2 = 200\text{ mH}$  and a coefficient of coupling  $K = 0.5$ . If coil 2 has 1000 turns and  $i_1 = 5 \sin 400t$ . Find the voltage at coil 2.

**PART B — (5 × 13 = 65 marks)**

11. (a) Determine the power dissipated in the 10 ohm resistor shown in Fig.6 [Fig.6: 15 A current source (arrow up) and two 8 ohm resistors in parallel on the left; top line 4 ohm, 2 ohm and 4 ohm in series; the 10 ohm shunt between the first 4 ohm and the 2 ohm; a 4 ohm shunt after the 2 ohm; 32 V battery on the right; a 12 A current source (arrow to the right) connected from the top of the left section to the node of the 4 ohm shunt]

Or

- (b) Determine the currents in various branches of the circuit shown in Fig.7 by mesh analysis [Fig.7: 50 V battery on the left; top line 5 ohm and 2 ohm; 3 ohm from the junction down to the middle line; 6 ohm on the right; middle line 4 ohm and a 20 V battery (- on the left, + on the right); bottom line 8 ohm]
12. (a) Compute the current in 23 ohm resistor using Superposition theorem for the circuit shown in Fig.8 [Fig.8: from left to right between top and bottom lines: 27 ohm; 47 ohm in series with a 200 V source (+ at top); then 4 ohm in the top line; 20 A current source (arrow up); 23 ohm]

Or

- (b) (i) Obtain dual of the network shown in Fig.9 [Fig.9: source  $100 \sin \omega t$  in series with a 3 F capacitor on the left; top line 2 ohm to node P, then an element marked 5 ohm (drawn as an inductor) to node Q; bottom line 0.25 H and 0.1 F in series to node R; 3 ohm from P to R; 7 ohm from Q to R; 5 F from Q to node S; 6 ohm from R to S] (6)
- (ii) Find the power loss in the 1 ohm resistor by applying Thevenin's theorem for the circuit shown in Fig.10 [Fig.10: 2 A current source (arrow up); 10 ohm in series with a 10 V source (+ at top); 5 ohm; and the 1 ohm load across terminals x-y, all in parallel] (7)
13. (a) Find the branch current for the circuit shown in Fig.11 [Fig.11: 5 angle 30 deg V source on the left;  $-j2$  ohm capacitor shunt;  $-j5$  ohm capacitor in the top line;  $j3$  ohm inductor in the bottom line;  $j5$  ohm inductor shunt; 10 angle 60 deg V source on the right]

Or

- (b) (i) Find the admittance  $Y_{AB}$  for the circuit shown in Fig.12. The Supply frequency is 50 Hz. [Fig.12: across A-B three parallel branches: 10 ohm; 5 ohm in series with 100 mH; 20 ohm in series with 100 microF] (6)
- (ii) A series RC circuit has the following parameter values,  $R = 10\text{ ohm}$ ,  $C = 0.02\text{ microF}$ , voltage source  $e(t) = 10 \sin 100t$ . Find the power dissipated and power factor. (7)
14. (a) In the circuit shown in Figure 13, the switch K is closed at position A at  $t = 0$ . After the lapse of time equivalent to one time constant, the switch is moved to position B. Determine the complete current. [Fig.13: switch K connects a series 500 ohm - 0.2 uF branch either to position A (10 V source, + at top) or to position B (20 V source, - at top)]

Or

- (b) (i) A coil having a Q-factor of 100 is connected in parallel with a capacitor of 100 pF. The circuit resonates at a frequency of 5 MHz. Determine. (1) the BW of the circuit (2) the amount of resistance required in parallel to increase the BW to 250 KHz (3) the amount of resistance required in series with the inductor in order to produce the same Bandwidth. (7)
- (ii) A current source is applied to the parallel R, L, C circuit, where  $R = 12$  ohm,  $L = 2$  H and  $C = 3$  microF. Compute the resonant frequency, quality factor, bandwidth. Compute the lower and upper cut-off frequencies and the voltage across the parallel elements, when the input signal is  $i(t) = 10 \sin 1800 t$ . (6)
15. (a) For the circuit shown in Fig.14. Find the ratio of output voltage  $V_2$  to the input voltage  $V_1$ . [Fig.14: source  $V_1 = 10$  V,  $\omega = 50$  rad/sec in series with 10 ohm (current  $i_1$ ) and a 10 H primary coil; secondary 100 H coil (current  $i_2$ ) across a 400 ohm load with output voltage  $V_2$ ; mutual inductance 5 H; dots at the top of both coils]

Or

- (b) The reduced incidence matrix of a network is given below. Draw the oriented graph. Choose a suitable tree and write the basic cut-set matrix. [Matrix, rows = nodes 1 to 6, columns = elements 1 to 8: node 1: 1 0 0 -1 0 0 1 0; node 2: 0 0 1 0 -1 0 1 0; node 3: 0 1 0 0 0 -1 -1 0; node 4: 0 -1 0 0 1 0 0 0; node 5: -1 0 0 0 0 0 0 0; node 6: 0 0 0 1 0 0 0 0]

**PART C — (1 × 15 = 15 marks)**

16. (a) (i) Find the voltage drop across the capacitor and resistor as shown in Fig.15 [Fig.15: source  $V = 5$  angle 45 deg in series with 3 ohm and  $j4$ ; a  $j5$  shunt coil coupled to the  $j4$  coil with mutual reactance  $j3$  (dots at the left of  $j4$  and the top of  $j5$ ); a  $-j6$  capacitor in parallel with the  $j5$  coil; mesh current  $I_2$ ] (8)
- (ii) In the coupled coil circuit shown in Fig.16, Prove that  $|I_1|/|I_2| = (L_2/M) [1 + R_2^2/(\omega^2 L_2^2)]^{1/2}$  [Fig.16: primary:  $V_1$  drives current  $I_1$  through coil  $L_1$  (dot at top); secondary: coil  $L_2$  (dot at bottom) in series with  $R_2$ , current  $I_2$ ; mutual inductance  $M$ ] (7)

Or

- (b) Calculate the current in 20 ohm resistor using Thevenin's theorem for the circuit shown in Fig.17 and verify the results using Norton's theorem. [Fig.17: 10 V source in series with 1 ohm (current  $i$ ); 1 A current source (arrow up) and 3 ohm as shunt branches; a dependent current source  $2i$  in the top line feeding a 2 ohm resistor on the right]
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