ELECTRICAL ENGINEERING 080097

Time : 3 hours *Full Marks* : 200

Instructions :

(1) Answer Question No. ***1*** *which is compulsory and any* ***nine*** *from the rest.*

(2) The figures in the margin indicate full marks for the questions.

1. *(a)* Determine the current in 20 Ω resistor of the network shown in Fig. 1 using Thevenin's theorem : 5

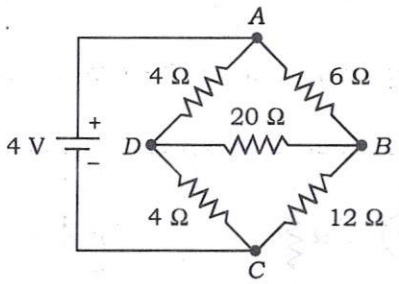

Fig. 1

(b) Find the transfer function $G(s) = X(s) / F(s)$ for the translational mechanical network shown in Fig. 2 : 5

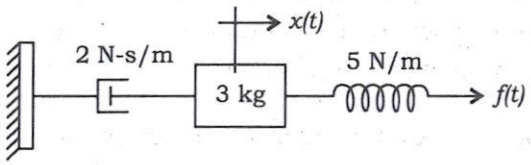

Fig. 2

(c) State three differences between RTD and thermistor. 3

(d) The potential field is given as $V = 2x^2y - 5z$. Find at point $P(-4, 3, 6)$, the potential (V), the electric field intensity (E) with its direction and the electric flux density (D). 4

(e) State two differences between lap winding and wave winding. 3

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2. *(a)* Use mesh current analysis to find the voltage V_x across the current source of Fig. 3 :

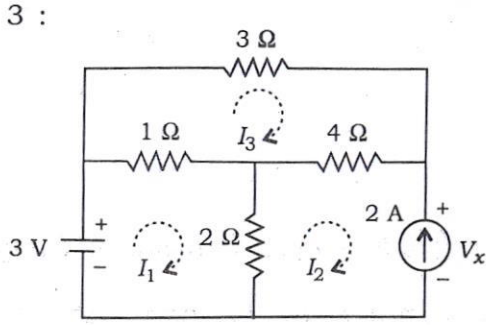

Fig. 3

(b) A balanced 3-phase star-connected load of 120 kW takes a leading current of 100 A when connected across a 3-phase, 3·3 kV, 50 Hz supply. Determine the impedance, resistance, capacitance and power factor of the load.

(c) Determine the time constant of the circuit shown in Fig. 4 :

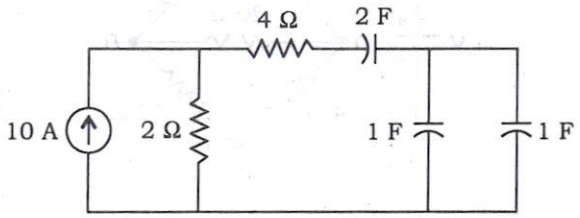

Fig. 4

(d) A 10 mH coil in series with a loss-free capacitor is connected to a variable frequency source which supplies a constant voltage of 10 V. The circuit has a maximum value of 0·1 A at a frequency of 80 kHz. Calculate *(i)* the capacitance of the capacitor and *(ii)* the *Q*-factor of the coil and the half-power frequencies. 5

3. *(a)* State maximum power transfer theorem in an a.c. network. 2

(b) The resonant frequency of the tuned circuit shown in Fig. 5 is 1000 rad/s. Calculate the self-inductances of the two coils and critical value of mutual inductance : 7

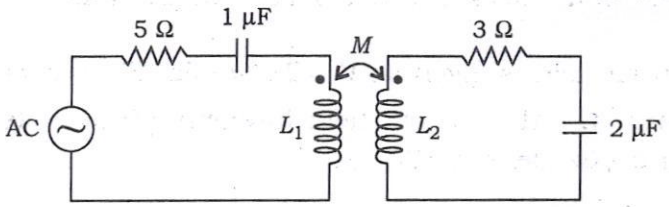

Fig. 5

(c) Distinguish between linear and non-linear system with a suitable example. 3

(d) State controllability and observability of a system. 3

(e) Find the h-parameter of the circuit shown in Fig. 6 : 5

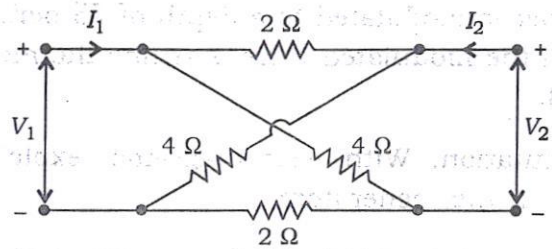

Fig. 6

4. (a) Define short-circuit ratio (SCR) of an a.c. generator. State three significances of SCR. 4

(b) What is meant by back e.m.f. in a d.c. motor? Derive the torque equation of a d.c. motor. 6

(c) A separately excited d.c. motor has an armature resistance of 0·5 Ω. It runs on a 250 V d.c. supply drawing an armature current of 20 A at 1500 r.p.m. Find the torque developed for armature current of 10 A for same field current. 5

(d) A 3-phase star-connected alternator is rated at 1600 kVA, 13·5 kV. The armature effective resistance and synchronous reactance are 1·5 Ω/phase and 30 Ω/phase respectively. Calculate the percentage voltage regulation for a load of 1280 kW at 0·8 leading power factor. 5

5. (a) The open-loop transfer function of a control system is given by

$$G(s) = \frac{2 \cdot 5K}{s(0 \cdot 4s + 1)(0 \cdot 2s + 1)}$$

(i) Sketch the Nyquist plot to determine phase crossover frequency and gain margin.

(ii) Determine phase margin for $K = 3$. 12