ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. (a) For the circuit shown in Fig Q1, determine EACH of the following:

   (i) the current through the 10 Ω resistor; (8)

   (ii) the p.d. across each resistor. (3)

   (b) The 10 Ω resistor is now disconnected from the circuit.

   Calculate the voltage V_{AB}. (5)

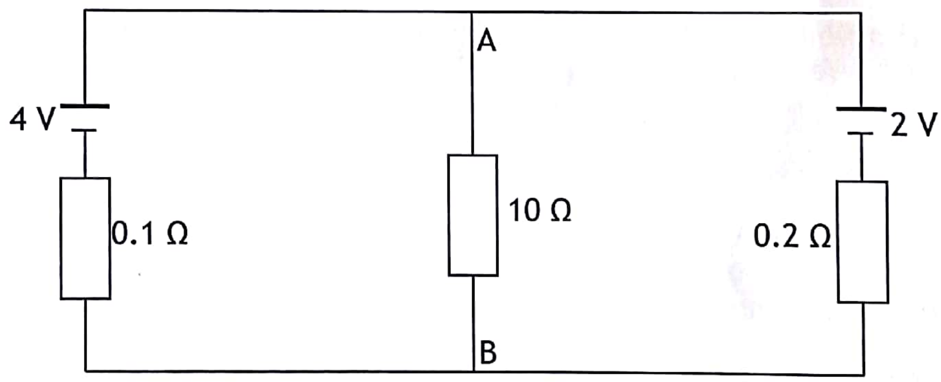

Fig Q1

2. A 120 μF capacitor is charged through a 4.7 kΩ resistor from a 12 V d.c. power supply.

(a) Calculate the instantaneous charging current at switch on. (2)

(b) State the expression for the capacitor charging voltage and determine its value 2 seconds after switch on. (4)

(c) Calculate the energy stored in the capacitor 2 seconds after switch on. (2)

(d) After 2 seconds of charging the supply is switched off and the capacitor is discharged through a 1.2 kΩ resistor.

(i) Determine the time taken during discharge for the capacitor voltage to fall to 5 V. (4)

(ii) Sketch a graph with approximately scaled axes to show the capacitor voltage changes over its charge/discharge cycle. (4)

3. Three resistive loads of 50 Ω, 20 Ω, and 30 Ω are connected respectively in star to the red, yellow and blue phases of a three-phase, 4-wire, 415 V, power supply.

(a) Determine EACH of the following:

(i) the current in each load; (3)

(ii) the current in the neutral wire; (6)

(iii) the total power supplied to the load. (3)

(b) Sketch, approximately to scale, the phasor diagram of the load and neutral currents. (4)

4. A 100 kW, three-phase induction motor runs on a 6600 V supply. Synchronous speed is 500 rev/min, motor slip and power factor at full-load are 1.8% and 0.85 lagging respectively, and the losses are as follows:

- stator copper losses 2.44 kW
- stator iron losses 3.5 kW
- rotational losses 1.2 kW

(a) Calculate EACH of the following:

(i) the rotor copper loss; (4)

(ii) the line current; (4)

(iii) the efficiency. (2)

(b) Sketch a labelled power-flow diagram for the motor indicating power at each stage. (6)

5. Two, three-phase, four-pole generators operating in parallel share a total load of 1000 kW at 0.8 power factor lagging. Test results are shown in Table Q5 and the load characteristic are linear.

Generator	Speed/kW	Voltage/kVAR
No. 1	1950 rev/min at no-load 1820 rev/min at 400 kW	470 V at no-load 430 V at 300 kVAR
No. 2	1910 rev/min at no-load 1830 rev/min at 400 kW	455 V at no-load 435 V at 300 kVAR

Table Q5

Determine EACH of the following:

(a) the bus-bar frequency; (5)

(b) the bus-bar voltage; (5)

(c) the operating power factor of each generator. (6)

[OVER

6. A 415/110 V, single-phase transformer takes a no-load current of 6.5 A at 0.3 power factor lagging. On load the transformer supplies 8.5 kW at 0.6 power factor lagging.

Calculate EACH of the following:

(a) the transformer secondary current; (2)

(b) the transformer primary current; (5)

(c) the primary power factor; (2)

(d) the transformer efficiency; (3)

(e) the equivalent primary resistance and series reactance load across the 415 V supply. (4)

7. With reference to the parallel operation of alternators:

(a) state FOUR ideal conditions that must be met prior to closing the circuit breaker of an incoming machine onto a live busbar; (4)

(b) sketch a labelled block diagram of a check-synchronizer; (6)

(c) describe the operation of the check-synchronizer sketched in Q7(b). (6)

8. With reference to a three-phase, cage rotor induction motor:

(a) sketch a labelled cross-section of the motor; (8)

(b) describe how the motor develops torque; (5)

(c) explain why the motor cannot run at synchronous speed. (3)

9. Fig Q9 shows a single-transistor amplifier. The voltage between the transistor base and emitter is 0.6 V and the d.c. voltage at the output terminals is 8 V.

(a) Calculate EACH of the following, assuming that the base current is small enough to be neglected:

(i) the voltage between the collector and the emitter of the transistor; (4)

(ii) the power dissipated in the emitter resistor; (3)

(iii) the power dissipated in the transistor. (3)

(b) Sketch the circuit shown in Fig Q9 to show the additional components needed to make the circuit suitable for amplifying a.c. signals. (3)

(c) State the purpose of the additional components shown in Q9(b). (3)

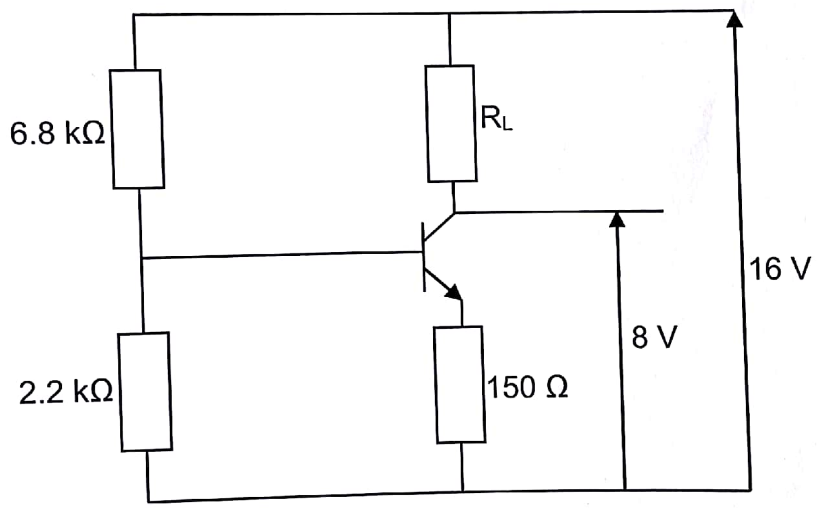

Fig Q9