CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY 16 JULY 2015

0915 - 1215 hrs

Examination paper inserts:

Notes for the guidance of candidates:

1. Non-programmable calculators may be used. 2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. For the network shown in Fig Q1 calculate EACH of the following:

   (a) the currents I_1, I_2 and I_3; (9)

   (b) the p.d across the 100 Ω resistor; (4)

   (c) the power dissipated in the 8 Ω resistor. (3)

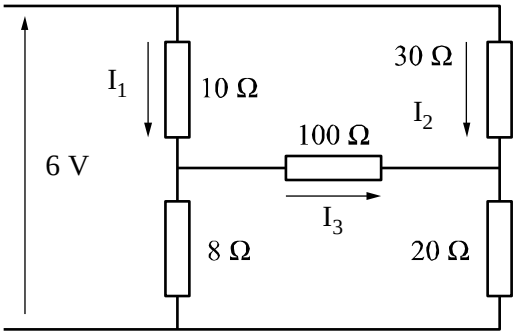

Fig Q1

2. A non-linear resistor whose characteristic is given by $I = kV^2$ is connected in series with a variable resistor across a 240 V d.c. supply. When the variable resistor is set to 10 Ω the supply current is 12 A.

   Determine EACH of the following:

   (a) the value to which the variable resistor must be set to reduce the current to 6 A; (6)

   (b) the power dissipated in the non-linear resistor when the current is 6 A; (2)

   (c) the current if the supply voltage is reduced to 150 V and the series resistor is set to 10 Ω. (8)

3. In the two-stage voltage amplifier shown in Fig Q3, both the npn and pnp transistors have high current gains and their leakage currents may be neglected. Transistor T_1 has a base-emitter volt drop of 0.7 V and transistor T_2 has a base-emitter drop of 0.3 V.

Calculate EACH of the following:

(a) the voltage between the collector and emitter for each transistor; (12)

(b) the power dissipated in each transistor. (4)

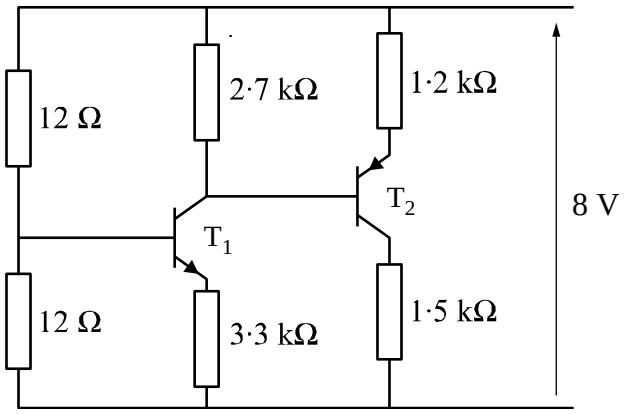

Fig Q3

4. A coil of inductance 0.1 H has a power factor of 0.7 and is connected in parallel with a capacitor 'C' across 120 V 60 Hz supply.

Calculate EACH of the following:

(a) the resistance of the coil; (3)

(b) the value of 'C' if the total current is 4 A at p.f. 0.4 leading; (7)

(c) the power dissipated by the combined circuit; (3)

(d) the kVA for the combined circuit. (3)

5. A three-phase star connected load has three identical legs each comprising a 40 Ω resistor in series with a 100 μF capacitor. It is supplied at 415 V, 50 Hz, from a three wire supply.

Calculate EACH of the following:

(a) the current in each phase; (4)

(b) the current in each phase if due to a fault, the red line becomes disconnected; (6)

(c) the current in each line if the red phase becomes short circuited. (6)

6. A three-phase six pole delta connected induction motor is supplied at 380 V, 60 Hz. It draws a current of 45 A at a p.f. of 0.85 lag. The stator losses are 4 kW and the windage and friction losses total 3 kW. It runs at 19 rev/sec.

Calculate EACH of the following:

(a) the rotor copper loss; (8)

(b) the shaft output power; (4)

(c) the shaft output torque. (4)

7. (a) State TWO advantages of turbo-electric or diesel-electric propulsion systems for marine use. (6)

(b) Explain one method by which a synchronous propulsion motor may be brought up to speed when required for service. (6)

(c) Explain how reversal of the propeller shaft is achieved without reversal of the prime mover in a turbo-electric or diesel-electric propulsion system. (4)

8. (a) Explain, with the aid of a circuit diagram, the auto transformer method of starting a large induction motor. (8)

(b) State ONE advantage of this method of starting compared to star delta starting. (2)

(c) State ONE disadvantage of the auto transformer method of starting. (2)

(d) State the advantage which accrues from the use of the Korndorfer modification to the basic auto transformer starter. (4)

9. With reference to an a.c. generator used in marine practice:

(a) state an expression for the frequency of the generated e.m.f. in terms of the speed of the machine and the number of poles; (3)

(b) explain the difference between the generated e.m.f. 'E' and the terminal voltage 'V' if the resistance of the stator output windings is low enough to be ignored; (5)

(c) state an expression for the regulation of the generator in terms of 'E' and 'V'; (3)

(d) explain the effect on the terminal voltage of increasing the load power factor without changing the excitation or the power input to the machine. (5)