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, 13 DECEMBER 2012

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; (3)

   (c) the power dissipated in the 8 Ω resistor. (4)

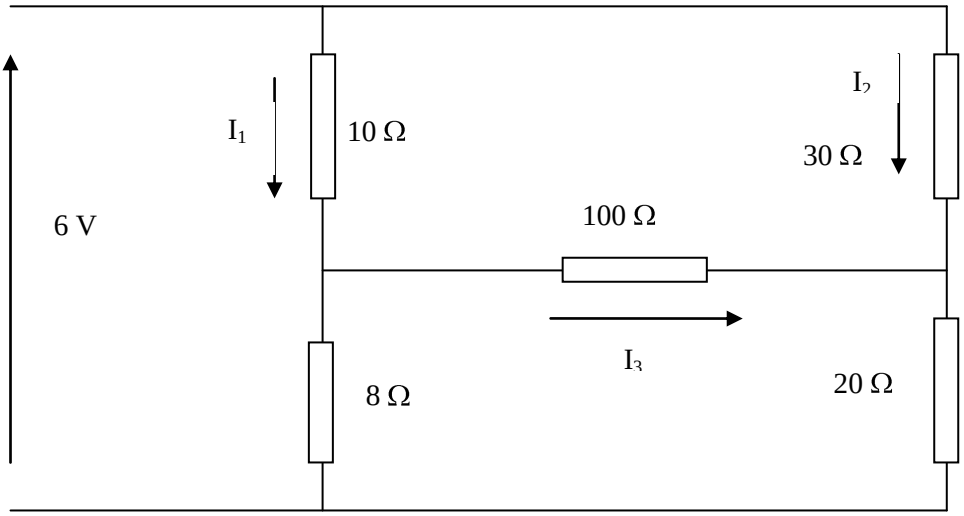

Fig Q1

2. A coil of inductance 2 H and unknown resistance is connected to a D.C. supply of 100 volts. After 4 ms the current has risen to 75% of its final steady state value.

   Calculate EACH of the following:

   (a) the resistance by the coil; (6)

   (b) the energy stored in the coil when the current has reached its steady state value; (4)

   (c) the time taken for the current to fall to 50% of its steady state value when the supply is switched off. (6)

3. The p.d. across the base-emitter junction of the silicon transistor shown in Fig Q3 is 0.6 V and the steady state voltage at the collector is 4 V.

Calculate EACH of the following, assuming the base current is negligible:

(a) the p.d across each of the bias resistors; (4)

(b) the p.d between the collector and emitter of the transistor; (4)

(c) the value of the load resistor R_L; (4)

(d) the power dissipated in $R_{L;}$ (2)

(e) the power dissipated in the transistor. (2)

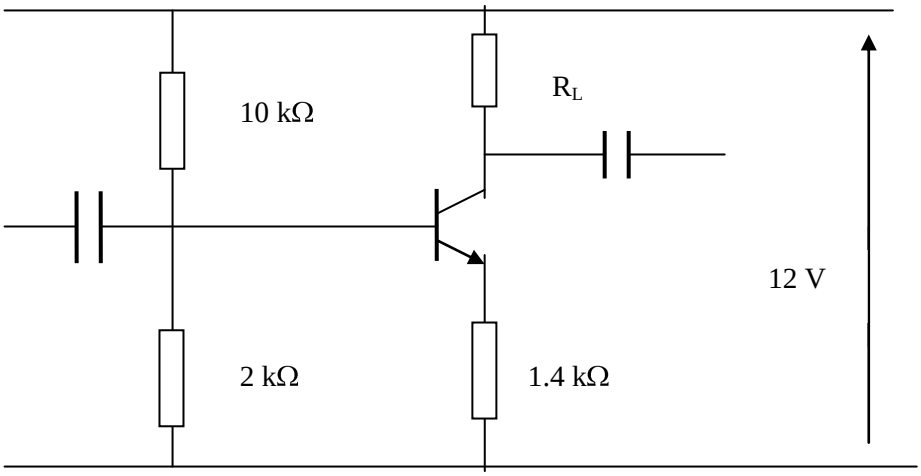

Fig Q3

4. A single phase circuit comprises a coil having resistance and inductance, 45 Ω resistor and a capacitor in series across a 40 V variable frequency supply. When the frequency is 400 Hz, the current reaches its maximum value of 0.8 A and the voltage across the capacitor is 170 V.

(a) Calculate EACH of the following:

(i) the value of the capacitor; (2)

(ii) the resistance and inductance of the coil; (4)

(iii) the p.d. across the coil; (4)

(iv) the supply kVAR. (2)

(b) Sketch a phasor diagram showing ALL the volt drops in relation to the circuit current. (4)

5. Three identical coils are delta connected to a 3 ph, 440 V, 60 Hz supply and consume a total power of 9 kW at a power factor of 0.8 lag.

(a) Calculate the resistance and inductance of EACH coil. (6)

(b) If the same three coils are now connected in star to the same supply, calculate the current in each line if:

(i) one coil is short circuited; (5)

(ii) one coil is open circuited. (5)

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 power factor of 0.85 lag. The stator losses are 4 kW and the windage and friction losses total 3 kW. It runs at 19 rev/s.

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 the reasons for using instrument transformers in a marine distribution system. (4)

(b) Sketch a circuit diagram showing how a voltmeter, an ammeter and a wattmeter can be connected to a single phase distribution system using two instrument transformers. (6)

(c) Explain why the secondary windings of such instrument transformers are generally earthed. (4)

(d) A wattmeter, an ammeter and a voltmeter connected to a single phase a.c. system read 4.5 kW, 22 A and 240 V respectively.

Calculate the power factor of the system. (2)

8. (a) State the conditions necessary to *turn on* and *turn off* a thyristor ('STC'). (4)

(b) Describe the operation of the circuit shown in Fig Q8. (8)

(c) Sketch the voltage waveform across the load for EACH of the following trigger delay angles:

(i) 60°; (2)

(ii) 120°. (2)

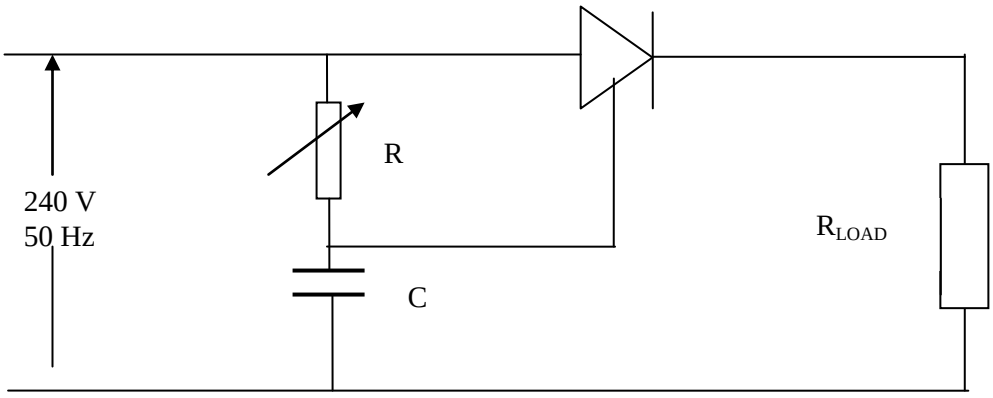

Fig Q8

9. (a) Explain, with the aid of a circuit diagram, the principle of the wound rotor induction motor. (8)

(b) State TWO advantages of the wound rotor induction rotor. (4)

(c) State TWO disadvantages of the wound rotor induction motor. (4)