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 18 DECEMBER 2014

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. Fig Q1 shows a ring main distributor fed at one point at 440 volts. The distances between the various loads are given in metres and the twin cable has a *go and return* resistance of 0.02 Ω per 100 metres.

   Determine EACH of the following:

   (a) the current in the cable between the 30A and 70 A loads; (8)

   (b) the lowest p.d. across any of the loads; (4)

   (c) the total power loss in the distributor. (4)

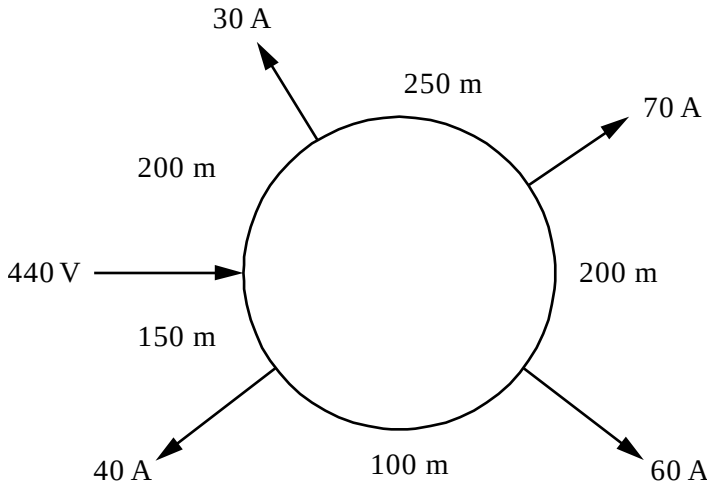

Fig Q1

2. A capacitor of 200 μF is charged from a 120 volt d.c. supply via a 100 kΩ resistor.

Determine EACH of the following:

(a) the time taken for the p.d. across the capacitor to reach 80 volts; (4)

(b) the charge on the capacitor at this time. (4)

If the capacitor is now disconnected from the supply and joined to another, uncharged, capacitor of 100 μF determine EACH of the following:

(c) the final p.d. across the pair of capacitors; (4)

(d) the energy stored by the pair of capacitors. (4)

3. Fig Q3 shows a simple voltage regulator circuit designed to provide a stable 15 V d.c. output from an unregulated supply which can vary between 20 V and 30 V. The Zener diode has a breakdown potential of 15 V and the slope resistance when conducting is 1 Ω.
It requires a minimum reverse current of 1 mA for satisfactory regulation.

Determine EACH of the following:

(a) the minimum value of the series resistor 'R' if the Zener diode does not exceed its power rating of 3 W; (6)

(b) the regulated output voltage when the input voltage is 20 V. and the load current is 30 mA; (4)

(c) the maximum permissible output current for satisfactory regulation when the input voltage is 30 V. (6)

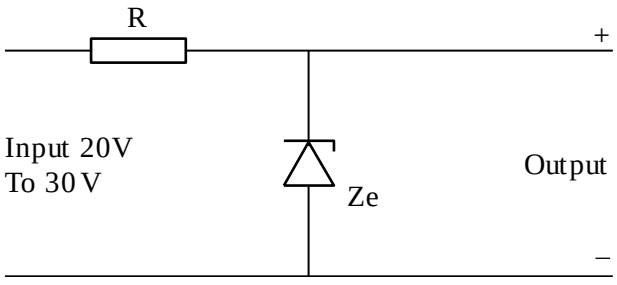

Fig Q3

4. A coil possessing resistance and inductance is connected to a 120 V variable frequency supply. When the frequency is 50 Hz the current is 4A and when the frequency is raised to 100 Hz the current falls to 3 A.

Determine EACH of the following:

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

(b) the inductance of the coil; (6)

(c) the power factor of the coil at 50 Hz; (2)

(d) the power dissipated by the coil at 100 Hz. (2)

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

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

The three coils are now connected in star to the same supply.

Determine EACH of the following:

(b) the line currents if one coil is short circuited; (5)

(c) the line currents if one coil is open circuited. (5)

6. A 3ph, 440 V, 60 Hz 8 pole induction motor drives a load of 7 kW and runs at 14.4 rev/min. The power factor is 0.8 lag. The stator loss is 0.6 kW and the rotational losses (windage and friction) are 0.4 kW.

Calculate EACH of the following:

(a) the slip; (4)

(b) the frequency of the rotor e.m.f; (2)

(c) the input power to the motor; (6)

(d) the line current. (4)

7. (a) State the main reason why switchboard instruments are supplied via instrument transformers from the power circuits which they monitor (4)

(b) Explain why it is hazardous to open circuit a current transformer whilst its primary is still energised. (4)

(c) Sketch a circuit diagram showing an ammeter, a voltmeter and a wattmeter fed from a single phase supply via current and voltage transformers. (4)

(d) An ammeter, a voltmeter and a wattmeter monitoring a single phase supply read 40 A, 240 V and 8 kW respectively.

Calculate the power factor of the circuit. (4)

8. (a) Sketch the circuit arrangement for a full wave three-phase rectifier indicating on your sketch the current directions for both positive and negative half cycles of one phase. (8)

(b) Sketch the output waveform for the circuit in part (a) above. (3)

(c) Add a smoothing capacitor to the rectifier circuit and explain why less capacitance is required for a three-phase rectifier circuit than for a single phase rectifier circuit for the same acceptable 'ripple' on the output voltage. (5)

9. (a) Explain the term *power factor correction*. (3)

(b) State TWO advantages of power factor correction. (4)

(c) Explain, with the aid of a circuit diagram, how power factor correction can be effected in a three-phase circuit using capacitors. (5)

(d) State ONE method, other than the use of capacitors, by which power factor correction can be effected in a 3 ph. circuit (4)