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 78 as amended MANAGEMENT ENGINEER REG. III/2 (UNLIMITED)

040-33 - ELECTROTECHNOLOGY

THURSDAY, 20 JULY 2017

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 two cables has a go and return distance of 0.02 Ω per 100 metres.

   Determine EACH of the following:

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

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

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

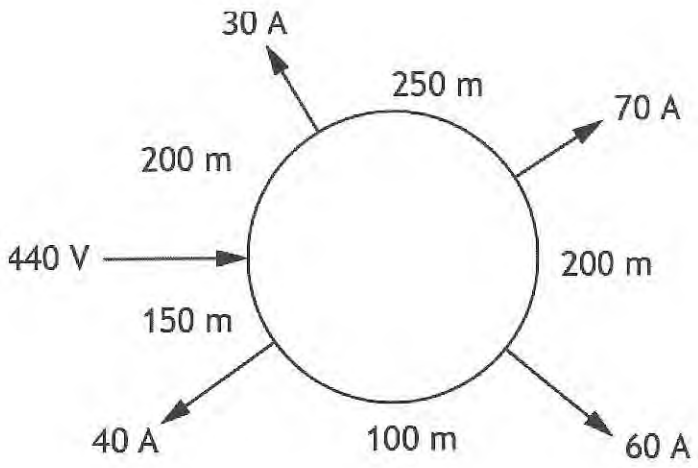

Fig Q1

2. When connected to a 20 v d.c. supply a relay starts to operate 0.52 ms after switching on the supply, at which time the instantaneous current is 200 mA. The relay coil has a time constant of 5 ms.

(a) Calculate EACH of the following:

(i) the final steady state relay current; (6)

(ii) the resistance and inductance of the relay coil. (4)

(b) To increase the operating time a 40 Ω resistor is connected in series with the relay coil.

Calculate the new time delay assuming the instantaneous current is still 200 mA. (6)

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

Calculate EACH of the following:

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

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

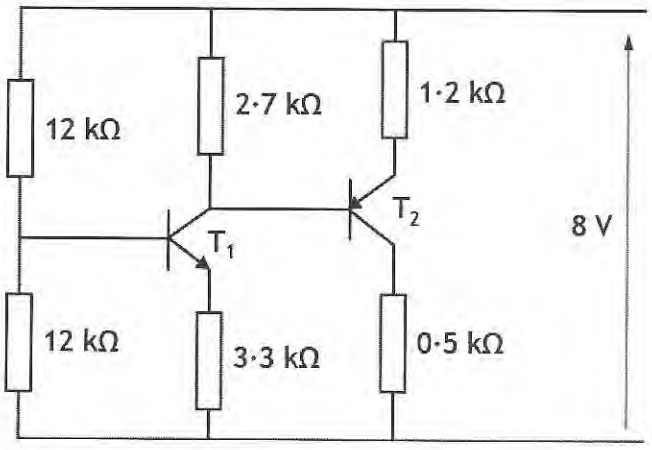

Fig Q3

4. A 40 kVA 400 V /110 V single phase transformer has an iron loss of 0.9 kW. Maximum efficiency occurs at 75% full load and 0.8 p.f. lag.

Calculate EACH of the following:

(a) the copper loss at full load; (6)

(b) the efficiency at full load and 0.8 p.f. lag; (6)

(c) the efficiency at half full load and unity p.f. (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/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) Describe the FOUR conditions which have to be met before an alternator can be connected to live busbars. (4)

(b) Explain the process by which kW load can be delivered by a newly synchronised alternator. (6)

(c) Describe the effect of increasing the excitation of an alternator which is sharing a load without increasing the power input to the machine. (6)

8. With reference to a 1 ph power transformer with air cooling:

(a) sketch a labelled diagram of the basic construction; (3)

(b) explain the principle of operation; (5)

(c) state why it is rated in KVA rather than KW; (2)

(d) explain why it may overheat if operated at reduced frequency; (3)

(e) explain how operation at reduced frequency can be compensated for. (3)

9. (a) Describe, with the aid of a detailed sketch, the construction of a double cage rotor for a squirrel cage induction motor. (6)

(b) Explain how the rotor current is distributed between the two windings as the machine runs up from standstill to full speed. (6)

(c) Sketch a torque/slip curve for each cage during the run up period. (4)