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, 15 OCTOBER 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

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. A two core feeder cable 1200 m long has a resistance ('go and return') of 0.005 Ω /100 m and is fed at each end with 440 V. It supplies the following loads at the distances given, all measured from the same end of the feeder.

   - 200 A at 400 m
   - 150 A at 700 m
   - 250 A at 1000 m

   Calculate EACH of the following:

   (a) the current supplied at each end of the feeder cable; (6)

   (b) the p.d. across the 150A load; (6)

   (c) the power loss in the feeder cable. (4)

2. A capacitor of 200 μF is charged from a 120V d.c. supply via a 100 kΩ resistor for 10 secs. It is now disconnected from the supply and a second capacitor of 150 μF is charged from the same supply via the same resistor for 15 secs. The two charged capacitors are now connected in parallel.

   Calculate EACH of the following:

   (a) the potential to which each of the capacitors has been charged; (6)

   (b) the energy stored in each capacitor at the end of the charging period; (4)

   (c) the final potential across the parallel combination of two capacitors. (6)

3. The NPN transistor shown in Fig Q3 has a volt drop between base and emitter of 0.4 V and the base current is small enough to be ignored. The volt drop across the emitter resistor is 3.6 V.

Calculate EACH of the following:

(a) the value of the resistor R_b in the bias network; (6)

(b) the value of the collector-emitter current; (4)

(c) the value of the load resistor R_L if the steady state voltage at the collector is 12 V as shown. (6)

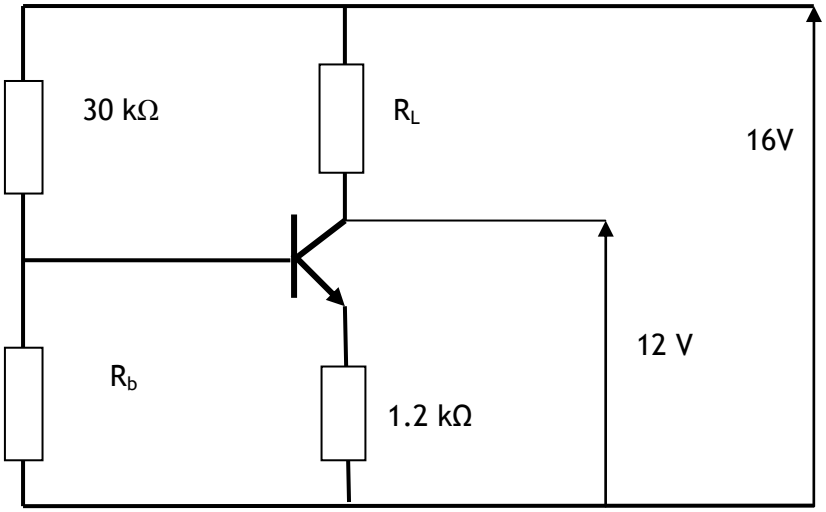

Fig Q3

4. A coil having inductance and resistance is connected to a supply of 120 V 50 Hz and draws a current of 2.5 A at a power factor of 0.75.

Calculate EACH of the following:

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

(b) the inductance of the coil. (3)

(c) A capacitor is now connected in series with the coil and the current rises to 3 A and the power factor is still lagging.

Calculate the value of the capacitor. (5)

(d) Calculate the value of capacitor which would have to be connected in series with the coil to raise the current to 3 A with a leading power factor. (5)

5. Fig Q5 shows three identical loads, each consisting of a 100 μF capacitor in series with a 50 Ω resistor, connected in star to a 415 V, 3ph, 50 Hz supply.

Calculate EACH of the following:

(a) the current drawn from the supply; (4)

(b) the power factor; (4)

(c) the power consumed by the three phase load; (4)

(d) the p.d. between points A and B. (4)

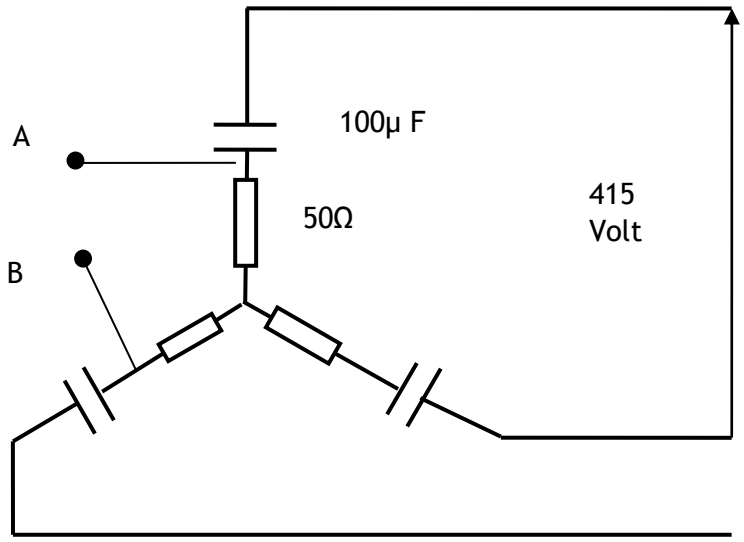

Fig Q5

6. A six pole three phase induction motor operates from a 380 V 60 Hz supply. It draws a current of 40 A at power factor 0.7. The frequency of the e.m.f. in the rotor is 2.4 Hz. If the stator loss is 4 kW and the rotational losses (windage and friction) total 3 kW, calculate EACH of the following:

(a) the power input; (3)

(b) the slip; (3)

(c) the rotor copper loss; (5)

(d) the shaft output power. (5)

7. (a) Draw a circuit diagram illustrating how a single thyristor (*silicon controlled rectifier*) may be used to provide a variable d.c. voltage output from a single phase a.c. supply. (8)

(b) Explain how the 'firing angle 'of the thyristor is varied. (4)

(c) Sketch the output voltage waveform when the firing angles are:

(i) 60° (2)

(ii) 120° (2)

8. (a) Describe, with the aid of a sketch, the construction of a double wound single phase transformer and explain the principle of its operation. (4)

(b) Explain why the transformer is rated in kVA rather than kW. (4)

(c) State why the iron loss in the transformer is not load dependent. (4)

(d) State how the copper losses in the two windings of the transformer vary with the load on the transformer. (4)

9. (a) Explain how torque is produced in a 3 phase squirrel cage induction motor. (5)

(b) State why the starting current is several times higher than the full load current. (3)

(c) State why the power factor is very low on starting. (3)

(d) Describe ONE method of construction by means of which the starting power factor may be raised, the starting current reduced and the starting torque improved. (5)