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, 20 OCTOBER 2011

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 current drawn from each battery; (8)

   (b) the potential difference across the 40 Ω resistor and across the 50 Ω resistor; (4)

   (c) the power dissipated in the 60 Ω resistor. (4)

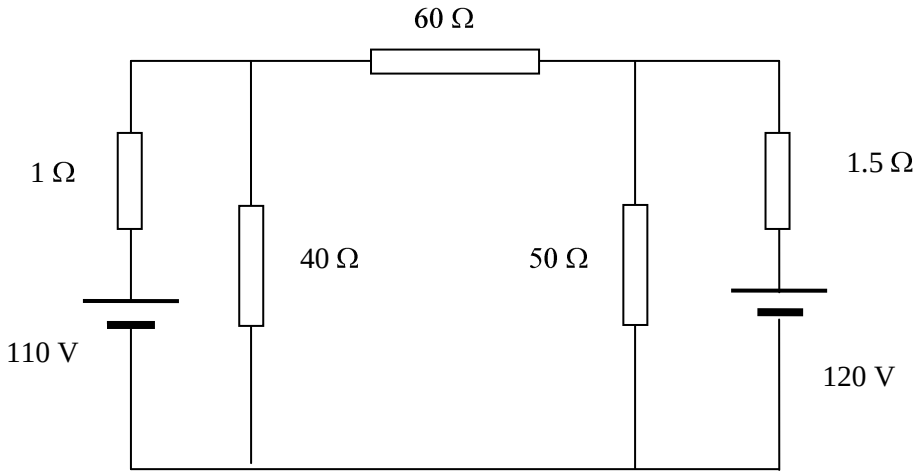


Fig Q1

2. The V/I characteristic of a non-linear resistor is shown in Table Q2.

V (volts)	40	60	80	100	120	140
I (mA)	0.65	1.05	1.55	2.20	3.20	4.70

Table Q2

This non-linear resistor is connected in series with a paralleled pair of resistors of 40 kΩ and 60 kΩ and the overall circuit is supplied at 120 V d.c.

Determine graphically or otherwise:

(a) the current in the non-linear resistor; (8)

(b) the effective resistance of the non-linear resistor; (4)

(c) the current in the 40 kΩ resistor. (4)

3. Fig Q3 shows a single stage transistor amplifier. The voltage between base and emitter is 0.3 V and the d.c. voltage at the output terminals is 8 V.

(a) Calculate EACH of the following, assuming the base current is small enough to be neglected:

(i) the voltage between emitter and collector; (6)

(ii) the power developed in the 150 Ω resistor; (5)

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

(b) Sketch the circuit diagram and show the additional components needed to make the amplifier suitable for amplifying small a.c. signals. (3)

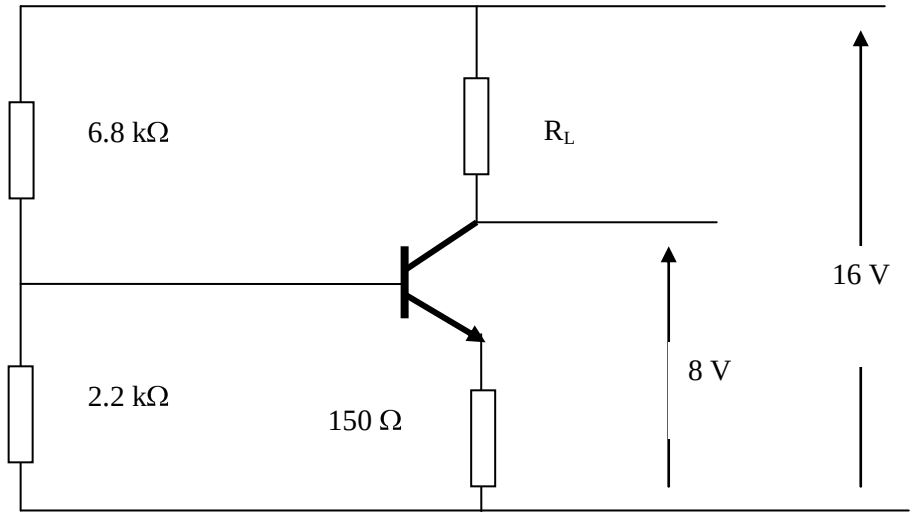


Fig Q3

4. For the circuit shown in Fig Q4, calculate EACH of the following:

(a) the supply current; (6)

(b) the power factor; (2)

(c) the voltages V_1 and V_2 and their respective phase angles to the supply current. (8)

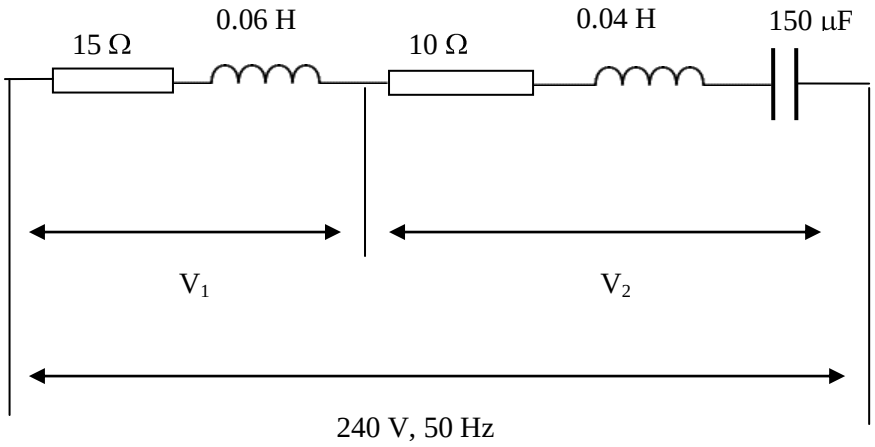


Fig Q4

5. Three identical delta connected coils each comprising both resistance and inductance draw a total power of 1.2 kW at a power factor of 0.8 from a 440 V, 50 Hz three phase supply.

Calculate EACH of the following:

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

(b) the resistance and inductance of each coil; (6)

(c) the power absorbed if the three coils are now reconnected in star to the same supply. (6)

6. (a) Explain why it is important, in the case of a star connected alternator with the star point earthed, to detect any appreciable leakage current between any of the phase windings and earth. (5)

(b) Sketch a circuit arrangement of current transformers and an earth fault relay which would enable such phase winding to earth faults to be detected. (7)

(c) It is normal practice to earth the star point of alternators supplying 1000 V and above via an earthing resistor. Explain how the value of such an earthing resistor is determined. (4)

7. Two 415 V three phase alternators supply a ship's load made up as follows:

- lighting totalling 900 kW at U.P.F.
- motors totalling 2100 kVA at power factor 0.7 lag

One alternator supplies 1600 kVA at power factor 0.75 lag

(a) Calculate for the other alternator EACH of the following:

(i) the kVA output; (4)

(ii) the power factor; (4)

(iii) the line current. (4)

(b) An over excited synchronous motor is now installed to raise the overall power factor to 0.9 lag.

Calculate the power factor of the synchronous motor if it takes 400 kW. (4)

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

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

(c) Sketch waveforms for the output waveform when the firing angle is:

(i) 60° (4)

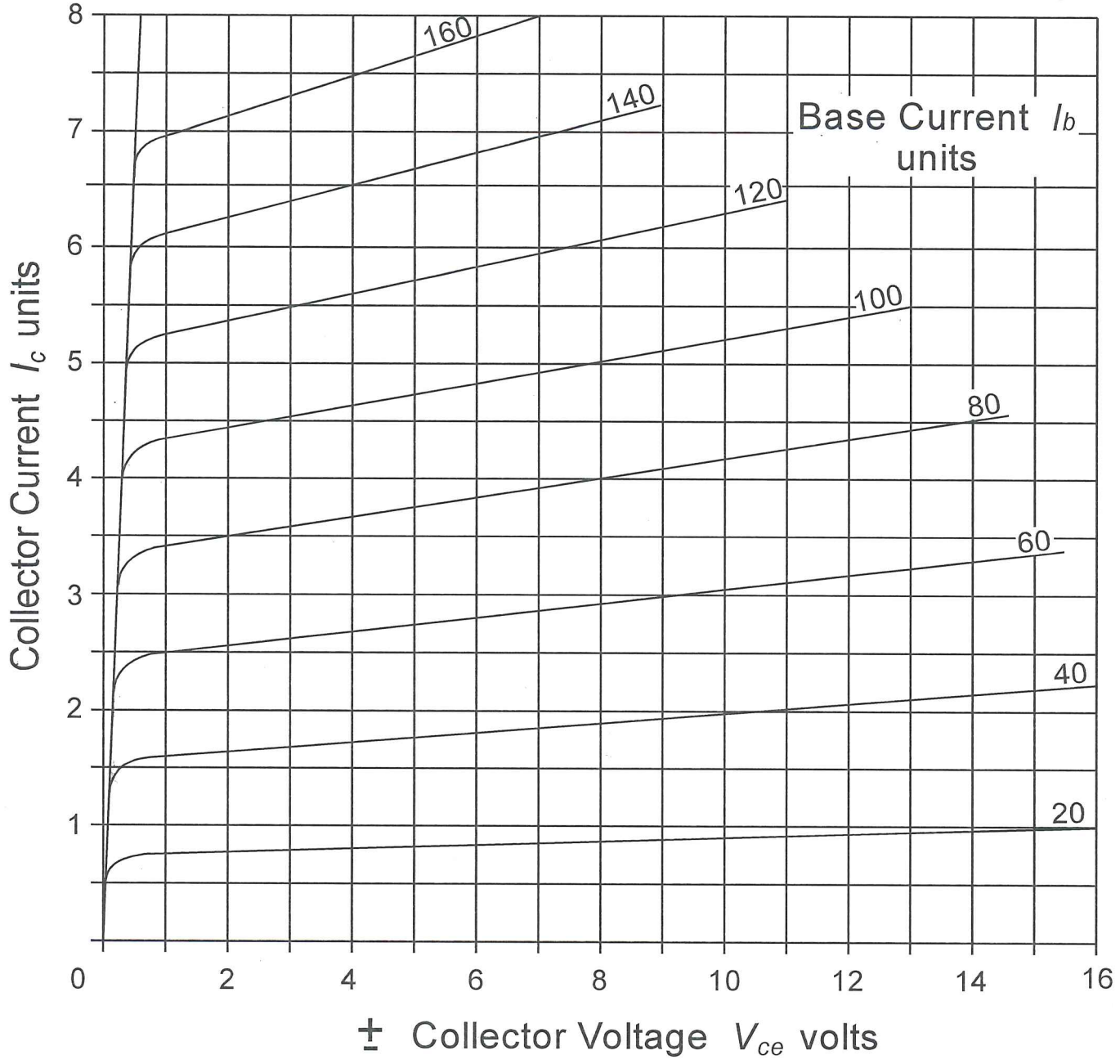
(ii) 120° (4)

9. (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 taken up 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)

(This Worksheet must be returned with your answer book)



COMMON EMITTER TRANSISTOR CHARACTERISTCS

TYPE	SCALE FACTORS per unit value of	
	I_b	I_c
1. Small Si 2. Power Si	1 μA 1 mA	1 mA 1 A

Candidate's Name .....

Examination Centre .....