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 OCTOBER 2012

0915 - 1215 hrs

Examination paper inserts:

> Worksheet Q3

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 in the indicating meter. (8)

    (b) the value to which the 1 kΩ resistor must be changed to make the current in the meter 1mA in the direction found in Q1(a). (8)
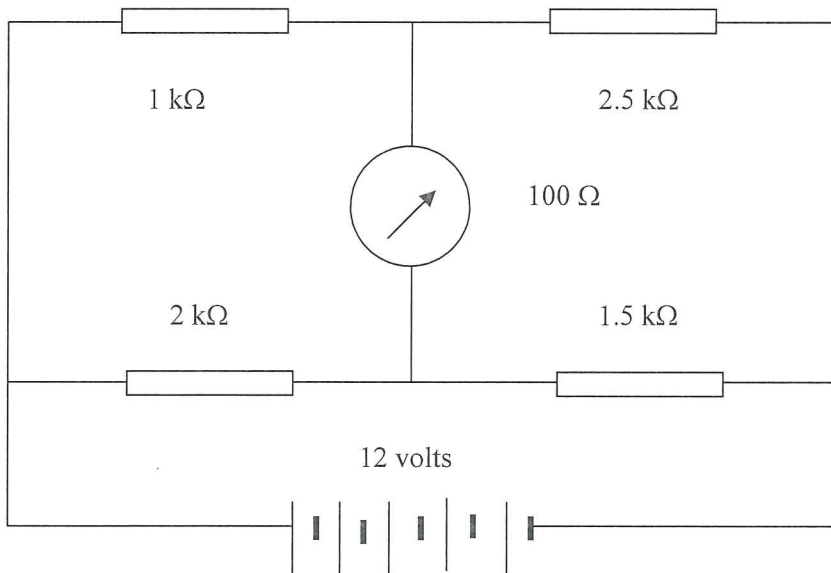

Fig Q1

2. A circuit comprises a resistor of 800 Ω in series with a non-linear element whose characteristic is given by $I = 0.5V^{3/2}$ where I is in mA and V is in volts. The circuit is connected to a 12 V d.c. supply.

    Determine EACH of the following:

    (a) the circuit current; (6)

    (b) the voltage across the non-linear element; (4)

    (c) the value to which the 800 Ω resistor must be changed to make the circuit current 10 mA. (6)

3. A power silicon transistor with the characteristics given in Worksheet Q3 is operated from a 16 V d.c. supply. The operating ('quiescent') point is $I_b = 40$ mA and $I_c = 2$A.

Determine EACH of the following:

(a) draw the load line on the characteristics;   (4)

(b) (i)   the value of the collector load resistance;   (4)

     (ii)   the peak-to-peak variation in collector current if a signal of +/- 20 mA is applied to the base;   (2)

     (iii) the corresponding variation in collector current;   (2)

     (iv)   the power dissipated in the transistor due to this signal.   (4)

4. An a.c. series circuit consists of four elements as shown in Fig Q4. The power dissipated in the 50 Ω resistor is 200 W and the volt drops across the various parts of the circuit are as shown.

Calculate EACH of the following:

(a) the values of C and L;   (8)

(b) the overall power factor of the circuit;   (5)

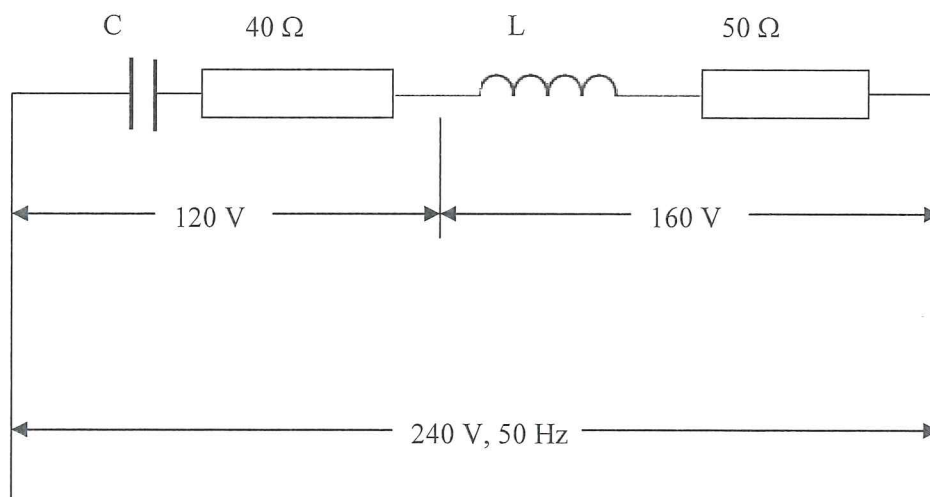(c) the kVAr for the inductance.   (3)

Fig Q4

5. A three phase star connected load each phase of which consists of a coil of resistance 40 Ω and inductance 0.1 H is connected together with a delta connected load, each phase of which comprises a resistor of 120 Ω in series with a 70 μF capacitor, to a supply of 440 V 50 Hz.

Calculate EACH of the following:

(a) the line current for each load; (6)

(b) the total line current drawn from the supply; (6)

(c) the overall power factor for the two loads. (4)

6. A 440 V/110 V single phase transformer is rated at 40 kVA full load output. The iron loss is 3 kW and it operates at maximum efficiency when delivering 80% full load.

Calculate EACH of the following:

(a) the full load copper loss; (5)

(b) the full load efficiency at 0.9 power factor; (5)

(c) the efficiency at 80% full load and unity power factor. (6)

7. With reference to a double cage induction motor:

(a) sketch a cross section through part of the rotor; (4)

(b) explain the operation of the motor from start up to operating speed; (8)

(c) sketch a torque speed curve for each cage on the same pair of axes. (4)

8. (a) Explain the operating principle of a double wound single phase power transformer. (5)

(b) State why the transformer is rated in kVA rather than kW. (3)

(c) Explain why the transformer will overheat if operated at a frequency less than the designed frequency. (5)

(d) State the relationship between iron losses and copper losses for maximum efficiency. (3)

9. (a) Explain what is meant by the expression *single phasing*. (6)

(b) Explain the probable effect of single phasing on a squirrel cage motor operating on load. (4)

(c) State ONE method by which a motor can be protected against the effects of single phasing. (6)

041-33 ELECTROTECHNOLOGY

WORKSHEET Q3

(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	1 μA	1 mA
2. Power Si	1 mA	1 A

Base Current I_b units

Collector Current I_c units

Collector Voltage V_{ce} volts

160
140
120
100
80
60
40
20

Candidate's Name ....

Examination Centre ....