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 JULY 2013

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. Determine EACH of the following, for the circuit shown in Fig Q1:

   (a) the current in the 1 kΩ moving coil meter; (8)

   (b) the value of a resistor to be placed in series with the meter to reduce the current in the meter to 1 mA. (8)

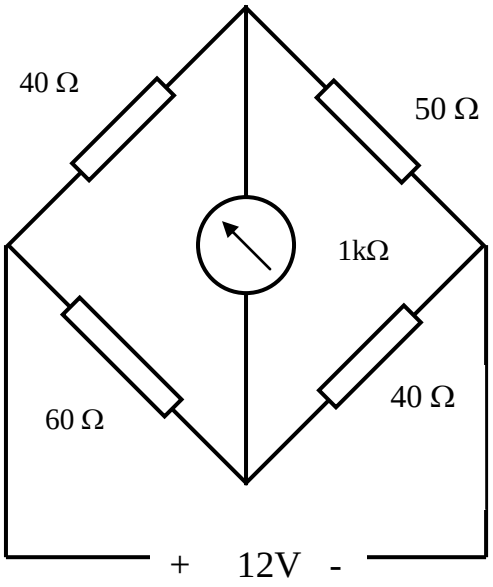

Fig Q1

2. A capacitor 'C' is connected in series with a resistor of 2 kΩ to a 150 V d.c. supply. When the capacitor is fully charged the energy stored is 4.5 J.

   Determine EACH of the following:

   (a) the value of the capacitor; (5)

   (b) the time taken for the capacitor to charge to half the supply voltage; (5)

   (c) the value of resistance to be added in series to increase the time found in part (b) above to 1.2 secs. (6)

3. Fig Q3 shows a two stage transistor amplifier using high gain transistors whose base currents are small enough to be neglected. The voltage between base and emitter for transistor T_1 is 0.4 V. and for transistor T_2 it is 0.6 V.

Determine EACH of the following:

(a) the collector current for T_1; (4)

(b) the voltage at the base of T_2; (4)

(c) the collector current for T_2; (4)

(d) the steady state value of V_{OUT}. (4)

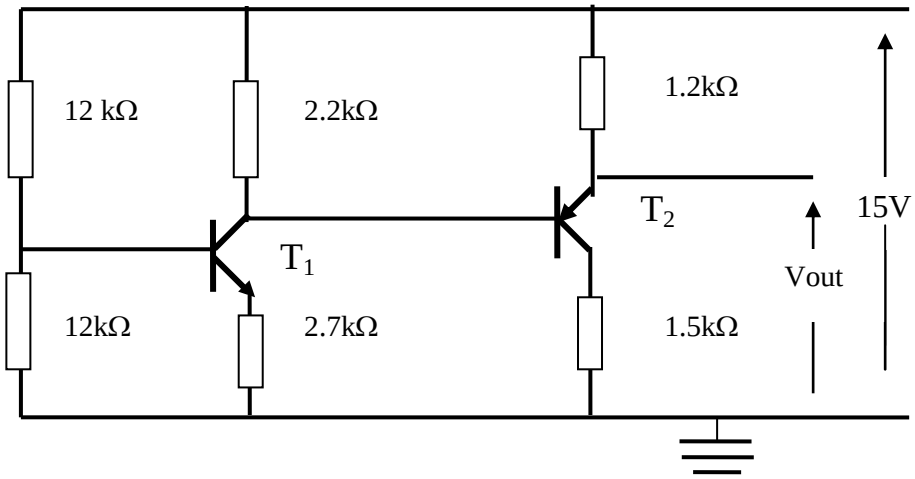

Fig Q3

4. A capacitor connected in series with a resistor is tested on 240 V 50 Hz and the current is found to be 3.6 A. When the frequency is raised to 100 Hz the current increases to 4.8 A.

Determine EACH of the following:

(a) the values of the resistor and the capacitor; (6)

(b) the power factor of the circuit at 50 Hz; (4)

(c) the value of an inductor which, when connected in series with the pair, will give the same current of 3.6 A at 50 Hz but with a lagging power factor equal to the value obtained in part (b). (6)

5. A three phase, 240 V, 4 wire unbalanced system has a current in the red phase of 5 A at unity power factor and a current in the yellow phase of 8 A lagging by 30º. If the current in the neutral line is 1.93A in phase with the red line voltage.

Calculate EACH of the following:

(a) the magnitude of the current in the blue line; (6)

(b) its angular relationship to the blue line voltage; (6)

(c) the total power drawn by this unbalanced circuit. (4)

6. A 3 ph, 440 V, 60 Hz, 8 pole induction motor runs at a power factor of 0.85 lag and drives a load of 8 kW at a speed of 14.4 rev/sec. The stator loss is 1 kW and the rotational losses (windage and friction) amount to 0.8 kW.

Calculate EACH of the following:

(a) the synchronous speed; (3)

(b) the rotor copper loss; (5)

(c) the input power to the motor; (4)

(d) the motor 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 only fed from a single phase supply via a current transformer and a voltage transformer. (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. With reference to a three phase squirrel cage induction motor:

(a) sketch a labelled diagram of the motor construction; (4)

(b) explain the process of torque production in the motor; (5)

(c) sketch a typical torque/speed curve for the motor and indicate the position of the starting, 'pull-out' and running points on the curve; (3)

(d) explain why the motor draws a high current and has a low power factor on starting. (4)

9. (a) Draw a 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. (4)

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

(i) 60^{o}; (2)

(ii) 120^{o}. (2)