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, 29 MARCH 2012

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

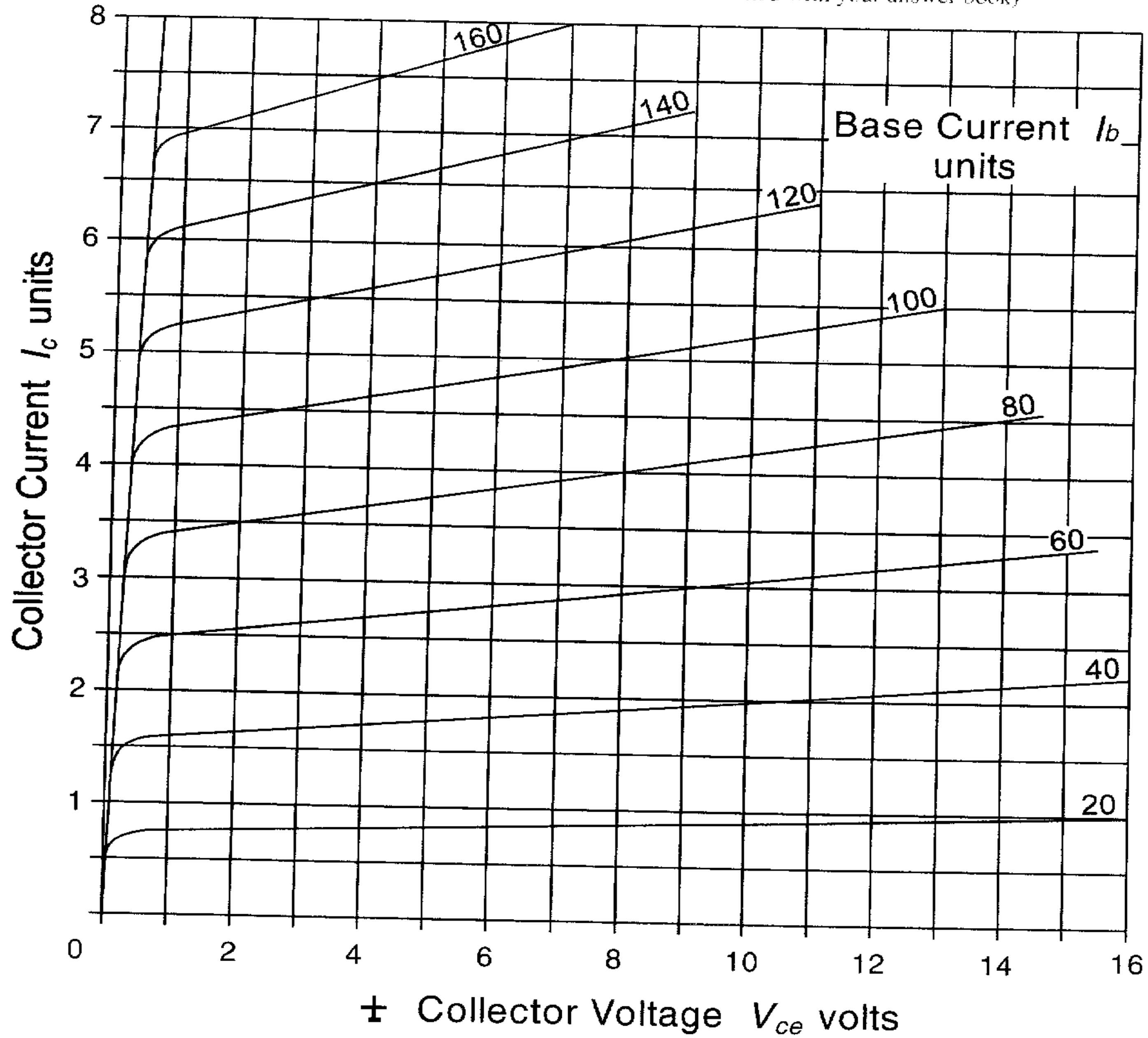
1. Non-programmable calculators may be used.
2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook
Graph Paper

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

Candidate's Name ....

Examination Centre ....

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. A two core cable is 400 metres long and is fed at each end with 240 V d.c. Three loads are connected to the distributor.

   - 120 A at 80 metres
   - 80 A at 160 metres
   - 100 A at 280 metres

   All distances are measured from the same end of the distributor.
   If the resistance of the twin cable (go and return) is 0.001 Ω/metre, calculate EACH of the following:

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

   (b) the p.d. at each load point; (6)

   (c) the total power lost in the distributor cable. (4)

2. A capacitor of 100 μF is charged from a 120 V d.c supply via a 100 kΩ resistor for 4 seconds.

   (a) Calculate EACH of the following:

   (i) the time constant of the circuit; (2)

   (ii) the voltage to which the capacitor has charged after 4 seconds. (4)

   (b) A second capacitor of 80 μF is now charged for 4 seconds from the same supply via the same 100 kΩ resistor. Both charged capacitors are now connected in parallel.

   Calculate EACH of the following:

   (i) the final steady state voltage across the pair of capacitors; (6)

   (ii) the total energy stored in the two capacitors. (4)

3. A silicon heavy power transistor with the characteristics given in Worksheet Q3 is operated from a 12 V supply and has a maximum power rating of 18 W.

   (a) Plot the 18 W power dissipation curve on the characteristics. (5)

   (b) Determine the minimum safe collector load resistance for the transistor. (4)

   (c) If the transistor is biased at the base with 80 mA and a sinusoidal signal of +/- 40 mA is applied to the base, calculate EACH of the following:

      (i) the variation in collector current; (2)

      (ii) the corresponding variation in collector voltage; (2)

      (iii) the a.c. power output of the transistor. (3)

4. A coil of inductance 0.1 H has a power factor of 0.7 and is connected in parallel with a capacitor 'C' across 120 V, 60 Hz supply.

   Calculate EACH of the following:

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

   (b) the value of the capacitor if the total current is 4 A at a leading power factor; (7)

   (c) the power factor of the combined circuit; (3)

   (d) the kVA for the combined circuit. (3)

5. A three phase star connected load has three identical legs each comprising a 40 Ω resistor in series with a 100 μF capacitor. It is supplied at 415 V, 50 Hz from a three wire supply.

   Calculate EACH of the following:

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

   (b) the current in each phase if due to a fault the red phase lead becomes disconnected; (6)

   (c) the current in each phase if the red phase becomes short circuited. (6)

6. A 440 V/110 V single phase step down transformer is rated at 60 kVA full load output. The iron loss is 4 kW and the copper loss at full load is 6 kW.

Calculate EACH of the following:

(a) the kVA output at which maximum efficiency will be achieved; (8)

(b) the efficiency at 50 kW output and 0.85 p.f. (8)

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 current and voltage transformers. (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. (a) Explain the term *power factor correction.* (4)

(b) State TWO advantages of improving the power factor of a distribution system. (6)

(c) Explain TWO methods by which the power factor of a power distribution system can be raised. (6)

9. (a) List the various losses which occur in the squirrel cage motor on load. (4)

(b) State, with reasons, which of these losses are:

(i) independent of load and speed; (4)

(ii) dependent on load; (4)

(iii) dependent on speed. (4)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 15 DECEMBER 2011

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

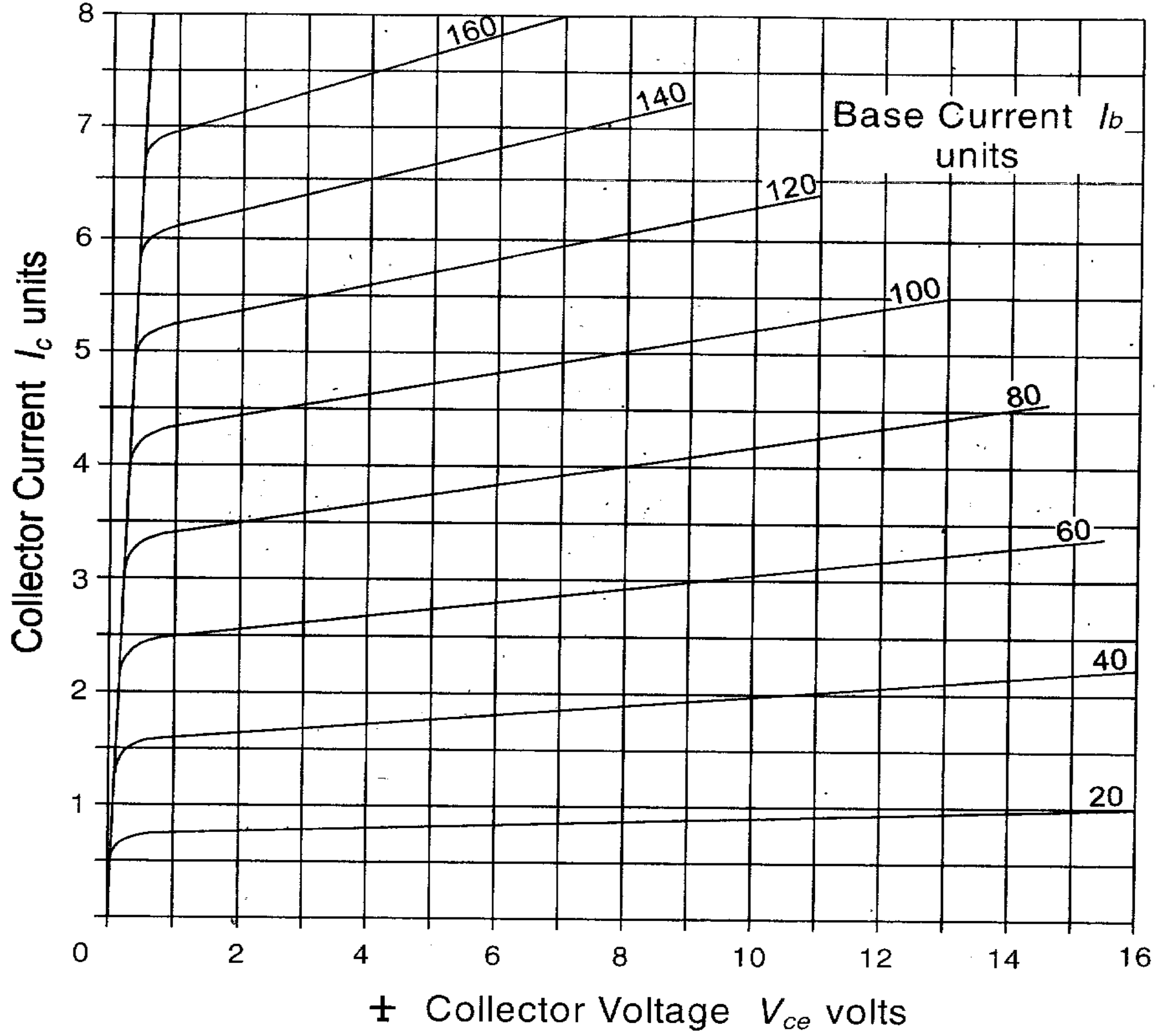
1. Non-programmable calculators may be used.
2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper

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

Candidate's Name

Examination Centre

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 value of R_X so that the total current drawn from the 12 V supply shall be 2 A as shown; (8)

   (b) the potential difference across R_X; (3)

   (c) the value to which the 5 Ω resistor must be changed to give zero potential difference across R_X. (5)

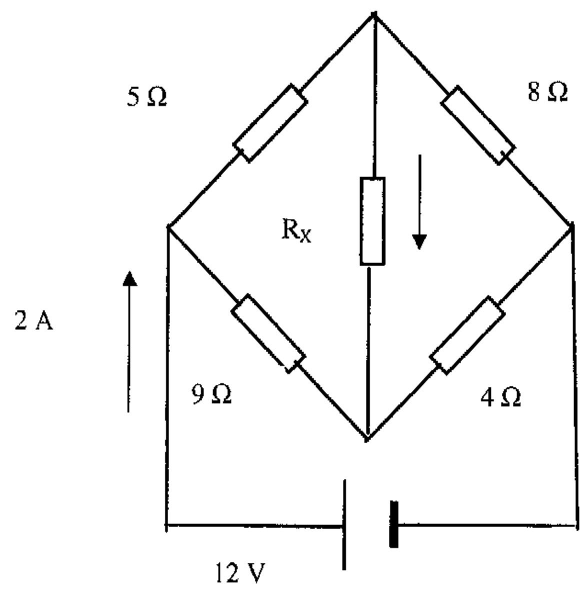


Fig Q1

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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 200 mA. (6)

3. A small silicon transistor with the characteristics given in Worksheet Q3 is used in a common emitter amplifier circuit with a 14 V d.c power supply and a 2 kΩ resistive load. The base bias current is 80 μA with a sinusoidal input signal of +/- 40 μA.

(a) Draw the load line on the characteristics. (2)

(b) Determine EACH of the following:

(i) the R.M.S. signal current in the load; (4)

(ii) the d.c. power dissipated in the load; (4)

(iii) the R.M.S. output voltage; (4)

(iv) the current gain of the transistor. (2)

4. The series a.c. circuit shown in Fig Q4 is connected to 120 V, 50 Hz supply. It draws a current of 2.4 A at a power factor of 0.8 lagging. The resistor R_2 dissipates 57.6 W and the volt drops across the various parts of the circuit are as shown.

Calculate EACH of the following:

(a) the values of R_1, L and C; (10)

(b) the power factor of the coil (R_1 and L); (3)

(c) the power factor of the combination R_2 and C. (3)

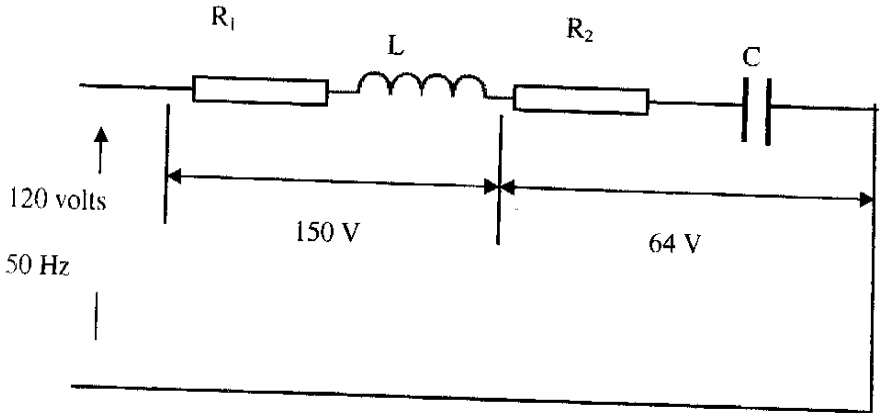

Fig Q4

5. A star connected three phase load has a coil of resistance 50 Ω and inductance 0.1 H in each phase. It is connected to a three phase three wire supply of 415 V, 50 Hz.

Calculate EACH of the following:

(a) the line current; (5)

(b) the power factor of the load; (4)

(c) the value of each of three identical delta connected capacitors which if connected in parallel with this load will raise the overall power factor to unity. (7)

6. A three phase, four pole induction motor runs off a 440 V, 50 Hz supply. It delivers a shaft output power of 50 kW. The rotational losses (windage and friction) amount to 4 kW and the speed is 24 rev/sec.

If the input current is 120 A at a lagging power factor of 0.7 and the stator copper loss is 3 kW, calculate EACH of the following:

(a) the rotor copper loss; (6)

(b) the stator iron loss; (6)

(c) the efficiency. (4)

7. (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 is not load dependent. (4)

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

8. (a) Sketch a basic circuit diagram for a star/delta starter for a squirrel cage motor. (8)

(b) Explain why the starting voltage and hence the starting current is reduced using a star/delta starter. (4)

(c) By what factor is the initial starting current reduced using a star/delta starter compared to the direct on line starting current. (4)

9. (a) Sketch a circuit for a basic d.c. voltage stabilising circuit using a Zener diode and a series resistor. (5)

(b) Sketch the reverse current characteristic for a typical Zener diode. (3)

(c) List the factors which determine the value of the series resistor in the circuit. (4)

(d) List the factors which determine the power rating of the chosen Zener diode. (4)

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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)

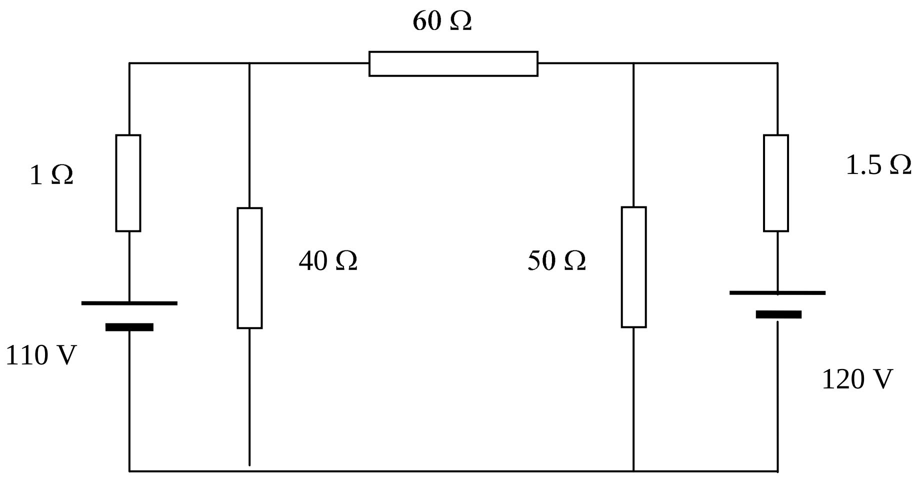


Fig Q1

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)

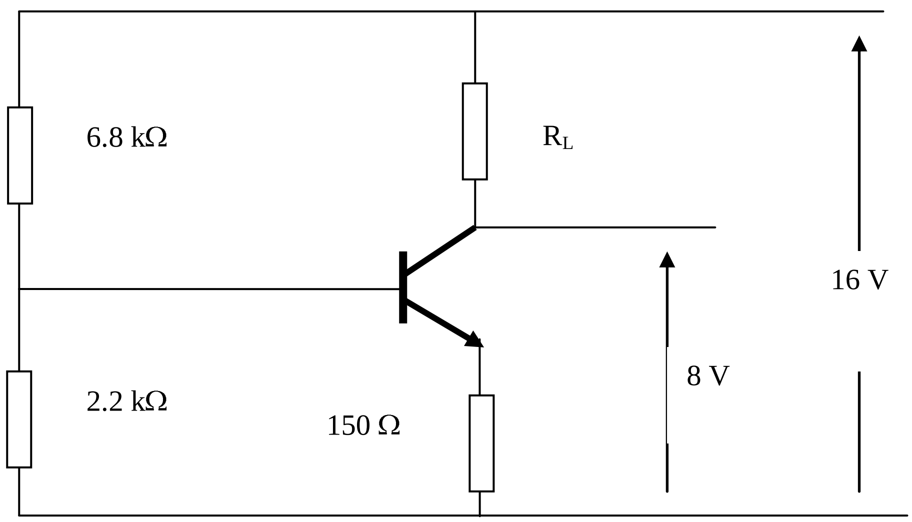


Fig Q3

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)

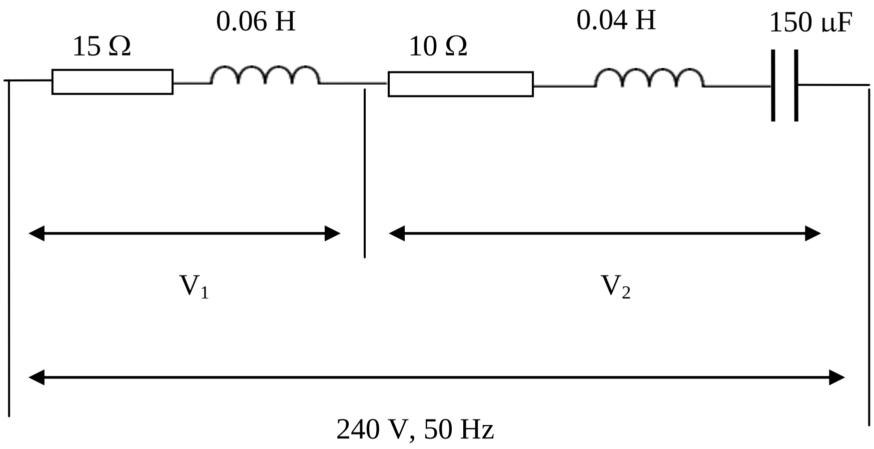


Fig Q4

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)

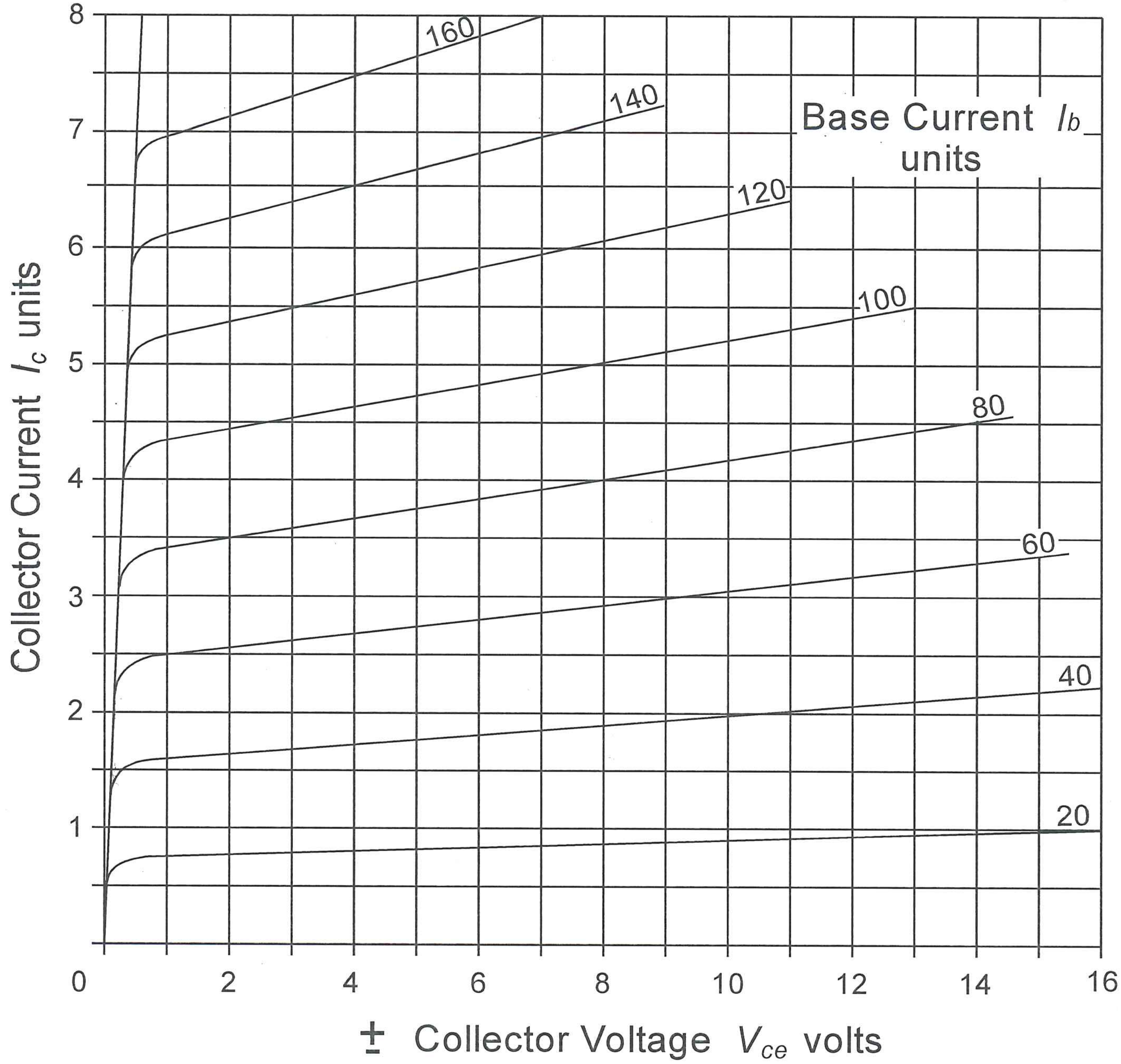
9. (a) Describe the FOUR conditions which have to be met before an alternator can be connected to live busbars. (4)

(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)

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

Candidate's Name ....

Examination Centre ....

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 21 JULY 2011

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

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. For the circuit shown in Fig Q1, determine EACH of the following:

   (a) the current supplied by each battery; (10)

   (b) the voltage across the 8 Ω load resistor; (3)

   (c) the power dissipated in the 8 Ω resistor. (3)

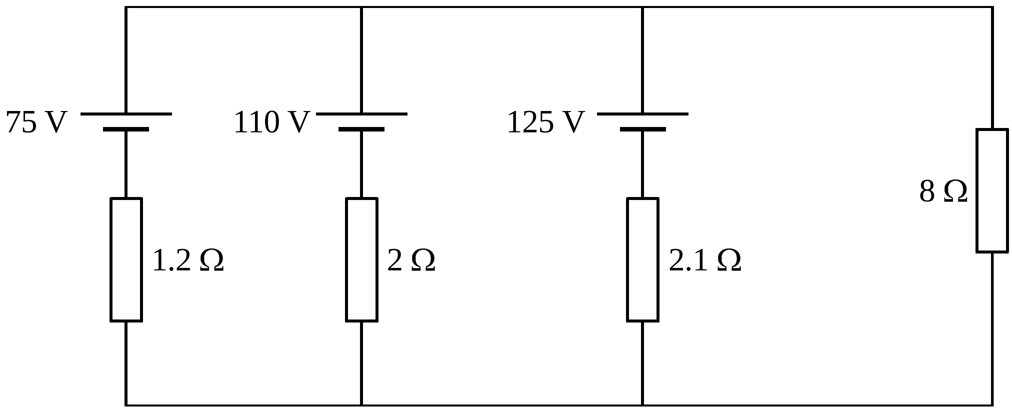

Fig Q1

2. A relay coil has resistance of 200 Ω and the current required to operate the relay is 150 mA. When the relay is connected to a 50 V d.c. supply the time between switch on and the operation of the relay is 40 ms.

   (a) Calculate EACH of the following:

      (i) the steady state relay current; (3)

      (ii) the time constant for the coil; (4)

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

   (b) To increase the operating time delay for the relay a 50 Ω resistor is connected in series with the coil.

      Calculate the new time delay for the relay. (6)

3. A small silicon transistor with the characteristics given in Worksheet Q3 has a maximum safe power dissipation of 18 mW and it is to be operated on a 12 volt d.c. supply.

(a) Plot the maximum power dissipation curve on the characteristics. (5)

(b) Determine the minimum value of collector load resistance for the transistor if this dissipation is not to be exceeded. (5)

(c) If the transistor is used in a common emitter configuration and is biased at a base current of 60 μA and an alternating signal of +/- 40 μA is applied to the base, determine EACH of the following:

(i) the r.m.s. voltage variation between collector and emitter; (3)

(ii) the r.m.s. value of the variation in collector current. (3)

4. A series circuit comprising a 50 Ω resistor, a capacitor and a coil having resistance and inductance is connected across a 50 V variable frequency supply.

When the frequency is 400 Hz the current reaches its maximum value of 0.6 A and the voltage across the capacitor is 200 V.

Calculate EACH of the following:

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

(b) the resistance and inductance of the coil; (5)

(c) the power taken; (3)

(d) the circuit power factor. (3)

5. A balanced three phase delta connected load comprises a coil of resistance 50 Ω and inductance 0.1 H in each phase. It is connected to a 440 V 50 Hz supply.

Calculate EACH of the following:

(a) the line current for the load; (5)

(b) the power factor of the load; (3)

(c) the power dissipated by the load; (3)

(d) the component values in each leg of a star connected load which would draw the same line current at a leading power factor numerically equal to that found in Q5(b). (5)

6. The load on a vessel's distribution system comprises:

- motors totalling 1200 kW at a p.f. of 0.7 lag
- lighting totalling 500 kW at unity p.f.
- an over excited synchronous motor taking 200 kW at p.f. 0.5 lead

This total load is shared by two identical alternators, one of which provides 1000 kVA at a p.f. of 0.85 lag.

Calculate EACH of the following:

(a) the kW supplied by the second alternator; (3)

(b) the kVA supplied by the second alternator; (5)

(c) the power factor of the second alternator; (3)

(d) the power factor of the synchronous motor if the overall p.f of the system is to be raised to unity. (5)

7. With reference to a 3 phase *double cage* induction motor:

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

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

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

8. (a) Sketch a circuit diagram for an auto-transformer starter for a 3 phase induction motor, showing the connections to the stator windings. (8)

(b) Explain the advantage of such a starter over the star/delta starter. (4)

(c) State the disadvantage that the basic auto-transformer starter shares with the star/delta starter. (4)

9. (a) Sketch the circuit diagram for a full wave three phase rectifier, indicating on the sketch the direction of current flow when the red phase is positive and the yellow and blue phases are negative. (8)

(b) Sketch the output voltage waveform for the circuit shown in Q9(a). (4)

(c) Add a smoothing capacitor to the rectifier circuit shown in Q9(a) and explain why less capacitance is needed for a three phase rectifier set than a single phase rectifier for the same acceptable level of *ripple* voltage at the output. (4)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 31 MARCH 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:

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Graph Paper

-- MAR 2011

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. A 2 wire distributor is 1500 m long and is fed at end *A* with 250 V d.c. and at end *B* with 240 V d.c. It supplies four loads: 700 A at 400 m, 600 A at 600 m, 500 A at 1000 m and 300 A at 1200 m, all distances being measured from end *A*. The resistance of the single conductor is 0.01 Ω/km.

   Calculate EACH of the following:

   (a) the current supplied at each end of the distributor; (10)

   (b) the voltage across each load; (4)

   (c) the total power supplied. (2)

2. A non-linear resistor whose characteristic is given by:

   $I(mA) = 0.1\ V^2$

   is connected in series with a resistor of 680 Ω to a 16 V d.c. supply.

   Determine EACH of the following:

   (a) the value of the voltage across each element; (6)

   (b) the circuit current; (4)

   (c) the value to which the linear resistance must be changed to give equal voltages across the two elements; (4)

   (d) the circuit current for the condition in Q2(c). (2)

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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 base-emitter volt drop of 0.7 V and transistor T_2 has a base-emitter volt drop of 0.3 V.

Calculate EACH of the following:

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

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

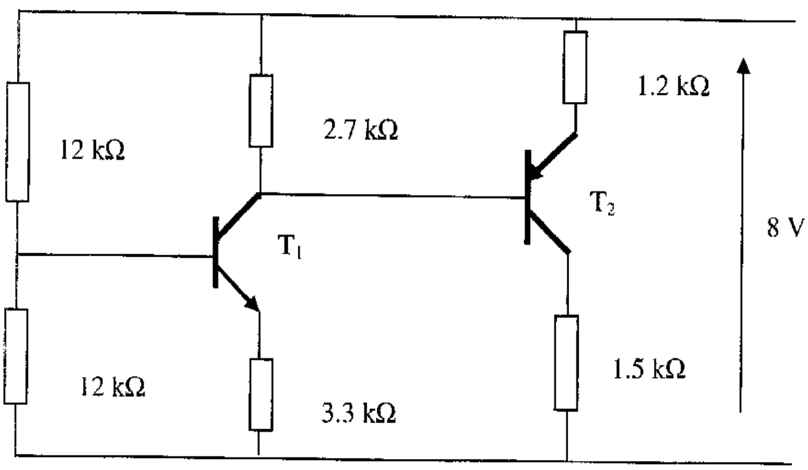

Fig Q3

4. Two impedances Z_1 and Z_2 are connected in parallel to a 240 V single phase a.c. supply. The total current drawn is 10 A at unity power factor. Impedance Z_1 takes a current of 5 A at p.f. 0.6 lag.

Calculate EACH of the following:

(a) the current in impedance Z_2; (6)

(b) the resistance and reactance of each impedance; (6)

(c) the power dissipated by each impedance. (4)

5. A three phase balanced star connected load has a capacitor of 100 μF in series with a resistor of 30 Ω in each phase. It is connected to a three phase supply of 440 V 50 Hz.

Calculate EACH of the following:

(a) the line current; (6)

(b) the power factor of the load; (4)

(c) the value of each of three identical delta connected resistors which, when connected to the same supply, will raise the overall power factor to 0.9. (6)

6. A 440 V/110 V single phase transformer takes a no load current of 5 A at power factor 0.25 lag. On load the transformer supplies 7.5 kVA at power factor 0.8 lag.

Calculate EACH of the following, for the on load condition:

(a) the transformer secondary current; (2)

(b) the transformer primary current; (8)

(c) the primary power factor; (3)

(d) the efficiency of the transformer at this load. (3)

7. (a) List the various losses which occur in a squirrel cage motor on load. (4)

(b) State, with reasons, which of these losses are:

(i) independent of load current and speed; (4)

(ii) dependent on load current. (4)

(iii) dependent on speed. (4)

8. (a) Sketch a circuit diagram for a basic voltage stabilising circuit using a Zener diode and a series resistance, explaining how the circuit operates. (6)

(b) State which factors determine the minimum values of the series resistor. (5)

(c) State which factors determine the maximum stabilised output current which can be drawn from the circuit. (5)

-- MAR 2011

9. (a) Sketch a circuit diagram showing the essential features of a star/ delta starter for a three phase induction motor, showing the connections to the stator windings. (8)

(b) Explain why the starting current is reduced by the use of such a starter. (4)

(c) State a disadvantage to the use of such a starter in practice. (4)

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 16 DECEMBER 2010

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. Fig Q1 shows a measuring circuit in the form of a bridge network. The meter, of resistance 200 Ω, reads 10 mA in the direction shown.

   (a) Calculate the value of the resistance R_X. (8)

   (b) The range of the instrument is increased by connecting a resistor of 200 Ω in parallel with the meter.

   Calculate the new reading on the meter. (8)

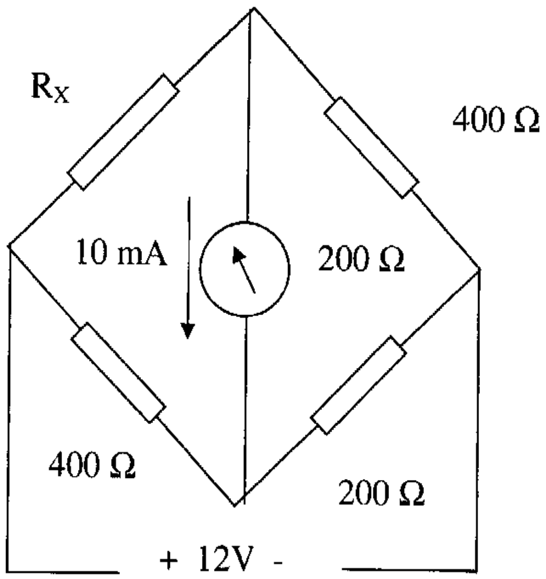

Fig Q1

2. A capacitor of 100 μF is charged for 5 secs from a 100 volt d.c. supply via a resistor of 100 kΩ.

   (a) Calculate EACH of the following:

      (i) the voltage across the capacitor at the end of this period; (4)

      (ii) the energy stored in the capacitor at the end of this period. (4)

   (b) At the end of this period the capacitor is disconnected and a second capacitor of 100 μF already charged to 70 volts is connected in parallel with it.

   Calculate EACH of the following:

      (i) the final steady state voltage across the pair; (4)

      (ii) the energy stored by the pair of capacitors. (4)

3. Fig Q3 shows a basic voltage stabilising circuit using a Zener diode and a series resistor. The Zener diode has a breakdown voltage of 12 V and is rated at 2 W maximum dissipation. The diode requires a minimum reverse current of 2 mA for satisfactory stabilisation and its slope resistance is negligible

   Calculate EACH of the following:

   (a) the maximum safe input voltage when the output current is zero; (8)

   (b) the maximum output current for satisfactory stabilisation when the input voltage is 18 volts. (8)

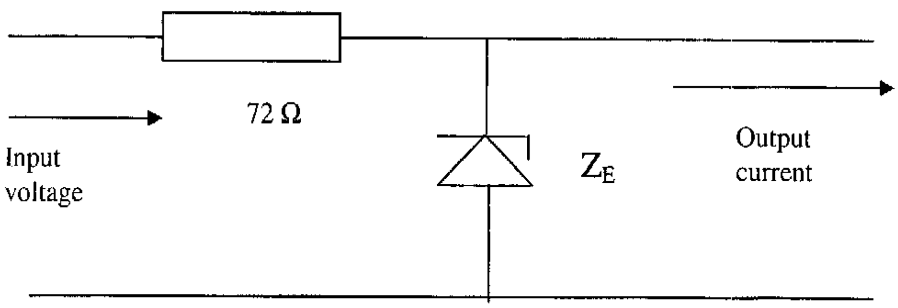

Fig Q3

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4. A single phase circuit consists of a capacitor of 50 μF in parallel with a coil of unknown resistance and unknown inductance. When connected to 240 V 50 Hz the circuit draws 7 A at power factor 0.8 lag.

(a) Calculate EACH of the following:

(i) the resistance of the coil; (5)

(ii) the inductance of the coil; (5)

(iii) the power factor of the coil. (2)

(b) Calculate the current drawn if the coil and capacitor are now connected in series to the same supply. (4)

5. A three phase 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 30°.

(a) If the current in the neutral line is 1.93 A in phase with the red line voltage, calculate EACH of the following:

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

(ii) its angular relationship to the blue line voltage. (6)

(b) Calculate the total power drawn by this unbalanced circuit, if the value of the phase voltage is 240 V. (4)

6. A four pole three phase induction motor runs off 440 Volt 50 Hz supply. It delivers a shaft output power of 50 kW. The rotational losses (windage and friction) amount to 4 kW and the speed is 24 rev/sec. If the input current is 120 A at a lagging power factor of 0.7 and the stator copper loss is 3 kW, calculate EACH of the following:

(a) the rotor copper loss; (6)

(b) the stator iron loss; (6)

(c) the efficiency. (4)

7. (a) Sketch a circuit diagram showing the essential features of a brushless alternator suitable for marine use. (8)

(b) Explain the function of EACH of the main features sketched in Q7(a). (8)

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8. (a) Sketch a circuit diagram showing how a thyristor (silicon controlled rectifier) may be used to vary the d.c. voltage supplied to a load from a single phase a.c. supply. (6)

(b) Explain the operation of the circuit sketched in Q8(a). (6)

(c) Sketch the load voltage waveform for EACH of the following delay angles:

(i) 60°; (2)

(ii) 120°. (2)

9. (a) Explain why it is the usual practice to use instrument transformers in a marine distribution system. (4)

(b) Explain why it may be dangerous to open circuit the secondary winding of a CT (current transformer) whilst operating on load. (4)

(c) Draw a circuit diagram showing a voltmeter, an ammeter and a wattmeter connected to a single phase power circuit from the same pair of instrument transformers. (5)

(d) A voltmeter, ammeter and wattmeter connected to a single phase system read 240 V, 70 A and 12.6 kW respectively.

Determine the load power factor. (3)

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 21 OCTOBER 2010

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

OCT 2010
CLASS-I/ET

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. (a) For the circuit shown in Fig Q1, calculate EACH of the following:

   (i) the current through the 12 Ω resistor; (8)

   (ii) the p.d. across each resistor. (3)

   (b) Calculate the voltage V_{AB}, if the 12 Ω resistor is now removed from the circuit. (5)

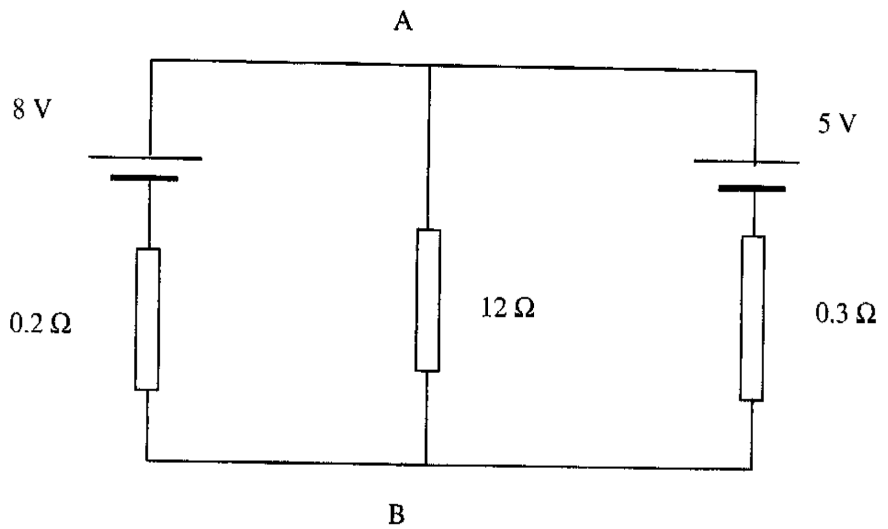

Fig Q1

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

This non-linear element is connected in series with a paralleled pair of resistors of 40 kΩ and 80 kΩ and the overall circuit is connected to 110 V d.c.

Determine EACH of the following:

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

(b) the effective resistance of the non-linear resistor; (3)

(c) the current in the 80 kΩ resistor. (5)

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

Table Q2

3. A 220 Ω resistor is connected in series with a coil of resistance R and inductance L across a 240 V 50 Hz supply.

The p.d. across the 220 Ω resistance is 110 V and across the coil is 200 V.

Calculate EACH of the following:

(a) the supply current; (3)

(b) the resistance of the coil; (5)

(c) the inductance of the coil; (5)

(d) the power factor of the coil. (3)

OCT 2010
CLASS 1/ET

4. The p.d. between base and emitter for the transistor shown in Fig Q4 is 0.4 V and the steady state output voltage is 6 V. The base current is negligible.

Calculate EACH of the following:

(a) the p.d. between the base and earth; (4)

(b) the collector current; (4)

(c) the value of the load resistor R_L; (4)

(d) the power dissipated in the 180 Ω resistor; (2)

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

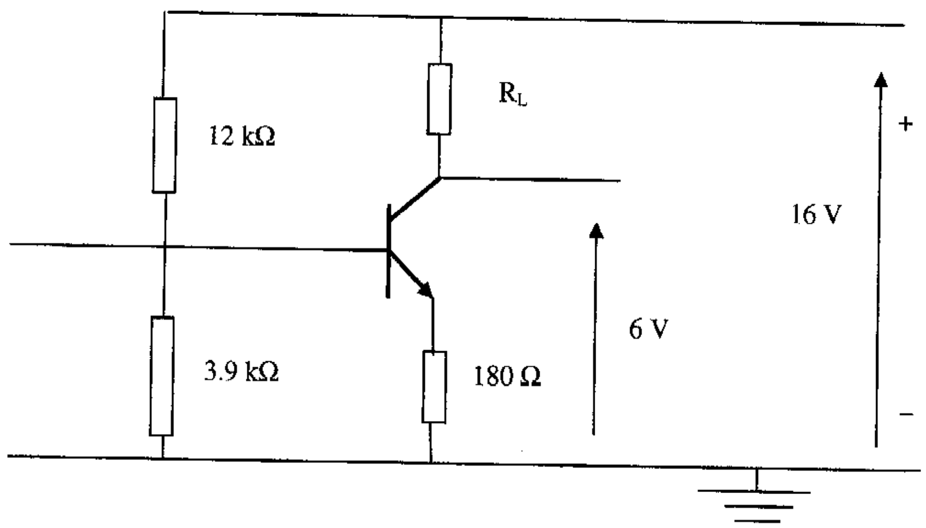

Fig Q4

5. A star connected unbalanced three phase load is connected to a four wire supply with a phase voltage of 240 V a.c. The resistive loads in each of the three phases are as follows:

Red to neutral 40 Ω; yellow to neutral 50 Ω; blue to neutral 60 Ω.

Determine EACH of the following:

(a) the current in each phase; (3)

(b) the current in the neutral wire; (7)

(c) the phase angle between the neutral current and the voltage V_{RN}. (6)

6. A 3ph 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. With reference to a 3 phase a.c. synchronous motor:

(a) sketch a simple construction diagram of stator and rotor; (4)

(b) explain the operating principle of the motor; (4)

(c) explain how start up and shaft reversal are effected; (4)

(d) state how the motor may be operated at a wide range of power factors from lag to lead. (4)

8. With reference to a Ward Leonard motor control system for powering a d.c. capstan motor from a 3 phase a.c. supply:

(a) sketch a circuit diagram for the arrangement; (7)

(b) explain how the speed of the capstan motor is varied; (5)

(c) state TWO advantages and TWO disadvantages of the Ward Leonard system of motor control. (4)

9. (a) Explain the term *power factor correction.* (3)

(b) State TWO advantages of p.f.. correction. (4)

(c) Explain, with the aid of a circuit diagram, how power factor correction can be effected using capacitors in a three phase circuit. (5)

(d) State ONE method, other than the use of capacitors, by which power factor correction can be effected. (4)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 15 JULY 2010

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

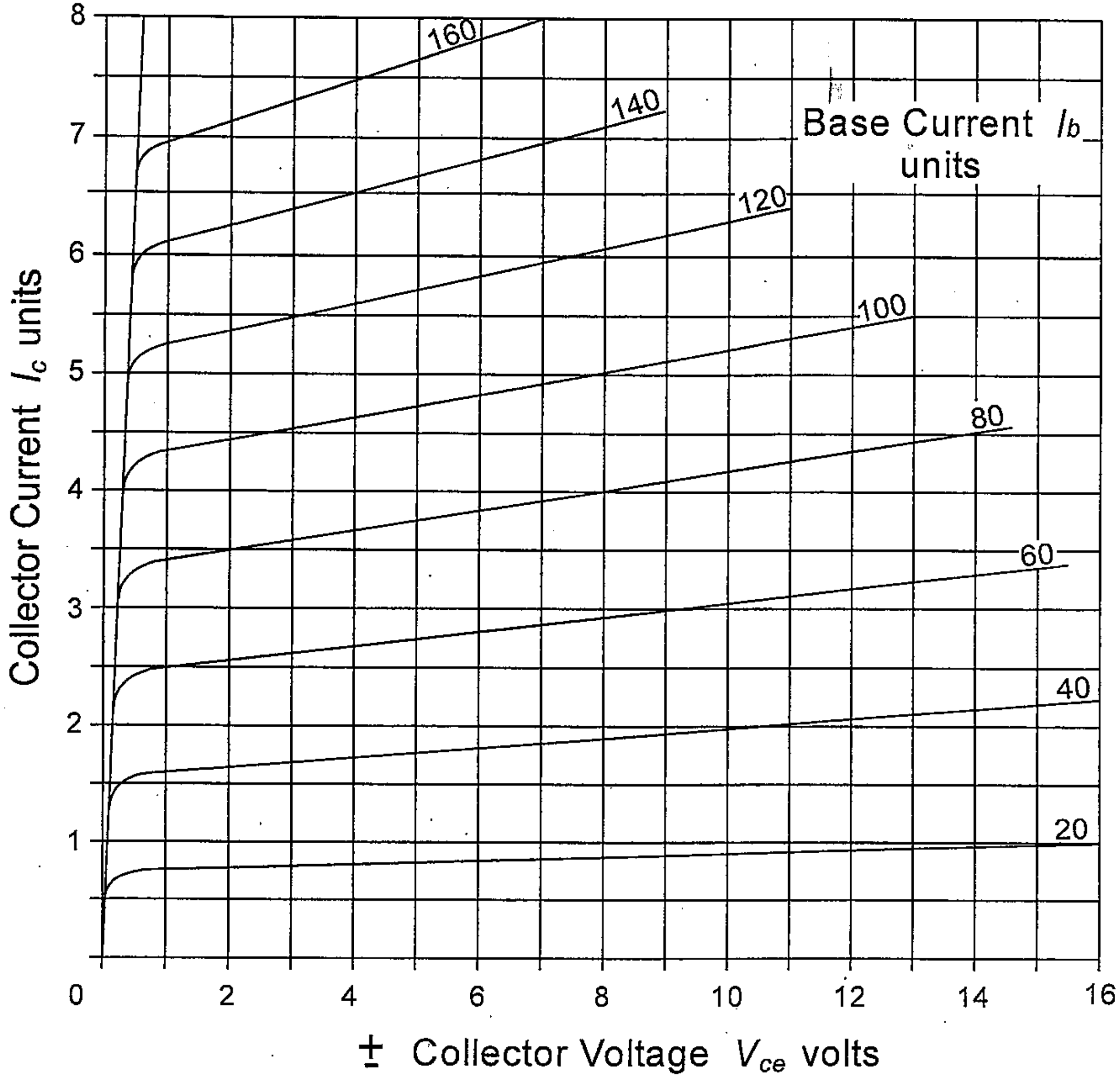
1. Non-programmable calculators may be used.
2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper

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

Candidate's Name ....

Examination Centre ....

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. The network shown in Fig Q1 is for sensing temperature.

(a) Calculate the value of the sensing element R_X so that the meter will read full scale deflection (FSD) of 1mA. (8)

(b) The meter becomes unserviceable and is replaced with one of the same resistance but full scale deflection 2mA.

Calculate the value to which the 200Ω resistor will have to be changed to enable the meter to continue reading FSD. (8)

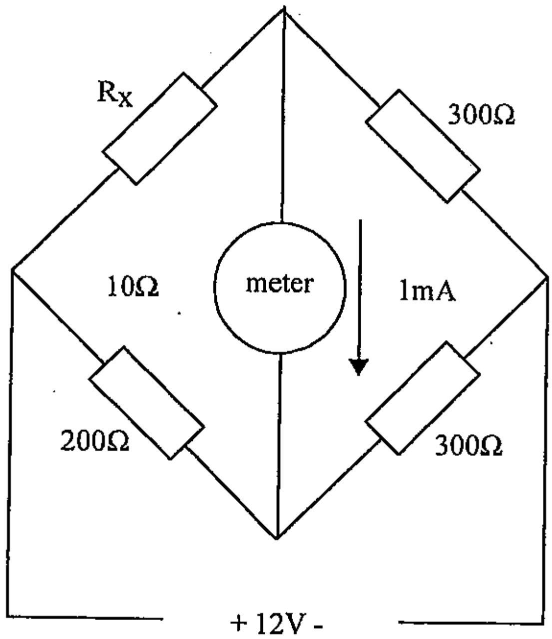


Fig Q1

2. Fig Q2 shows a ring main of total length 1000m fed at 240V d.c. Three loads are taken from the ring, 60A at 200m, 90A at 500m and 150A at 700m from the feed point respectively, all distances being measured in a clockwise direction.

Calculate EACH of the following, if the resistance of the feeder (*go* + *return*) is 0.002Ω/m:

(a) the currents fed into the ring main in each direction; (6)

(b) the lowest voltage across any of the three loads; (5)

(c) the total power loss in the ring main. (5)

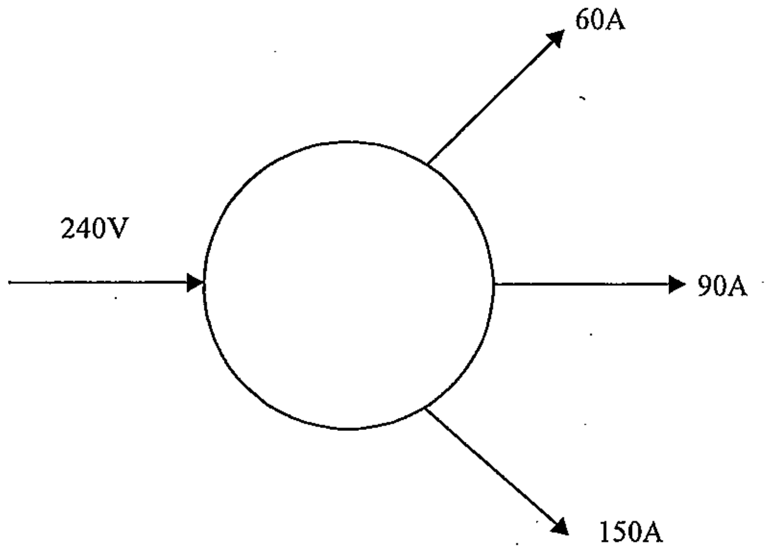


Fig Q2

3. A silicon power transistor with the characteristics given in Worksheet Q3 is operated from a 12V supply and has a maximum power rating of 18W.

(a) Plot the 18W power dissipation curve on the characteristics. (5)

(b) Determine the minimum safe collector load resistance for the transistor (4)

(c) If the transistor is biased at the base with 80mA and a sinusoidal signal is applied to the base with an amplitude of ±40mA.

Determine EACH of the following:

(i) the variation in collector current; (2)

(ii) the corresponding variation in collector voltage; (2)

(iii) the a.c. power output of the transistor. (3)

4. A coil of unknown resistance and unknown inductance is tested on 60V 50Hz and draws a current of 4A. When a 300μF capacitor is connected in series with the coil the current rises to 5A.

Calculate EACH of the following:

(a) the resistance of the coil; (5)

(b) the inductance of the coil; (5)

(c) the power factor of the coil; (3)

(d) the power factor of the coil and capacitor in series. (3)

5. Two 415V 3-ph alternators supply a ship's load comprising:

- lighting totalling 800kW at unity power factor
- motors totalling 1700kW at power factor 0.7 lag

One alternator supplies 1400kVA at power factor 0.75 lagging.

(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 added to the system to raise the overall power factor to 0.9 lag.

If this motor takes 300kW determine the power factor at which it must operate. (4)

6. A 440/110V single phase transformer is rated at 40KVA full load output. The iron loss is 3kW 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 the squirrel cage induction motor:

(a) state TWO reasons why the starting current is much higher (typically 3-6 times) than the full load running current; (4)

(b) explain why the rotor power factor is very low on starting (typically 0.2); (3)

(c) explain why almost the entire iron loss occurs in the stator, with only a tiny iron loss in the rotor; (3)

(d) describe, with the aid of a sketch, one form of construction which provides improved starting torque and reduced starting current. (6)

8. (a) List the advantages of turbo-electric or diesel-electric drive systems for marine propulsion. (6)

(b) Explain ONE method by means of which the synchronous propulsion motor is brought up to speed when requires for service. (6)

(c) Explain how reversal of the drive motor is achieved without reversal of the prime mover. (4)

9. (a) State the conditions necessary for *turn on* and *turn off* of a thyristor (silicon controlled rectifier). (4)

(b) (i) describe the operation of the circuit shown in Fig Q9. (8)

(ii) sketch the load current waveforms for EACH of the following switching delay angles:

(1) 45° (2)

(2) 120° (2)

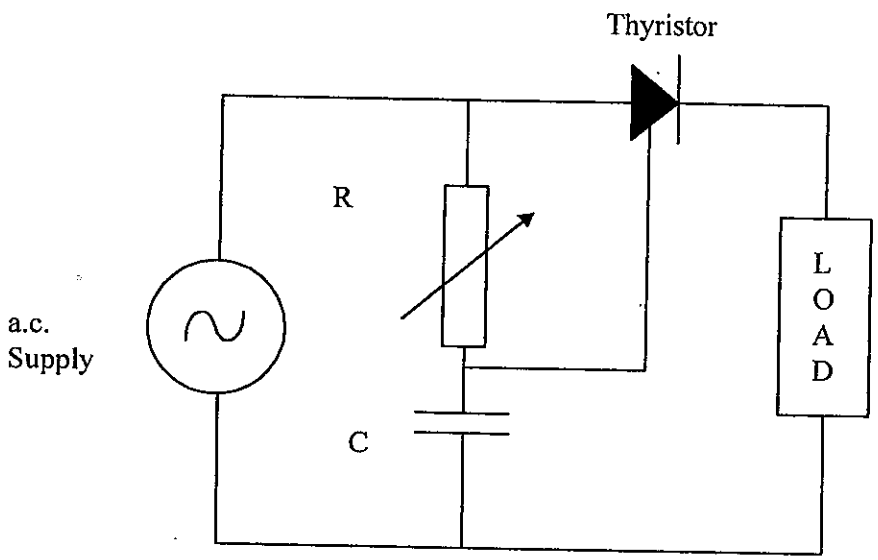


Fig Q9

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY
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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 25 MARCH 2010

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

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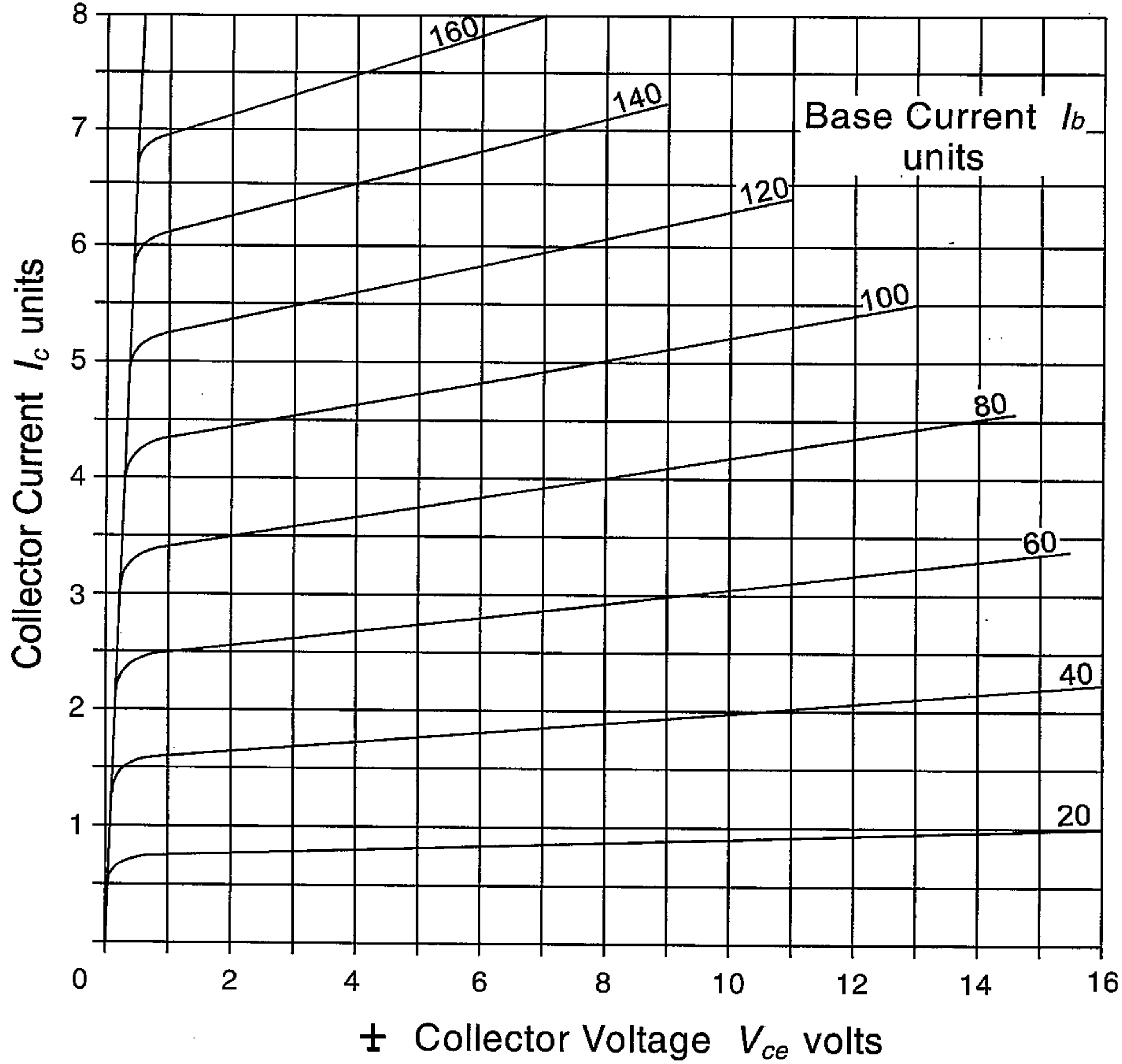
Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper

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

Candidate's Name ……………………………………………

Examination Centre ……………………………………………

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. (a) For the circuit shown in Fig Q1, determine EACH of the following:

   (i) the current in the 12Ω resistor; (6)

   (ii) the p.d. across each resistor. (6)

   (b) The 12Ω resistor is now removed from the circuit, calculate the voltage between points A and B. (4)

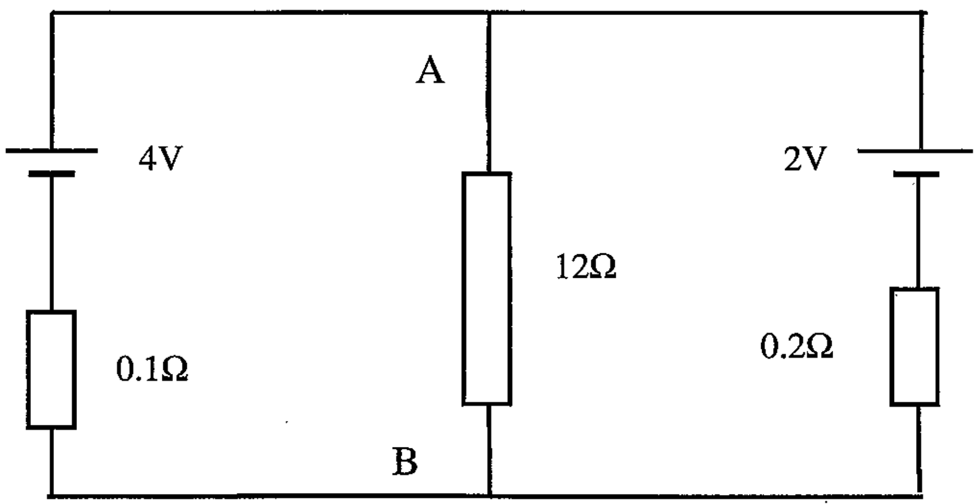


Fig Q1

2. A non linear resistor which has the characteristic $I = 0.5\ V^{0.5}$ is connected in series with a linear resistor of 16Ω across a 120V d.c. supply.

   (a) Determine EACH of the following:

   (i) the circuit current; (6)

   (ii) the p.d. across the non-linear resistor. (2)

   (b) If the supply voltage is now reduced to 75V, calculate the p.d. across the linear resistor. (8)

[OVER

3. A small silicon transistor whose characteristics are given in Worksheet Q3 is used as a common emitter amplifier with a 16V supply and a 2.2kΩ load resistor in the collector circuit. The bias current at the base is 80μA and the sinusoidal input signal varies between ±40μA.

(a) Construct the load line on Worksheet Q3. (2)

(b) Determine EACH of the following:

(i) the d.c .power dissipated in the transistor; (4)

(ii) the R.M.S. signal current in the transistor; (4)

(iii) the R.M.S. output voltage; (4)

(iv) the current gain of the amplifier circuit. (2)

4. A 200Ω resistor is connected in series with a coil of resistance *R* and inductance *L* across a 240V 50Hz a.c. supply.

The p.d. across the 200Ω is 120V and the p.d. across the coil is 190V.

Determine EACH of the following:

(a) the supply current; (3)

(b) the resistance *R* and inductance *L* for the coil; (10)

(c) the power factor of the coil. (3)

5. Three resistors of 80Ω, 60Ω and 40Ω are connected in star to a 4 wire 3-ph supply of 415V.

Calculate EACH of the following:

(a) the current in each resistor; (3)

(b) the current in the neutral wire; (10)

(c) the power dissipated in each resistor. (3)

6. A propulsion-shaft generator shares the total 3-ph 440V load for a ship with a diesel driven generator. An over excited synchronous motor is used to improve the power factor. The total load for the ship is 1.2MVA at a p.f. of 0.83 lag and the synchronous motor takes an additional 40kW. The diesel generator operates at a p.f. 0.9 lag and the shaft generator supplies its rated load of 650kW at unity power factor.

Calculate EACH of the following:

(a) the KVA and KVAR loading of the diesel generator; (4)

(b) the current supplied by the diesel generator; (3)

(c) the current supplied by the shaft generator; (3)

(d) the power factor of the synchronous motor. (6)

7. (a) Explain how the rotor current is produced in a three phase squirrel cage induction motor and how, in turn, this current produces a torque on the rotor. (5)

(b) Explain how the ratio of rotor resistance to rotor reactance influences both the running torque and the starting torque. (6)

(c) Explain why the power factor of the basic squirrel cage motor is low on starting but improves as the motor approaches full load speed. (5)

8. (a) Explain why it is important, in the case of a star connected alternator with the star point earthed, to detect any high leakage current between one 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. (6)

(c) It is normal practice to earth the star point of alternators generating 1000V and above via an earthing resistor. Explain how the value of such an earthing resistor is determined. (5)

9. (a) Sketch the reverse voltage/current characteristic for a low power Zener diode with a breakdown voltage of 12V. (4)

(b) Sketch a circuit diagram for a voltage stabilising circuit using the Zener diode described in Q9(a). (4)

(c) State which factors determine the value of the series resistor used in the circuit diagram in Q9(b). (4)

(d) State the conditions under which the dissipation of the Zener diode is a maximum. (4)

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 10 DECEMBER 2009

0915 - 1215 hrs

Examination paper inserts:

Notes for the guidance of candidates:

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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:

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Graph Paper

10 DEC 2009

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

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1. A non-linear resistor whose characteristic is given in Table Q1 is connected in series with a 6.8kΩ resistor to 80V d.c. supply.

   Determine EACH of the following:

   (a) the circuit current; (8)

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

   (c) the value to which the series resistance must be changed to make the voltages across the two resistors equal. (4)

V_{NL} volts	0	10	20	30	40	50	60
I_{NL} mA	0	1.6	3.6	5.9	8.4	10.9	13.6

Table Q1

2. A capacitor of 100μF is charged from a 120V d.c. supply via a resistor of 10kΩ.

   Calculate EACH of the following:

   (a) the time taken for the voltage across the capacitor to reach 80V; (4)

   (b) the value of the energy stored in the capacitor at this point; (4)

   (c) if the supply is now removed and a second 10kΩ resistor is connected in its place, calculate EACH of the following:

      (i) the time taken for the voltage across the capacitor to drop to 50V; (4)

      (ii) the current in the circuit at this point. (4)

[OVER

3. A simple voltage stabilizer circuit consists of a 1 Watt Zener diode and a series resistor *R* The Zener diode has a breakdown voltage of 12V and a slope resistance of 2Ω. It requires a minimum current of 2mA for successful stabilisation. The unregulated supply voltage can vary between 18V and 24V.

Calculate EACH of the following:

(a) the minimum value of resistor *R* if the output current is zero and the input voltage is at its maximum of 24V; (7)

(b) the maximum output current which can be drawn when the input voltage is 18V if satisfactory stabilization is to be maintained; (6)

(c) the power dissipated by the Zener diode in Q3(b). (3)

4. An a.c. circuit consists of a capacitor *C* connected in series with a pure resistor *R*. This combination is supplied from a 120V a.c. supply of variable frequency. When the frequency is 50Hz, the circuit current is 4A and when the frequency is increased to 100Hz the current rises to 5A.

Calculate EACH of the following:

(a) the value of *R*; (4)

(b) the value of *C*; (4)

(c) the power factor at 50Hz; (3)

(d) the frequency when the current is 4.5A. (5)

5. A balanced star connected three phase load has a coil of inductance 0.2 H and resistance 50Ω in each phase. It is supplied at 415V 50Hz.

Calculate EACH of the following:

(a) the line current; (4)

(b) the power factor; (3)

(c) the value of each of three identical delta connected capacitors to be connected to the same supply to raise the overall power factor to 0.9 lag; (6)

(d) the value of the new line current. (3)

6. A six pole 3-ph induction motor runs off a 380V 60Hz supply. It delivers a useful shaft output power of 40kW. The rotational losses (windage and friction) amount to 3kW and the speed is 19 rev/sec. The input current is 104A at a lagging power factor of 0.7.

Calculate EACH of the following:

(a) the rotor copper loss; (6)

(b) the stator loss; (6)

(c) the efficiency. (4)

7. (a) Explain why earth fault monitoring is necessary in an insulated 3-ph a.c. electrical power supply system. (4)

(b) (i) Sketch a circuit diagram to show how three lamps may be connected to a 3-ph 440V a.c. power system to indicate the presence of earth faults; (4)

(ii) Explain how this circuit would indicate an earth fault on the blue line. (4)

(iii) State the effect of a simultaneous earth fault on the red and yellow lines. (4)

8. With reference to a single phase power transformer with air cooling:

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

(b) explain the principle of operation; (4)

(c) state why it is rated in KVA not KW; (2)

(d) explain why it may overheat if supplied at a lower frequency than normal; (3)

(e) state how operation at reduced frequency may be compensated for to avoid overheating. (3)

9. (a) State TWO advantages of using a Ward-Leonard system employing an induction motor drive for operating winches aboard ship. (4)

(b) State TWO disadvantages of using the Ward Leonard system. (4)

(c) Describe ONE alternative system of providing a variable speed electrical drive which does not use the Ward-Leonard system, stating ONE advantage and ONE disadvantage of the chosen method. (8)

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, 22 OCTOBER 2009

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 total resistance of the network between terminals A and B; (8)

   (b) the current in the 10Ω resistor; (4)

   (c) the voltage across the 12Ω resistor. (4)

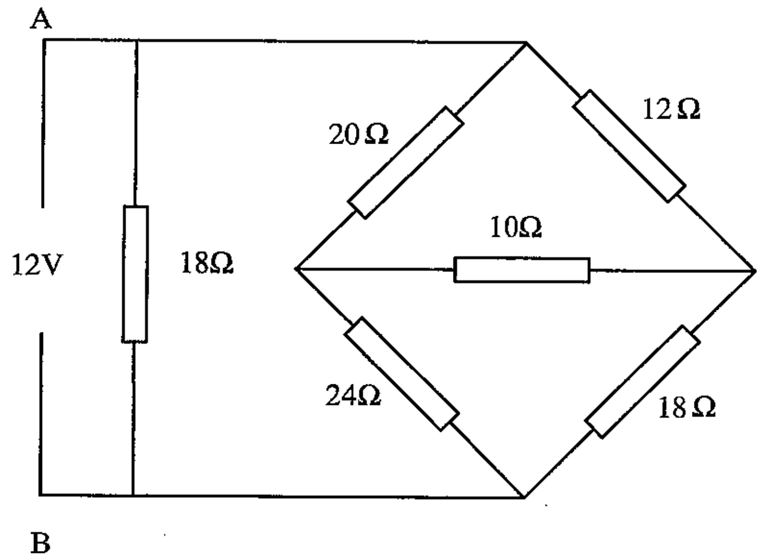

Fig Q1

2. A relay coil has a resistance of 200Ω and the current required to operate the relay is 150mA. When the coil is connected to 50V d.c. it takes 40ms for the relay to operate.

   (a) Calculate EACH of the following:

   (i) the steady state relay current; (2)

   (ii) the time constant for the coil; (4)

   (iii) the inductance of the coil. (4)

   (b) To increase the operating time for the relay, a 50Ω resistor is connected in series with the coil.

   Calculate the new operating time for the relay. (6)

[OVER

3. The p.d. between base and emitter for the transistor shown in Fig Q3 is 0.3V and the steady state output voltage V_C is 6V.

Determine EACH of the following, assuming that the base current is small enough to be ignored:

(a) the voltage at the base with respect to earth; (3)

(b) the p.d. between emitter and collector; (3)

(c) the value of the load resistor R_L; (3)

(d) the power dissipated in the 200Ω resistor; (3)

(e) the power dissipated in the transistor. (4)

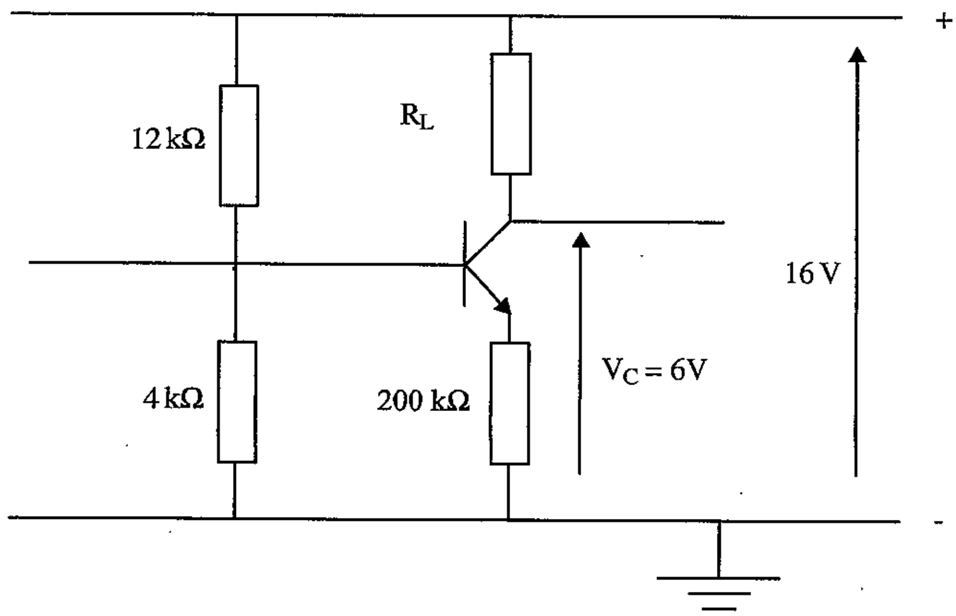

Fig Q3

4. A coil of unknown inductance and unknown resistance is connected across a variable frequency supply of 120V. When the frequency is 50Hz the current is 4A and when the frequency is increased to 100Hz the current falls to 3A.

Determine EACH of the following:

(a) the resistance of the coil; (6)

(b) the inductance of the coil; (6)

(c) the power factor of the coil at 50Hz (2)

(d) the power dissipated by the coil at 100Hz. (2)

5. Three identical coils are delta connected across a 3-ph. 440V 60Hz. supply and consume a total power of 9kW at a power factor of 0.8 lag.

(a) Determine the resistance and inductance of each coil. (6)

(b) The three coils are now connected in star to the same supply, determine EACH of the following:

(i) the line currents if one coil is short circuited; (5)

(ii) the line currents if one coil is open circuited. (5)

6. A 3-ph. 440V 60Hz 8 pole induction motor drives a load of 7kW and runs at 14.4 rev/sec. The power factor is 0.8 lag. The stator loss is 0.6kW and the rotational losses (windage and friction) are 0.4kW.

Calculate EACH of the following:

(a) the slip; (4)

(b) the frequency of the rotor emf.; (2)

(c) the input power to the motor; (6)

(d) the line current. (4)

7. (a) Explain why a synchronous motor is not self-starting. (4)

(b) (i) Sketch a block diagram showing the essential features of an electrical propulsion system utilising a synchronous motor as the final drive element. (4)

(ii) Explain how starting, speed control and reversal of direction of rotation are achieved. (6)

(c) State the advantages of operating a synchronous motor at unity power factor by adjustment of the excitation. (2)

8. (a) Two 3-ph a.c. alternators are operating in parallel under normal load condition.

Describe the probable outcome of EACH of the following:

(i) faulty automatic voltage regulator causes a total loss of excitation to one generator; (4)

(ii) a faulty governor causes a total loss of fuel supply to one prime mover. (4)

(b) Describe the effect of EACH of the following:

(i) increasing the excitation of one machine; (4)

(ii) increasing the input power to one machine. (4)

9. (a) Sketch an auto transformer starter suitable for starting a large induction motor. (6)

(b) Explain the sequence of operations and the effect on the motor being started when the starter shown in Q9(a) is operated. (6)

(c) State ONE advantage of the auto transformer over the star-delta method of starting. (2)

(d) State ONE disadvantage of the autotransformer compared to the star-delta starter. (2)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 16 JULY 2009

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

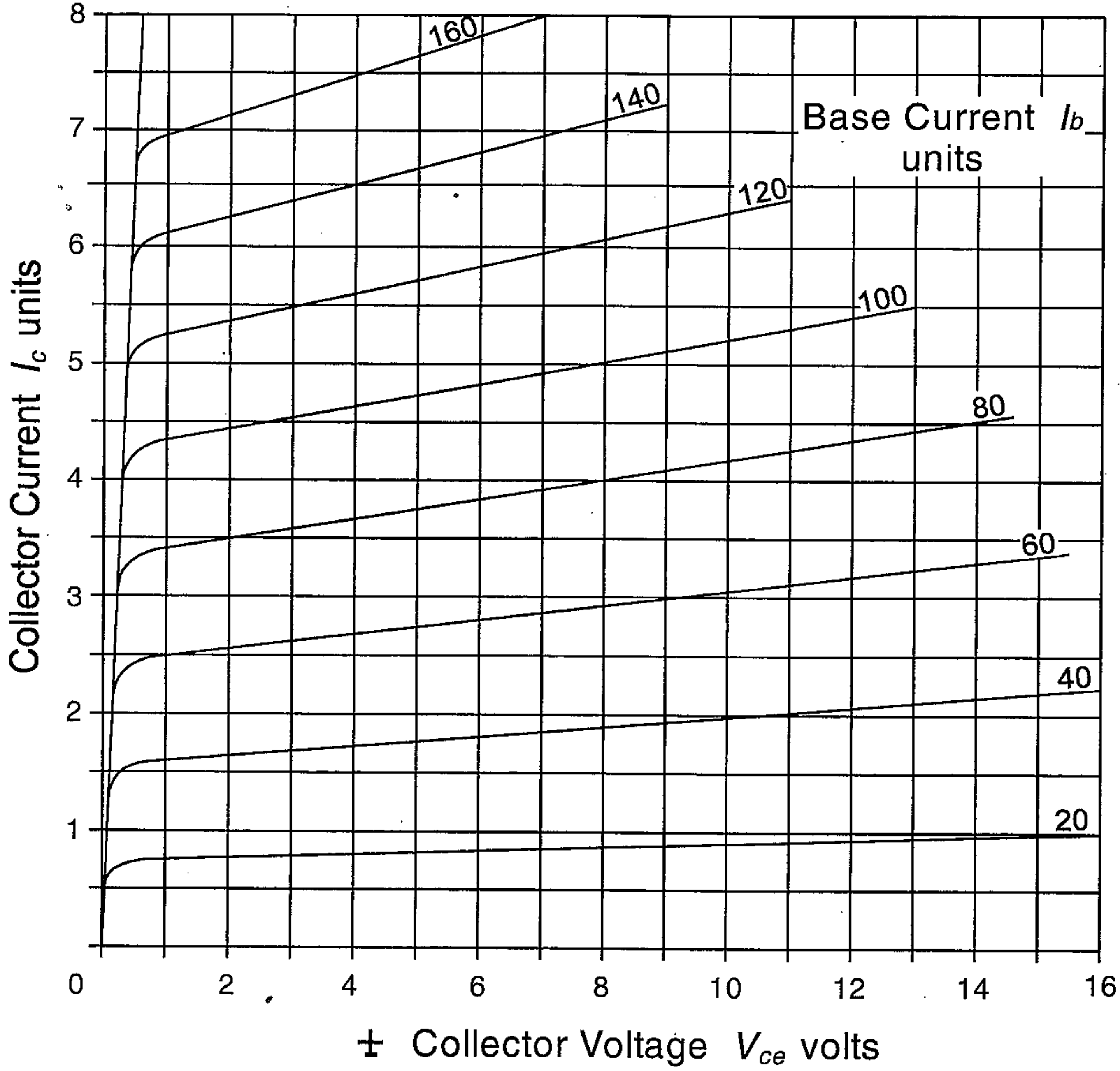
1. Non-programmable calculators may be used.
2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper

WORKSHEET Q3

(This Worksheet must be returned with your answer book)



COMMON EMITTER TRANSISTOR CHARACTERISTCS

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

Candidate's Name ....

Examination Centre ....

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. In the network shown in Fig Q1 the meter indicates 2mA in the direction shown.

   Determine EACH of the following:

   (a) the resistance of the meter; (8)

   (b) the reading on the meter if the 1.5kΩ and the 2kΩ resistors are interchanged. (8)

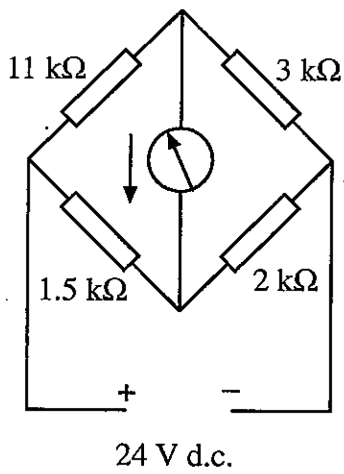


Fig Q1

[OVER

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

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 Q2(b) to 1.2 secs. (6)

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

(a) Draw the load line on the characteristics. (4)

(b) Determine EACH of the following:

(i) the value of the collector load resistor; (4)

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

(iii) the corresponding peak-to-peak variation in collector voltage; (2)

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

4. A single phase a.c. circuit comprises a coil of inductance 0.5H and resistance 100Ω in series with a capacitor C. It is connected to 120V 50Hz and draws a current at a leading power factor. The volt drop across the coil is 150V.

Determine EACH of the following:

(a) the current in the circuit; (4)

(b) the value of the capacitor; (6)

(c) the power factor of the circuit; (4)

(d) the power dissipated in the coil. (2)

5. A three phase star connected circuit has a coil of inductance 0.1H and resistance 25Ω in each phase. It is connected to 440V 50Hz supply.

(a) Find EACH of the following:

(i) the line current drawn by the load; (5)

(ii) the power factor; (3)

(iii) the power taken by the load. (3)

(b) Calculate the values of three identical capacitors which when connected in delta to the same supply will raise the overall power factor to unity. (5)

6. A 6 pole squirrel cage induction motor runs on 380V 60Hz supply. It draws a line current of 80A at a power factor of 0.8 lag. The shaft speed is 19 rev/sec. If the iron losses are 2kW, the stator copper loss is 1kW and the windage and friction loss is 1.5kW.

Calculate EACH of the following:

(a) the slip as a per unit value; (3)

(b) the rotor copper loss; (5)

(c) the shaft output power; (5)

(d) the efficiency. (3)

7. (a) Sketch a circuit diagram showing the method of starting a squirrel cage induction motor by the star-delta method. (8)

(b) Explain why the starting current is reduced by this method of starting compared to direct-on-line starting. (4)

(c) State by what factor the starting current is reduced when using this method of starting. (4)

8. With reference to a single phase air cooled transformer:

(a) sketch a labelled diagram showing the method of construction; (5)

(b) explain the principle of operation; (4)

(c) state why it is rated in kVA rather than kW; (3)

(d) explain why the transformer may overheat if operated at a higher frequency than that for which it was designed; (2)

(e) state how operation at enhanced frequency may be compensated for to prevent overheating. (2)

9. (a) Sketch a basic circuit diagram for a pair of winch motors operated on the Ward-Leonard principle, employing a squirrel cage induction motor as the drive element in the Ward-Leonard set. (8)

(b) Explain how the speed of the winch motors is varied, with reference to the circuit diagram given in Q9(a). (4)

(c) Explain how the direction of rotation of the winch motors is reversed. (4)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 2 APRIL 2009

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. Q.1 shows a d.c. distribution system fed with a different supply voltage at each end. The resistance of the twin supply cables ('go and return') is 0.001Ω/m.

   Determine EACH of the following:

   (a) the current supplied from each end of the system; (6)

   (b) the p.d. at each of the three load points; (6)

   (c) the power lost in the supply cables. (4)

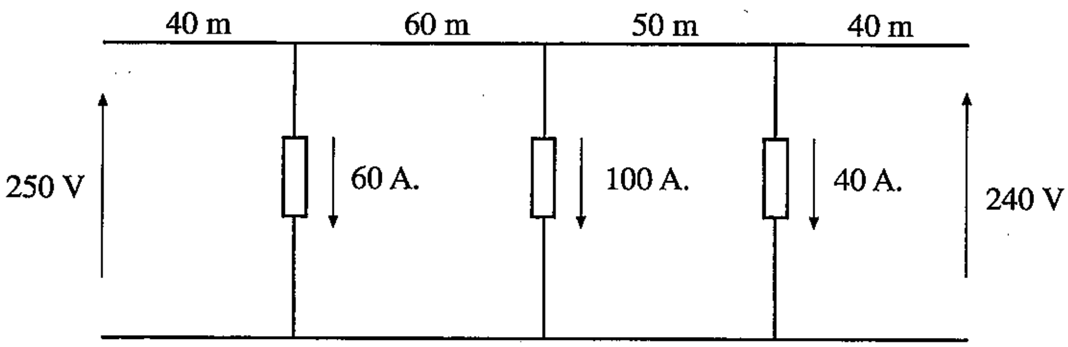

Fig Q. 1

2. A coil of inductance 2H and unknown resistance is connected to a d.c. supply of 100V. After 4msec the current has risen to 75% of its final steady state value.

   Determine EACH of the following:

   (a) the resistance of the coil; (6)

   (b) the energy stores in the coil when the current has reached its steady state value; (4)

   (c) the time taken for the current to fall to 50% of its steady state value when the supply is switched off. (6)

3. Fig Q3 shows a basic voltage regulator circuit using a Zener diode and a series resistor. The input voltage can vary between 16 and 24 volts and the Zener diode has a breakdown voltage of 12V. The slope resistance of the Zener diode is 1Ω and it requires a minimum reverse current of 2mA. for satisfactory regulation. If the regulated output current can range between 20 mA and 200mA.

(a) Determine the maximum permissible value of the resistor 'R' when the input voltage is 16V and the output current is 200mA. (6)

(b) Using the value of R, calculated in Q3(a), determine EACH of the following:

(i) the Zener diode current when the input voltage is 24V and the output current is 20mA; (5)

(ii) the regulated output voltage when the input voltage is 20V and the output current is 100mA. (5)

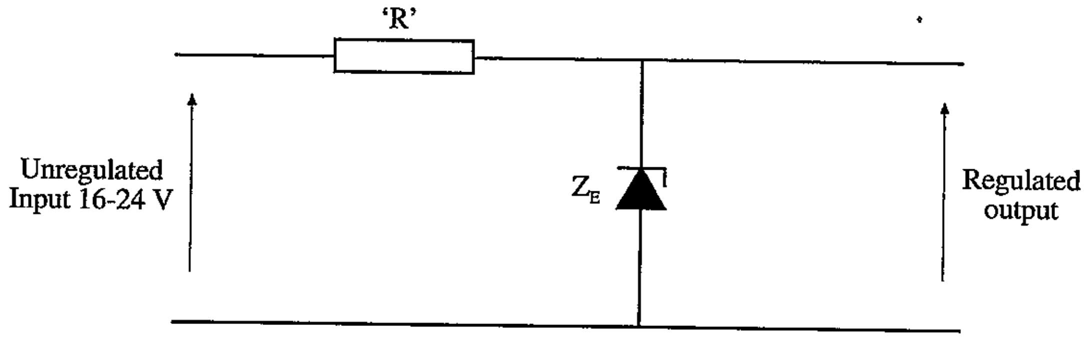

Fig Q3

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

(a) Determine the values of the resistor and the capacitor.

(b) When the frequency is 50HZ, determine EACH of the following: (6)

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

(ii) the value of an inductor which, when connected in series with the pair, will give the same current of 3.6A but with a lagging power factor equal to the value obtained in Q4(b)(i). (6)

5. Two 6 pole 3 phase a.c. generators operating in parallel supply a total load of 2000kVA at a power factor of 0.8 lag.

Their load characteristics are linear with the test results given in Table Q5:

Generator	Speed/kW	Voltage/kVAR
No. 1	1440 rev/min on N/L 1200 rev/min on 1200 KW	500 V on N/L: 415 V on 1000 kVAR
No. 2	1360 rev/min on N/L 1180 rev/min on 900 kW	490 V on N/L 425 V on 800 kVAR

Table Q5

Determine EACH of the following :

(a) the supply frequency; (6)

(b) the bus bar voltage; (6)

(c) the kVA output of each generator; (2)

(d) the operating power factor of each machine. (2)

6. A balanced three phase star connected load has a coil of inductance 0.2H and resistance 100Ω in each leg. The supply is 415 V.50 Hz.

Determine EACH of the following:

(a) the line current drawn by the circuit; (5)

(b) the power factor of the circuit; (3)

(c) the components of a delta connected circuit which would draw the same line current but at a leading power factor numerically equal to that found in Q6(b); (6)

(d) the power dissipated by either circuit. (2)

[OVER

7. (a) Explain, with the aid of a circuit diagram, the *auto transformer* method of starting a squirrel cage induction motor. (8)

(b) State two advantages of the auto transformer method of starting over the star delta method of starting. (4)

(c) State two disadvantages of the auto transformer method of starting. (4)

8. (a) State the conditions necessary to *turn on* and *turn off* a thyristor (silicon controlled rectifier). (4)

(b) Describe the operation of the circuit shown in Fig Q8. (8)

(c) Sketch load waveforms for switching delay angles of :

(i) 45° (2)

(ii) 120° (2)

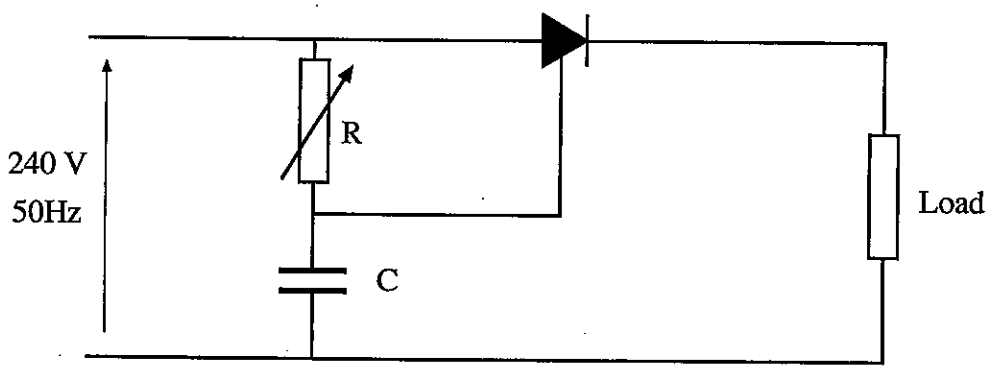

Fig Q8

9. (a) Sketch the circuit arrangement of a *wound rotor* type of induction motor, including brushes, slip rings and starting resistors. (8)

(b) State two advantages of the wound rotor type of motor. (4)

(c) State two disadvantages of the wound rotor machine. (4)

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 11 DECEMBER 2008

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

DEC. 2008

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. A non-linear resistor whose characteristic is given by $V = kI^{1.5}$ (where I is in mA) is connected in series with a variable resistor 'R' to a d.c. supply of 90 volts. When 'R' is set to 4kΩ the current is found to be 9mA.

   Determine EACH of the following :-

   (a) the value of the constant 'k'; (6)

   (b) the resistance of the non-linear resistor when the current is 9mA; (4)

   (c) the value to which 'R' must be adjusted to make the circuit current 4mA. (6)

2. For the network shown in Fig Q2 determine EACH of the following:

   (a) the resistance between the terminals A and B; (8)

   (b) the current in the 10Ω resistor; (4)

   (c) the p.d. across the 15Ω resistor. (4)

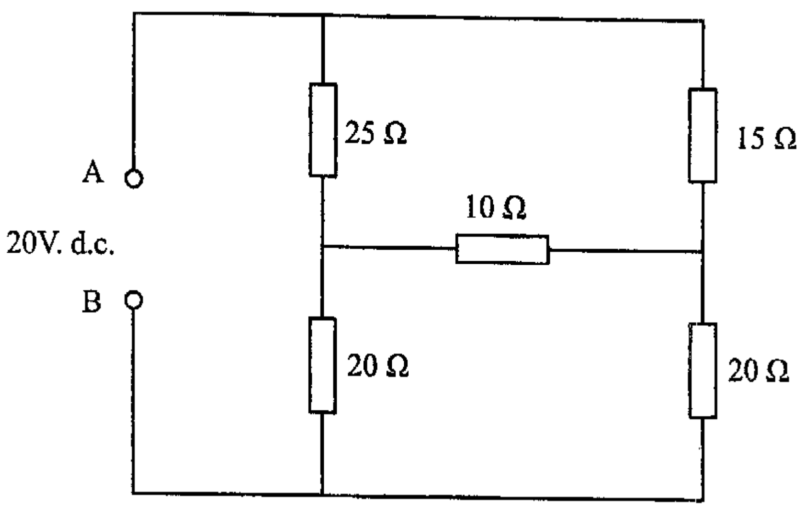

Fig Q2

4 The parallel a.c circuit shown in Fig Q4 is supplied at 240V 50Hz and draws a total current of 5A at power factor 0.95 lagging.

Determine EACH of the following:-

(a) the value of 'R'; (3)

(b) the value of 'C'; (3)

(c) the value to which 'R' must be changed to make the overall p.f. unity; (6)

(d) the new total current. (4)

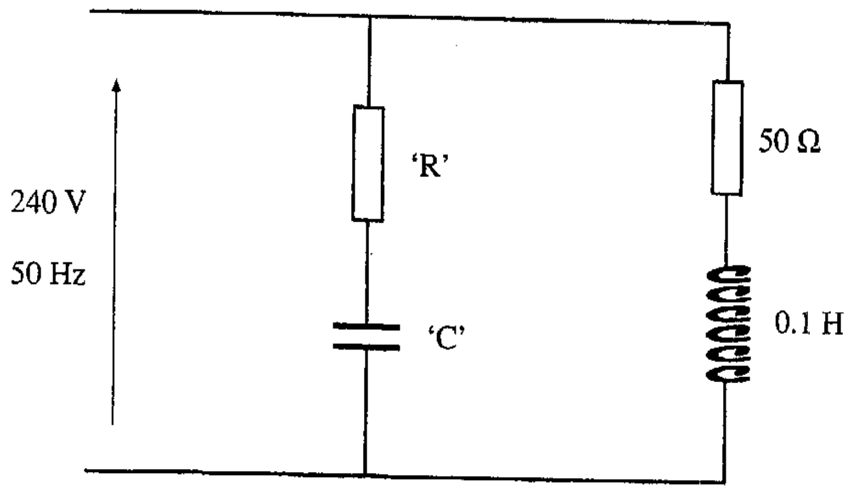

Fig. Q.4

5. A 440V 400kVA three phase transformer is designed to operate at maximum efficiency at ¾ full load and unity power factor. The iron losses total 8kW.

Determine EACH of the following:

(a) the efficiency at ¾ full load and 0.8 p.f.; (6)

(b) the total losses at full load; (6)

(c) the full load efficiency at unity p.f. (4)

DEC. 2008

6. An unbalanced three phase load is supplied from a 440V 50Hz four wire supply. The current in the red line is 6A. lagging by 30^0, the current in the yellow line is 5A in phase and the current in the blue line is 7A. leading by 15^0.

Determine EACH of the following:

(a) the current in the neutral line; (6)

(b) its phase angle relative to the voltage between the red line and the neutral line; (5)

(c) the total power dissipated by the circuit. (5)

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

8. (a) State the reasons for using instrument transformers in a marine distribution system. (4)

(b) Sketch a diagram of a voltmeter, ammeter and wattmeter connected to a single phase system using the appropriate voltage and current transformers. (6)

(c) Explain why the secondary windings of such instrument transformers are invariably earthed. (4)

(d) A voltmeter, an ammeter and a wattmeter on a single phase system read 240V, 22A and 4.5kW respectively. Calculate the power factor of the circuit. (2)

9. (a) Explain the term '*power factor correction*'. (3)

(b) State two advantages of power factor correction. (4)

(c) Explain, with the aid of a suitable circuit diagram, how power factor correction can be effected by using capacitors in a circuit. (5)

(d) State one other method, other than the use of capacitors, of bringing about power factor correction. (4)

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

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MARITIME AND COASTGUARD AGENCY

STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 16 OCTOBER 2008

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. In the network shown in Fig Q1 the current in the 100Ω resistor is 2 mA in the direction shown.

   Determine EACH of the following:

   (a) the value of the resistor 'R'; (8)

   (b) the value of 'R' to give the same current in the 100Ω but in the opposite direction. (8)

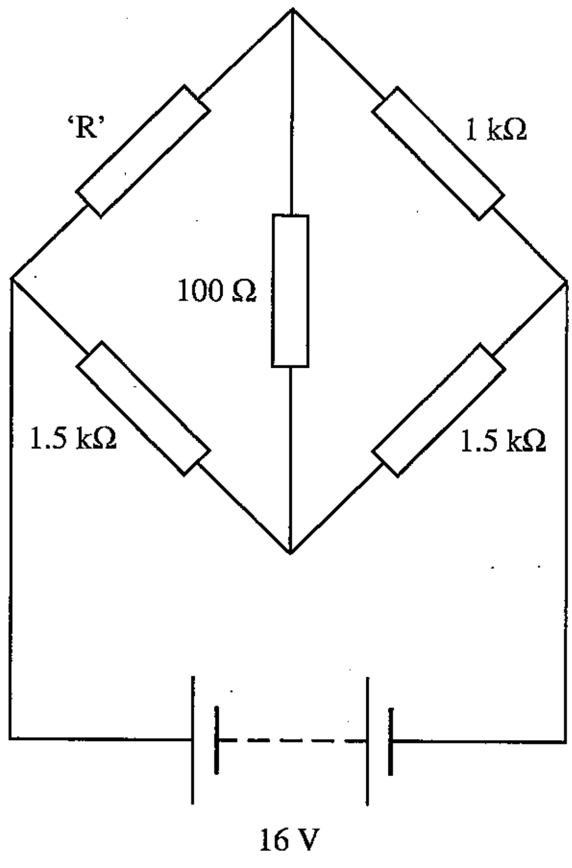

Fig Q1

2. A non-linear resistor whose characteristic is given in Table Q.2. is connected in parallel with a resistor of 2kΩ and the pair are connected in series with a resistor of 500Ω to a d.c. supply of 35 V.

Determine EACH of the following:

(a) the current in the circuit. (8)

(b) the current in the non-linear resistor. (4)

(c) the effective resistance of the parallel combination. (4)

V (volts)	5.0	10.0	15.0	20.0	25.0	30.0	35.0
I(mA)	5.6	15.8	29.0	44.7	63.0	82.0	104.0

Table Q2

3. Fig Q.3 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)

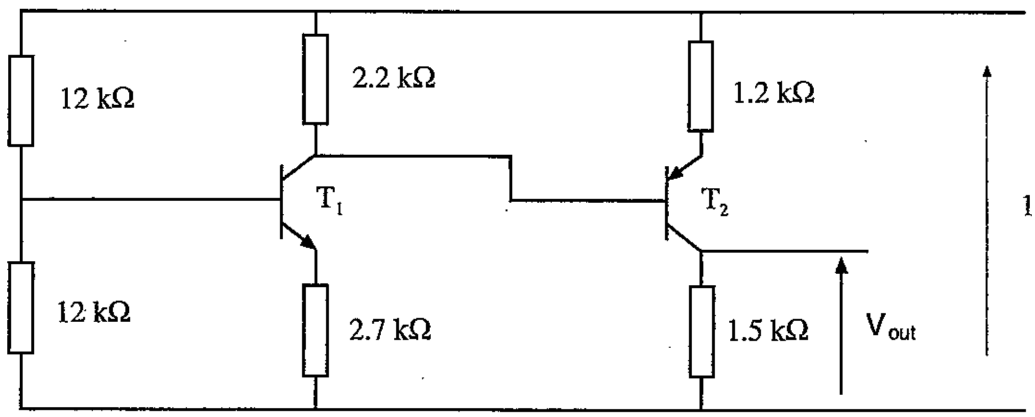

Fig Q3

4. A coil of inductance 0.1 H. has a power factor of 0.7 and is connected in parallel with a capacitor 'C' across 120 V. 60 Hz.

Determine EACH of the following:

(a) the resistance of the coil; (4)

(b) the value of the capacitor if the total current is 4 A.at a leading power factor; (5)

(c) the power factor for the two branches in parallel; (5)

(d) the kVA for the combined circuit. (2)

5. A three phase 4 pole induction motor runs at 24 rev./sec. from a 440 V. 50 Hz. supply. It produces a shaft output power of 60 kW. The rotational loss (friction and windage) is 2 kW, the stator loss is 3kW and the power factor is 0.7.

Determine EACH of the following:

(a) the per unit slip; (3)

(b) the rotor copper loss; (5)

(c) the power input to the motor; (5)

(d) the line current. (3)

6. Two 3.3 kV. Three phase alternators operating in parallel supply the following three loads:

- a lighting load of 600 kW at U.P.F.;
- motors totalling 2500 kW at p.f. 0.7 lag;
- a synchronous motor driving a large circulating pump.

One alternator supplies 350 A. at p.f. 0.9 lag and the other provides 330 A. at p.f. 0.95 lag.

Determine EACH of the following :

(a) the kW supplied to the synchronous machine; (6)

(b) the p.f. of the synchronous machine; (6)

(c) the overall p.f. of the system. (4)

7. With reference to a three phase synchronous motor:

(a) sketch a simple constructional diagram of the motor; (6)

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

(c) explain one method of starting such a motor; (3)

(d) state how the motor may be used for power factor correction. (2)

8. (a) Sketch the reverse current / voltage characteristic for a low power Zener diode with a breakdown voltage of 10V indicating typical values on the current axis. (5)

(b) Sketch a simple voltage regulator circuit using a Zener diode. (5)

(c) State which factors determine the value of the series resistor used in the circuit described in 8(b). (3)

(d) State which factors determine the power rating of the Zener diode in the circuit described in 8(b). (3)

9. (a) Explain the term *single phasing* when applied to a three phase induction motor. (6)

(b) Describe the probable effects of single phasing on a three phase delta connected induction operating at 75% of full load . (5)

(c) Describe one method by which a motor may be protected against the harmful effects of single phasing. (5)

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MARITIME AND COASTGUARD AGENCY

STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 17 JULY 2008

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.

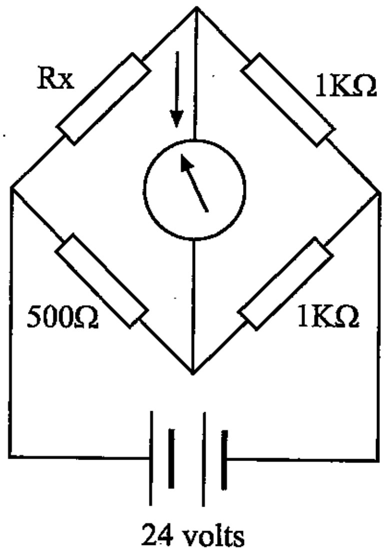
Marks for each part question are shown in brackets.

1. In the metering network shown in Fig Q1 the sensing element is represented by resistor R_x.

   (a) Calculate the value of R_x when the current through the meter is 1mA in the direction shown. (8)

   (b) The meter becomes damaged and has to be replaced with one of 400Ω.

   Calculate the value to which the 500Ω resistor will have to be changed to keep the meter current at 1mA. (8)



Meter resistance = 200Ω

Fig Q1

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2. (a) A capacitor of 100μF is connected in series with a 1kΩ resistor to a d.c. supply of 200 volts.

Calculate EACH of the following:

(i) the potential across the capacitor 0.05 seconds after switching on; (3)

(ii) the energy stored in the capacitor after this time. (3)

(b) The supply is removed after 0.05 seconds and is replaced by a resistor of 2kΩ.

Calculate EACH of the following:

(i) the initial current when this resistor is connected; (3)

(ii) the new time constant for the circuit; (3)

(iii) the time taken for the current to fall to half of its initial value. (4)

3. Fig Q3 shows a simple voltage regulator using a Zener diode and a series resistor.

The Zener diode has the following characteristics:

- Breakdown voltage 12 volts
- Minimum current for stabilisation 1mA
- Slope resistance 10Ω
- Maximum power dissipation 0.5W

Calculate EACH of the following:

(a) the minimum value of the resistor R when the input voltage is 24 volts and there is no load current drawn from the output terminals; (6)

(b) the maximum output current which can be drawn when the input voltage is 14 volts to give reliable stabilisation; (6)

(c) the value of the stabilised output voltage in condition Q3(b). (4)

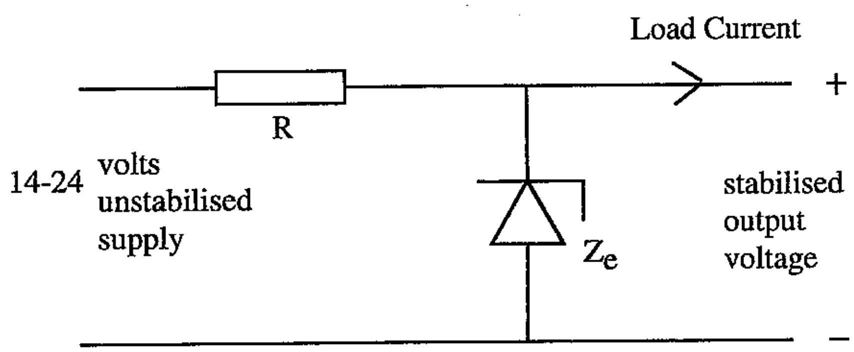

Fig Q3

4. A circuit consists of a resistor in series with a pure inductor. When it is connected to 120 volts 50Hz the current drawn is 2A. A capacitor of 100μF is now connected in series with the pair and the current rises to 3A.

Calculate EACH of the following:

(a) the value of R; (5)

(b) the value of L; (5)

(c) the power factor of the final circuit arrangement; (3)

(d) the power dissipated by R in the final circuit arrangement. (3)

5. Three identical coils each of inductance 0.1H and resistance 30Ω are connected in delta to a three- phase three wire supply of 440 volts 50Hz. Three identical capacitors, connected in star, are now joined in parallel with this load to raise the power factor to 0.9 lagging.

Calculate EACH of the following:

(a) the value of each capacitor; (6)

(b) the percentage reduction in line current; (4)

(c) the KVA_r taken by the three capacitors. (6)

6. A three-phase 6 pole delta connected induction motor is supplied with 380 volts 60Hz. It draws a current of 45A at a power factor of 0.85 lagging. The stator losses are 4kW and the windage and friction losses total 3kW. 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 output torque. (4)

7. (a) State THREE reasons why it is desirable to improve the power factor of an electrical power system. (6)

(b) Describe, with the aid of a circuit diagram, a method by which power factor correction may be effected in a three phase distribution system. (6)

(c) Calculate the percentage reduction in line current for a three phase distribution system if the power factor is improved from 0.7 lag to 0.9 lag. (4)

8. (a) Explain, with the aid of a sketch, the principle of the auto-transformer. (6)

(b) Explain why the auto-transformer is not a suitable choice of transformer for applications where the transformation ratio differs widely from 1:2 or 2:1. (5)

(c) Explain why it is possible with an auto transformer of ratio 2:1 to use the same gauge of conductor throughout the windings. (5)

9. (a) Describe the process by which torque is developed in a single cage induction motor. (8)

(b) Describe ONE form of construction by means of which the starting torque and power factor of the induction motor may be improved with an attendant reduction in starting current. (8)

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

EXAMINATIONS ADMINISTERED BY THE
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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 10 APRIL 2008

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

1. Non-programmable calculators may be used.
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ELECTROTECHNOLOGY

Attempt SIX questions only.

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1. The network shown in Fig Q1 is for measuring purposes. The meter reads 10mA in the direction shown.

   (a) Calculate the resistance of the meter. (8)

   (b) Calculate the value to which the R_1 will have to be changed to enable both meters to read 10mA, if a second meter of the same resistance is added in parallel with the first, for remote indication purposes. (8)

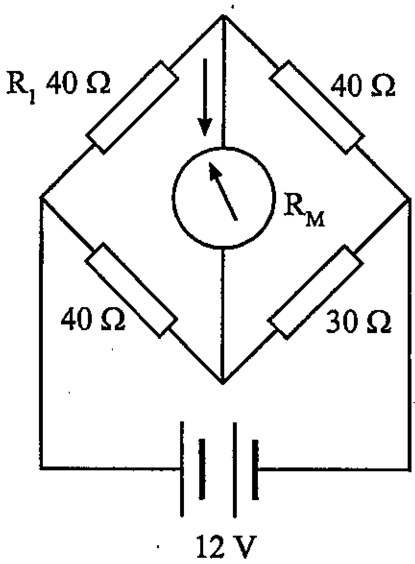

Fig Q1

2. A capacitor C is connected in series with a 20kΩ resistor across a 120V.d.c. supply. One second after switching on the current in the resistor is 3mA.

   (a) Calculate the value of the capacitor. (6)

   (b) Calculate EACH of the following:

      (i) the voltage across the resistor 2 seconds after switching on; (4)

      (ii) the energy stored in the capacitor when it is fully charged; (4)

      (iii) the voltage across the capacitor when it is charged to half its final energy. (2)

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3. A small signal silicon transistor having the characteristics given in Worksheet Q3 is operated on a 12 volt supply with a collector load resistor of 1.5kΩ. The base bias current is 80μA.

(a) Plot the load line on Worksheet Q3. (4)

(b) Determine EACH of the following:

(i) the *peak to peak* value of the collector current for a signal at the base of +/-40μA; (4)

(ii) the corresponding *peak to peak* change in collector voltage; (4)

(iii) the power dissipation of the transistor for this signal input. (4)

4. In the parallel single phase circuit shown in Fig Q4, calculate EACH of the following:

(a) the value of *R* if the overall power factor of the circuit is unity; (8)

(b) the power dissipated in the circuit; (4)

(c) the total impedance of the three branches in parallel. (4)

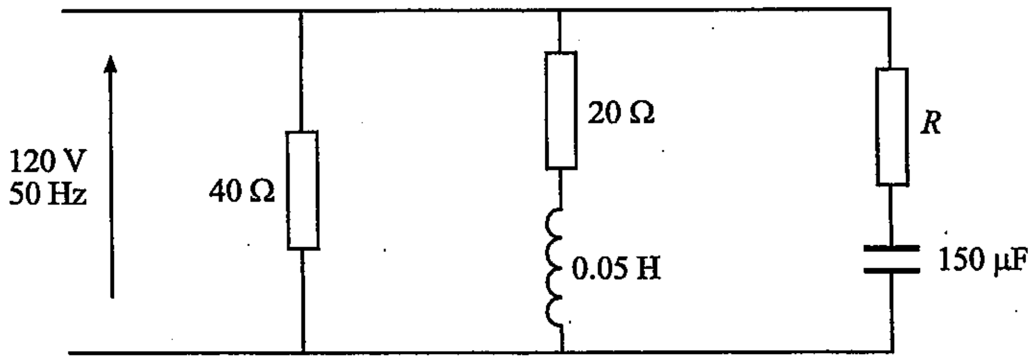

Fig Q4

5. A 415V 50Hz four-pole three-phase induction motor runs at 24 rev/sec and develops an output torque of 200Nm. The rotational losses are 3kW and the stator loss is 4kW.

Calculate EACH of the following:

(a) the rotor copper loss; (6)

(b) the motor input power; (4)

(c) the efficiency; (2)

(d) the input current if the power factor is 0.7 lag. (4)

6. A 440V/240V single phase transformer has an iron loss of 2kW. When delivering its full load output of 40kVA, the copper loss is 2.5kW.

(a) Calculate the output kVA for maximum efficiency. (4)

(b) If the transformer is operated at half full load and 0.7 p.f., calculate EACH of the following:

(i) the copper loss under these conditions; (4)

(ii) the input current to the transformer; (4)

(iii) the efficiency at this load and p.f. (4)

7. (a) Sketch the reverse voltage/current characteristics for a low power Zener diode with a breakdown voltage of 10 volts, indicating typical values on the current axis. (4)

(b) Sketch a simple voltage stabilising circuit using the Zener diode described in Q7(a). (4)

(c) State which factors determine the choice of series resistor in the circuit sketched in Q7(b). (4)

(d) State the circuit conditions which cause the power dissipated in the Zener diode to be a maximum. (4)

8. (a) Describe, with the aid of a basic circuit diagram, a method of reducing the current drawn by a squirrel cage motor during starting. (8)

(b) Explain how the starting torque will be affected by the method of starting outlined in Q8(a) compared to the torque available using direct on line starting. (5)

(c) State ONE type of load which is suited to being driven by an induction motor started at reduced voltage. (3)

9. (a) State the conditions necessary to *turn on* and *turn off* a thyristor (silicon controlled rectifier). (4)

(b) Describe the operation of the circuit shown in Fig Q9. (8)

(c) Sketch the voltage waveform applied to the load for EACH of the following trigger delay angles:

(i) 40^0 (2)

(ii) 120^0 (2)

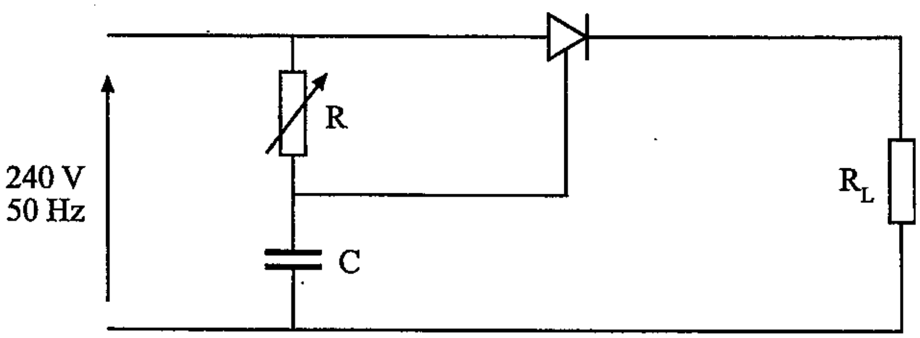

Fig Q9

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 13 DECEMBER 2007

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. The distribution system shown in Fig Q1 is fed at each end with 240 volts. The resistance of the twin cable (Go + Return) is 0.01Ω/m.

   Calculate EACH of the following:

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

   (b) the potential difference across each of the three loads; (6)

   (c) the power lost in the distribution cables. (4)

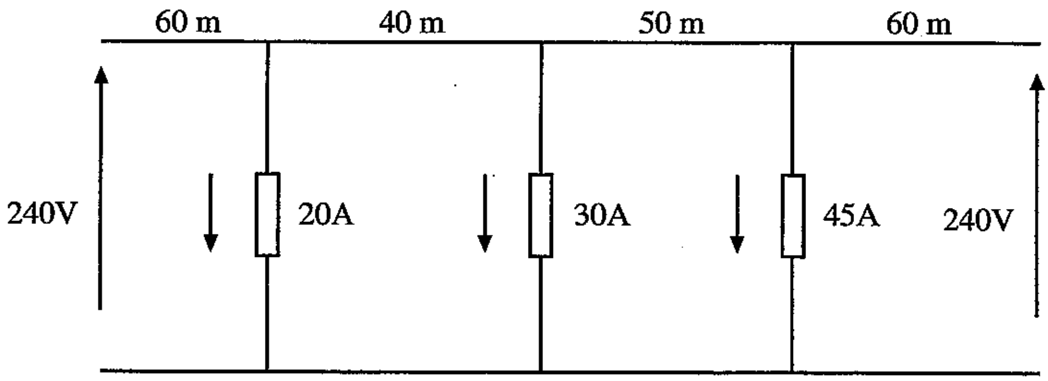

Fig Q1

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2. The V/I characteristic of a non-linear circuit element is given in Table Q2.

V (volts)	60	90	120	150	180
I (mA)	1.3	2.2	3.0	4.4	6.6

Table Q2

This non-linear device is connected in series with a resistor of 27kΩ across a supply of 170Vd.c.

Determine EACH of the following:

(a) the supply current; (8)

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

(c) the power dissipated in the 27kΩ resistor. (4)

3. Fig Q3 shows a two stage small signal amplifier using transistors of high gain whose base currents may be ignored. Transistor T_1 has a volt drop of 0.6V between base and emitter and transistor T_2 has a volt drop of 0.3V between base and emitter.

Calculate EACH of the following:

(a) the value of R_L to give a steady state voltage of 6V at the collector of T_2; (8)

(b) the power dissipated in transistor T_1; (4)

(c) the power dissipated in resistor R_L. (4)

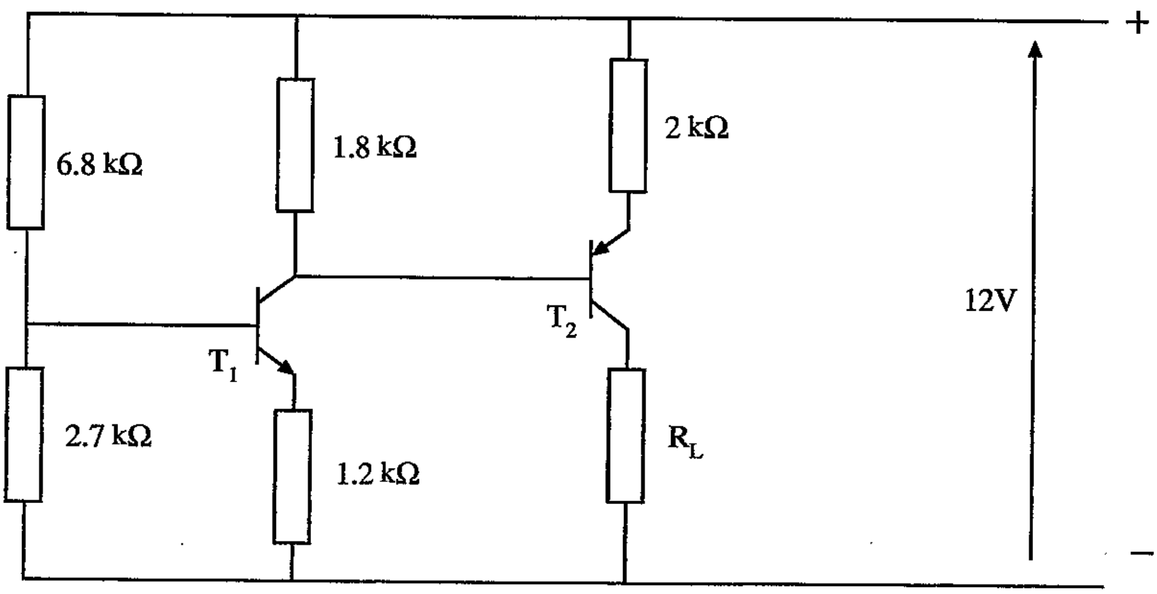

Fig Q3

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

(a) the total current for the circuit; (6)

(b) the overall power factor of the circuit; (4)

(c) the value to which the capacitor would have to be changed to give an overall power factor of unity. (6)

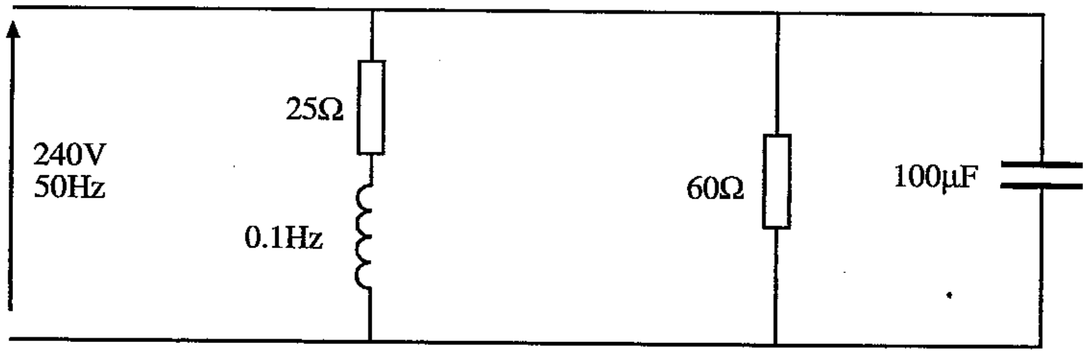

Fig Q4

5. In the delta connected load shown in Fig Q5 each coil has a resistance of 100Ω and an inductance of 0.2H.

Calculate EACH of the following:

(a) the values of resistance and inductance for a star connected circuit which would draw the same line current and have the same power factor; (8)

(b) the value of resistance to be connected in parallel with each leg of this star connected circuit to increase the power consumption by 50%; (5)

(c) the new power factor. (3)

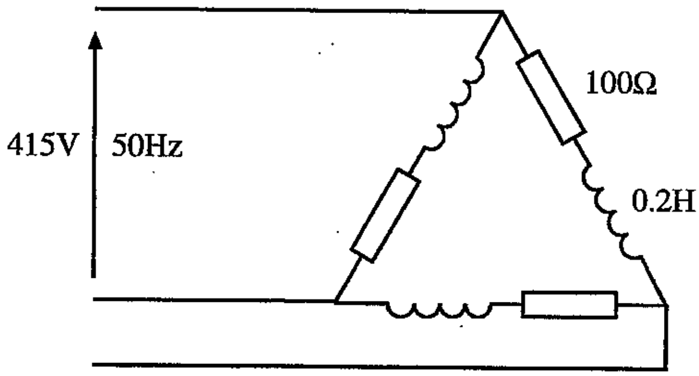

Fig Q5

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6. Two 440 volt three-phase alternators operating in parallel supply the three loads specified below:

- 1200kVA at p.f. 0.8 lag;
- 900kW at U.P.F;
- 450kW at p.f. 0.75 lead.

Calculate EACH of the following, if one alternator provides 1200kW at U.P.F.:

(a) the power factor of the second alternator; (6)

(b) the output current of the second alternator; (6)

(c) the total current supplied to the three loads. (4)

7. (a) State the reasons for using instrument transformers in a shipboard electrical distribution system. (4)

(b) Sketch a circuit showing a voltmeter, an ammeter and a wattmeter connected to a single phase distribution system using instrument transformers. (6)

(c) Explain why the secondary windings of instrument transformers are usually earthed. (2)

(d) A voltmeter, an ammeter and a wattmeter connected to a single phase inductive circuit read 440V, 150A, and 50kW respectively.

Determine the power factor of the circuit. (4)

8. (a) Explain, with the aid of a sketch, the principle of the synchronous motor. (6)

(b) State how the synchronous motor may be used to improve the power factor of an a.c. supply system. (4)

(c) State ONE method by which a synchronous motor may be started and synchronised to the supply, if the synchronous motor is not self starting. (6)

9. (a) Sketch a circuit diagram showing the rotor/slip ring and starting resistor connections for a three phase wound rotor induction motor. (6)

(b) Sketch, on the same axes, three curves showing the relationship between torque and speed for a wound rotor induction motor for EACH of the following conditions: (6)

- the rotor circuit resistance and reactance are equal
- the rotor circuit resistance is one half the rotor reactance
- the rotor circuit resistance is one tenth the rotor reactance

(c) Explain, with the aid of the curves, how the speed of the motor can be varied. (4)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 18 OCTOBER 2007

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:

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Graph Paper

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. A non-linear resistor whose characteristic is given by $I=kV^{1/2}$ is connected in series with a variable resistance across a 120V d.c. supply. When the variable resistance is adjusted to 56Ω the current in the circuit is 1A.

   Calculate EACH of the following:

   (a) the value of the constant *k*; (6)

   (b) the value to which the variable resistor must be adjusted to make the circuit current 0.75A; (6)

   (c) the power dissipated in the non-linear resistor when the current is 0.75A. (4)

2. A relay coil consists of resistance in series with an inductance of 1 Henry and is designed for operation from a 24V supply. The relay closes when the current in its winding is 100mA and this takes place when the relay current has risen to 63.2% of its final value.

   (a) Calculate the resistance of the relay coil. (4)

   (b) The relay will open when the current has fallen to 70mA.

   Calculate EACH of the following:

   (i) the time taken after switching off for the relay to open. (6)

   (ii) the new time to close the relay if the supply voltage falls to 18V. (6)

3. Fig Q3 shows a small signal transistor biased by means of a Zener diode and a resistor. A steady voltage of 6 volts is required across the emitter resistor R_E which carries 1A.

Calculate EACH of the following, if the voltage between the base and emitter of the transistor is 0.6V and the base current is negligible:

(a) the breakdown voltage of the Zener diode; (4)

(b) the maximum permissible value of the resistor R if the Zener diode requires a minimum current of 2mA for satisfactory regulation; (6)

(c) the power dissipated by the transistor when the current in R_E is 0.75A. (6)

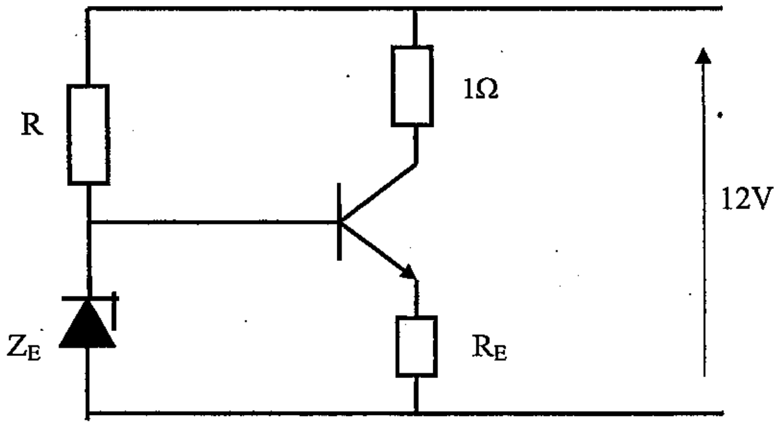

Fig Q3

4. The series circuit shown in Fig Q4 is connected to 120V 50Hz supply. It draws a current of 2.4A at a power factor of 0.8 lagging. The resistor R_2 dissipates 57.6W and the volt drops across the various parts of the circuit are as shown.

Calculate EACH of the following:

(a) the values of R_1, L and C; (10)

(b) the power factor of the coil (R_1 and L); (3)

(c) the power factor of the combination (R_2 and C). (3)

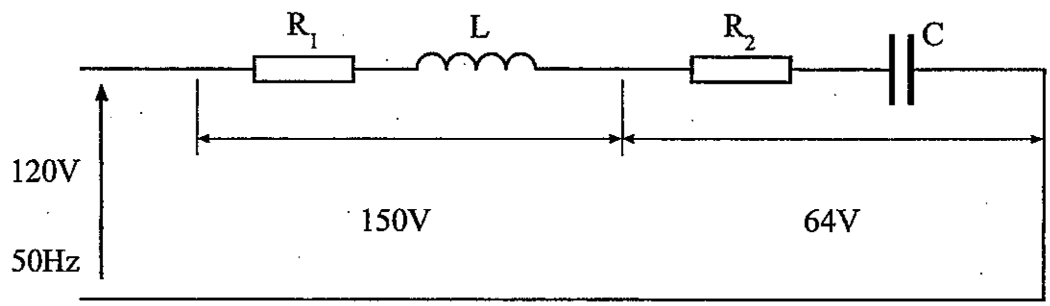

Fig Q4

5. A non-symmetrical three phase star connected load is supplied by a four wire 440V three phase supply. The current in the red line is 7A lagging by 30^0, the current in the yellow line is 4A in phase and the current in the blue line is 3A leading by 15^0.

Calculate EACH of the following:

(a) the value of the current in the neutral line; (6)

(b) the phase angle of this current relative to the voltage between the red line and the neutral; (6)

(c) the total power dissipated in the circuit. (4)

6. A 440V/110V, 60Hz three phase step down transformer is delta connected on the primary side and star connected on the secondary side.

(a) Calculate the number of turns in each phase winding of the primary and the secondary winding, if the maximum permissible flux in the core is 0.0012Wb. (7)

(b) Calculate the transformer efficiency when supplying an output current of 300A at U.P.F. given the following: (9)

- the resistance of each primary phase winding is 0.4Ω
- the resistance of each secondary phase winding is 0.01Ω
- the iron losses are 2.5kW

[OVER

7. Fig Q7 shows a *soft start* circuit for a delta connected induction motor, using six thyristors (silicon controlled rectifiers).

(a) Explain how the circuit works to reduce the current drawn by the motor during starting. (7)

(b) Sketch the voltage waveform applied to 1 phase of the motor at EACH of the following points of the starting sequence:

(i) at the beginning; (3)

(ii) part way through; (3)

(iii) at the completion. (3)

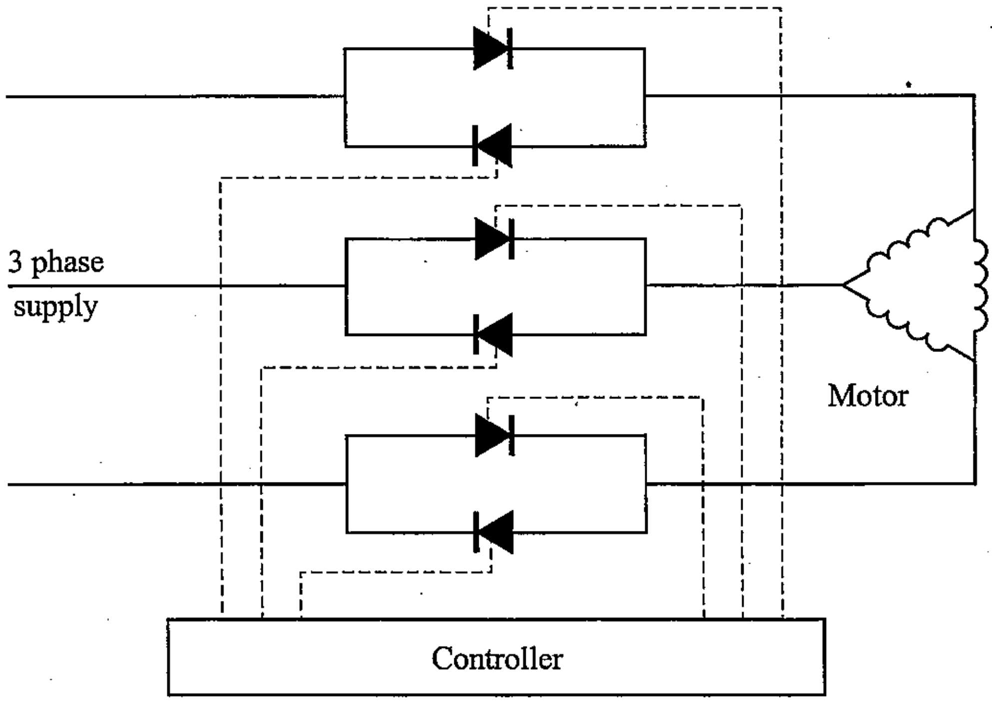

Fig Q7

8. (a) With reference to an electrical supply system using a 3-phase generator, state the advantages and disadvantages of an earthed neutral connection and an insulated neutral system. (6)

(b) Describe a method of reducing the prospective earth fault current in a high voltage generation and distribution system. (4)

(c) Explain how an earth fault can be detected, in a power system using a 3-phase generator with an insulated neutral. (6)

9. (a) Sketch a circuit diagram for driving a ship's winch by means of a Ward-Leonard system utilising a three-phase fixed speed induction motor as the first element in the drive chain. (8)

(b) Explain how the speed of the winch motor is controlled. (4)

(c) Explain how reversal of the winch motor is achieved. (4)

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041-33 - ELECTROTECHNOLOGY

THURSDAY, 19 JULY 2007

0915 - 1215 hrs

Examination paper inserts:

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ELECTROTECHNOLOGY

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1. (a) Calculate the current in the 100Ω meter in the bridge network shown n Fig Q1. (8)

   (b) Calculate the value to which the 1kΩ resistor would have to change to make the current in the meter 1mA in the same direction to that calculated in Q1(a). (8)

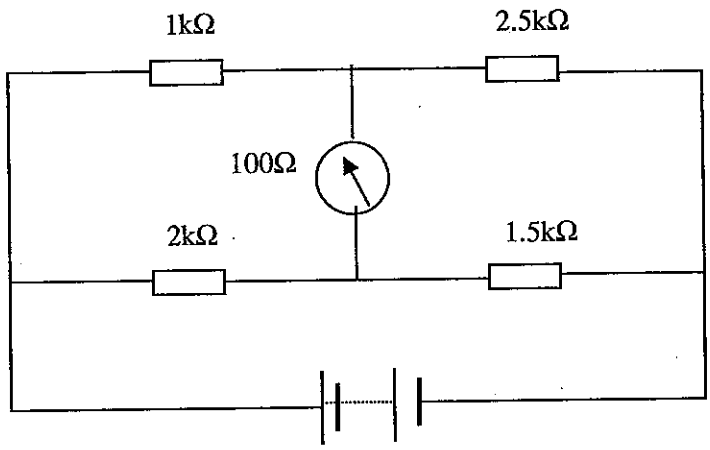

Fig Q1

2. A capacitor of 10uF is connected in series with a 100kΩ resistor to a d.c supply.

   (a) After a time of 0.5 seconds from switching on the voltage across the capacitor is 160 volts. Calculate the voltage of the d.c. supply. (6)

   (b) When the capacitor is fully charged it is disconnected from the supply and discharged through the same resistor.

   Calculate the time taken for the voltage across the capacitor to fall to 160 volts. (6)

   (c) Calculate the energy stored in the capacitor when it is charged to half the supply volts. (4)

[OVER

3. In the two stage transistor amplifier shown in Fig Q3 the volt drop between emitter and base for each transistor is 0.4V and the base currents are small enough to be neglected.

(a) calculate the voltage at the base of transistor T_2; (6)

(b) calculate the voltage at the collector of transistor T_2; (6)

(c) calculate the total current drawn by the amplifier circuit. (4)

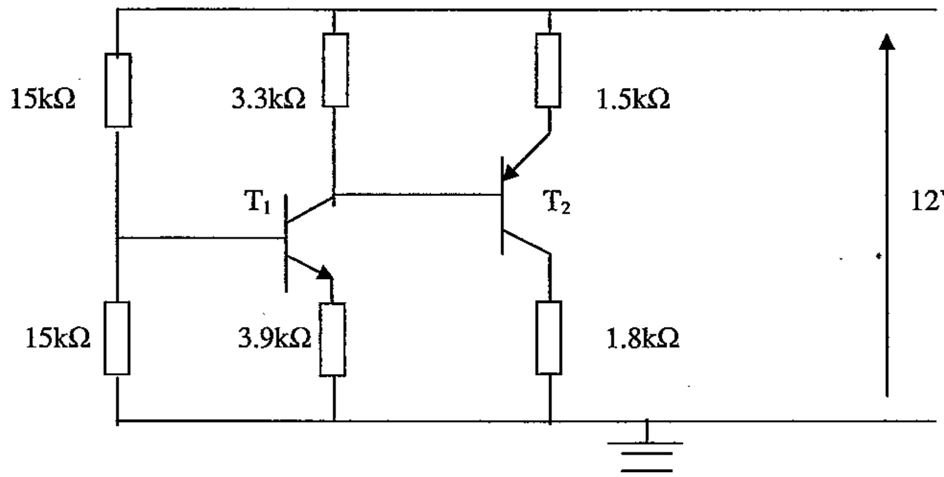

Fig Q3

4. A three phase star connected load, each phase of which comprises a pure resistance of 40Ω in series with an inductance of 0.1H, is connected in parallel with a delta connected load, each phase comprising a pure resistance of 120Ω in series with a capacitor of 70uF, to a supply of 440V 50Hz.

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)

5. A four pole d.c. series wound motor runs off 240 volts and drives a load of constant torque. The armature resistance is 0.6Ω and the four field windings are each of 0.1Ω When the four field coils are connected in series the motor runs at 15 rev/sec and takes a current of 20A. Calculate EACH of the following, if the four field coils are now reconnected in two parallel paths EACH having two coils in series:

(a) the new speed of the motor; (7)

(b) the new supply current; (4)

(c) the efficiency if the rotational losses for the motor are 400W. (5)

6. A 3-ph 440 Volt a.c generator supplies the following loads:

- 400kW at power factor 0.8 lagging
- 300kW at unity power factor
- 250kW at power factor 0.9 leading

Calculate EACH of the following:

(a) the total kW, kVA and kVA_R supplied by the generator; (12)

(b) the generator current and power factor. (4)

7. (a) Sketch the circuit arrangement for a full wave three phase rectifier. (6)

(b) Explain the operation of the circuit sketched in Q7(a), including reference to the order in which the various diodes conduct. (7)

(c) Sketch the output waveform for the circuit sketched in Q7(a). (3)

8. (a) State TWO advantages and TWO disadvantages of the wound rotor method of starting an induction motor. (4)

(b) Sketch a circuit diagram showing the rotor/slip rings/ starting resistors connection for a three phase wound rotor induction motor. (6)

(c) A three phase 4 pole wound rotor induction motor has a rotor induced e.m.f. of 230V, 60Hz between the slip rings at standstill.

Calculate EACH of the following:

(i) the rotor e.m.f. and rotor frequency at a slip of 0.05 p.u. (4)

(ii) the synchronous speed. (2)

9. (a) Sketch a circuit diagram for a switch start fluorescent luminaire. (4)

(b) Explain EACH of the following:

(i) the dual functions performed by the choke coil; (6)

(ii) the purpose of each of the capacitors in the circuit. (4)

(c) State the effect of EACH of the following faults occurring in the choke coil:

(i) a short circuit; (1)

(ii) an open circuit. (1)

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

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SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 29 MARCH 2007

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

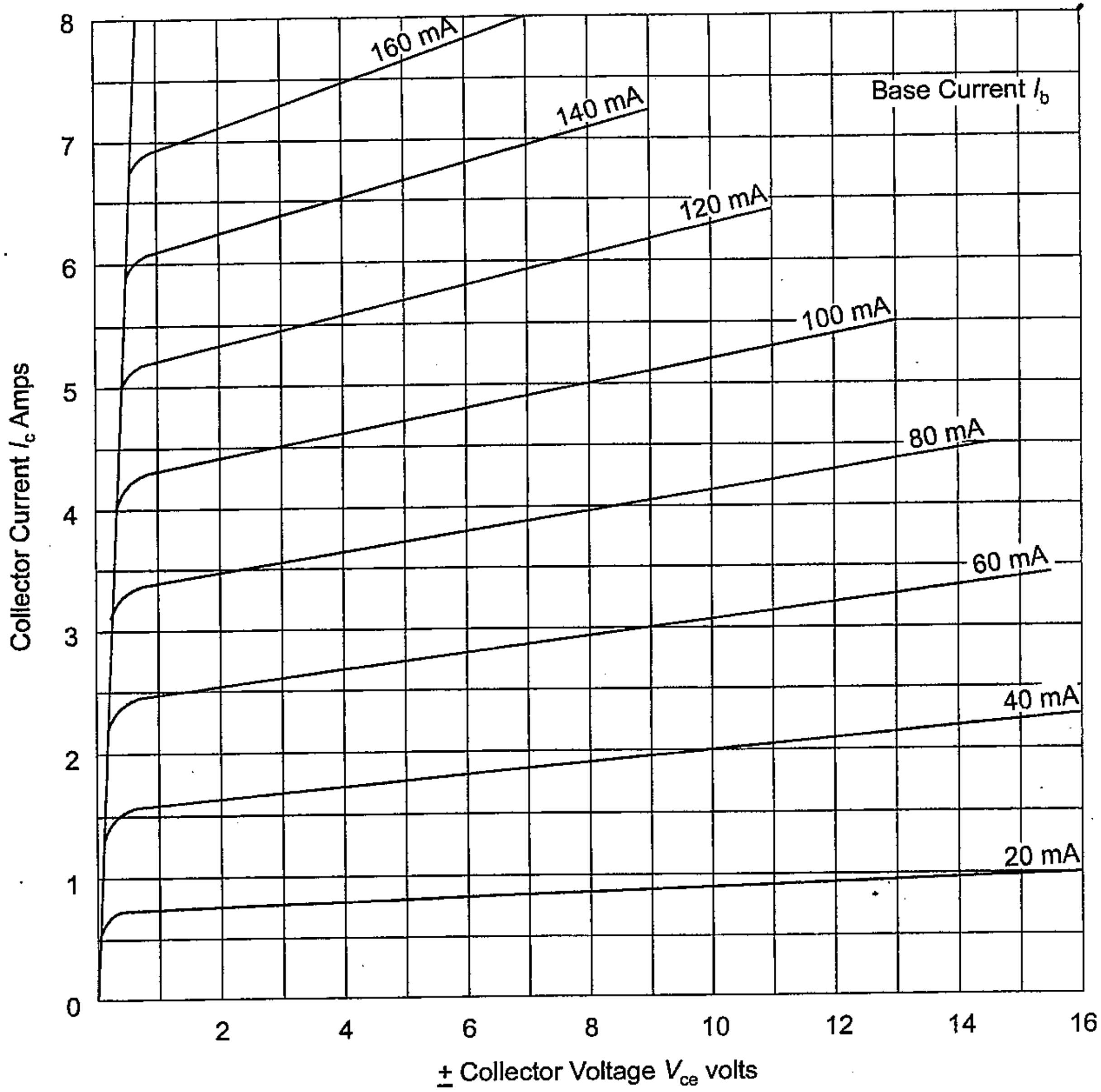
1. Non-programmable calculators may be used.
2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper

WORKSHEET Q3

(This Worksheet must be returned with your answer book)



Candidate's Name ....

Examination Centre ....

ELECTROTECHNOLOGY

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets.

1. The V/I characteristic for a non- linear resistor is given in Table Q1. It is connected in series with a 1.5kΩ resistor to a 12 Volt d.c. supply.

   Determine EACH of the following:

   (a) the circuit current; (8)

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

   (c) the power dissipated in the 1.5kΩ resistor. (4)

V(volts)	2	4	6	8	10	12
I(mA)	1.35	2.10	3.00	4.30	6.30	8.00

TableQ1

2. A two wire distribution system 400 metres long is fed with 220 Volts d.c. at each end. It supplies loads as follows:

   - 65A at 120 metres
   - 80A at 240 metres
   - 100A at 300 metres

   All distances being measured from the same end of the system. The resistance of one core of the supply cable is 0·05Ω /100m.

   Calculate EACH of the following:

   (a) the current supplied at each end of the distribution system; (6)

   (b) the voltage across each load; (6)

   (c) the total power wasted in the distribution cables. (4)

[OVER

3. Worksheet Q3 gives the common emitter characteristics of a silicon power transistor. The units of I_C are amps. The maximum permissible dissipation of the transistor is 16 Watts.

(a) Plot on the characteristics a curve of 16 Watts dissipation. (6)

(b) By superimposing a suitable load line on the characteristics, determine the minimum safe value of the collector load resistance which may be used with a supply voltage of 12V. (6)

(c) Find from the graphs the variation in collector current for a *swing* in base current of ± 40mA, if the bias is fixed at 60mA. (4)

4. A 6 pole delta connected 3-ph induction motor runs at 960 rev/min on 380 Volts 50Hz and draws a current of 40A at 0.8 p.f. The motor has a stator loss of 2kW.

Calculate EACH of the following:

(a) the slip; (3)

(b) the rotor input; (4)

(c) the rotor copper loss; (3)

(d) the output torque if the mechanical losses total 3kW; (4)

(e) the efficiency. (2)

5. A 40kVA 440/110 volt single phase transformer has an iron loss of 0.9kW. 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)

6. An a.c. series circuit consists of four elements as shown in Fig Q6. The power generated in the 50Ω resistor is 200W 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 for the circuit; (5)

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

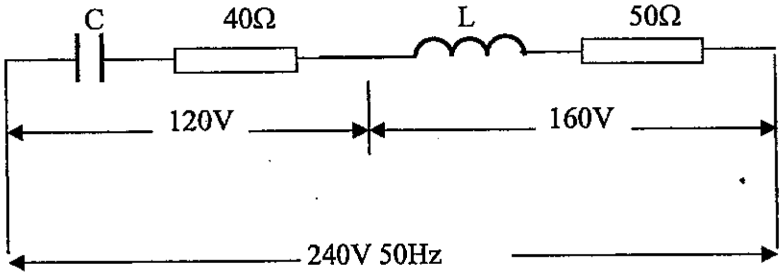


Fig Q6

7. (a) Explain why it is important, in the case of a star connected alternator with the star point earthed, to detect any leakage between one 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 to earth faults to be detected. (6)

(c) It is normal practice to earth the star point of three phase alternators of 1000 volts and above via an earthing resistor.

State how the value of this earthing resistor is determined. (5)

8. (a) Explain how the rotor current is produced in a three phase squirrel cage induction motor and how in turn this current generates torque in the rotor. (5)

(b) Explain how the ratio of resistance to reactance in the rotor of an induction motor affects both the starting and running torque of the machine. (7)

(c) Explain why the power factor of the squirrel cage rotor is normally low on starting but improves as the motor approaches operating speed. (4)

[OVER

9. (a) Sketch the V/I load characteristics for a three phase alternator operating at constant speed and excitation with EACH of the following load power factors:

(i) unity; (2)

(ii) 0.8 lagging; (2)

(iii) 0.8 leading. (2)

(b) Two 3-ph alternators are operating in parallel under normal load conditions. Explain what happens if EACH of the following occurs:

(i) a faulty automatic voltage regulator causes a reduction in excitation to one machine; (5)

(ii) a faulty governor causes a total loss of fuel to the prime mover of one alternator. (5)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 14 DECEMBER 2006

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. A d.c circuit consists of a non-linear resistor in series with a variable resistor R and is connected across a d.c. supply of 48V. The characteristic of the non-linear resistor is given by $I=kV^2$. When R is adjusted to 6Ω the current is 3A.

   Determine EACH of the following:

   (a) the value to which R must be adjusted for the current to be 2A; (8)

   (b) the resistance of the non-linear resistor under these conditions; (4)

   (c) the power dissipated in the non-linear resistor. (4)

2. For the network of resistors shown in Fig Q2, determine EACH of the following:

   (a) the current supplied by each battery; (10)

   (b) the voltage across the 30Ω resistor; (3)

   (c) the power dissipated in the 40Ω resistor. (3)

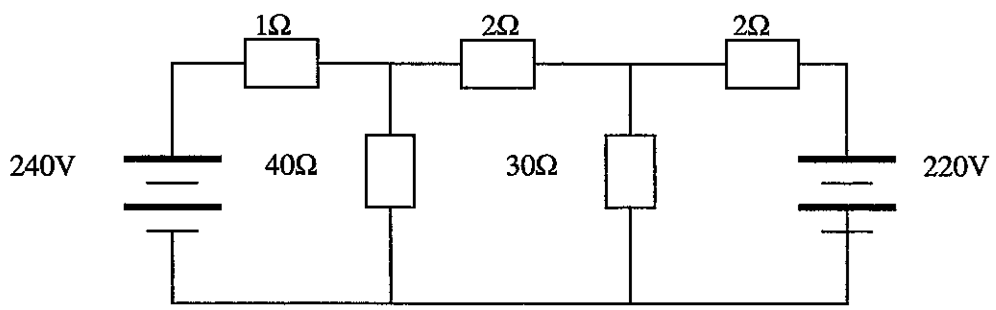

Fig Q2

3. Fig Q3 shows a basic voltage regulator circuit comprising a Zener diode and a series resistor R. The Zener diode has a breakdown voltage of 8.6 volts and a slope resistance of 10Ω after breakdown. It requires a minimum current of 2mA for successful voltage regulation. The unregulated input voltage can vary between 16 and 24 Volts.

Calculate EACH of the following:

(a) the maximum permissible value of R for an input voltage of 16 Volts and an output current of 40mA; (4)

(b) the regulated output voltage for an input voltage of 20 Volts and an output current of 25mA. with the value of R calculated in Q3(a); (6)

(c) the minimum power rating of the Zener diode for an input voltage of 24 Volts and zero output current, for the same value of R. (6)

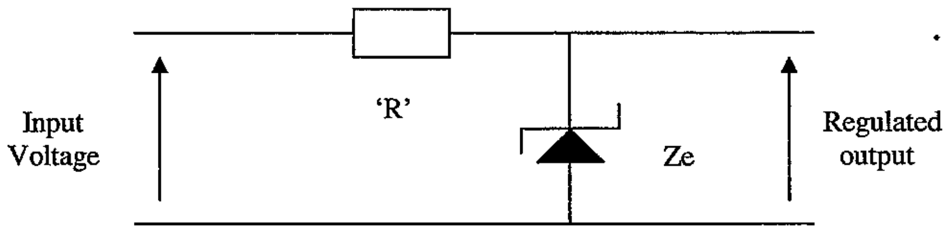

Fig Q3

4. A coil, consisting of resistance in series with inductance, is tested on an a.c. supply of 240 Volts and variable frequency. When the frequency is 50Hz the current drawn by the coil is 4A and when the frequency is increased to 100Hz the current falls to 3A.

Calculate EACH of the following:

(a) the resistance and inductance of the coil; (8)

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

(c) the frequency at which the coil would draw a current of 2A from the supply. (4)

5. A three phase star connected circuit has identical legs each comprising a 25Ω resistor in series with a 200uF capacitor. It is connected to a 440V 50Hz. three wire supply.

(a) Calculate the current in EACH phase. (4)

(b) Calculate the new current in EACH phase lead, if due to a fault one of the phase leads becomes disconnected from the load. (4)

(c) Calculate EACH of the following, if the three legs are now connected in delta:

(i) the current in each phase lead; (4)

(ii) the current in EACH phase lead if one phase becomes disconnected as in Q5(b). (4)

6. Two diesel driven 3-ph, 440V 50Hz alternators share the total electrical load for a ship made up as follows:

1200kW	at power factor 0.8 lag.
400kW	at unity power factor.
200kW	at power factor 0.95 lead.

One of the alternators supplies 800 kW at power factor 0.9 lag.

(a) Calculate EACH of the following:

(i) the kVA loading of the second alternator; (5)

(ii) the power factor of the second alternator. (3)

(b) An over excited synchronous motor taking 100kW is added to the system to raise the overall power factor of the system to unity.

Calculate EACH of the following:

(i) the kVA of the synchronous motor; (5)

(ii) the power factor of the synchronous motor. (3)

7. (a) Explain, with the aid of a circuit diagram, the Ward-Leonard method of speed control for a d.c. motor suitable for a winch or crane. (8)

(b) Explain the advantages of the Ward-Leonard system over other methods of speed control for a d.c. motor. (4)

(c) Explain how reversal of the direction of the winch/crane motor is effected in the Ward-Leonard system. (4)

8. (a) Explain the production of rotor torque in a 3-ph squirrel cage induction motor. (8)

(b) Explain why the power factor of the simple squirrel cage motor is low on starting with a consequentially low starting torque. (4)

(c) Describe ONE method by which the starting power factor and torque may be improved. (4)

9. With reference to a single phase power transformer with natural air cooling:

(a) sketch the basic construction; (4)

(b) explain the principle of operation; (4)

(c) explain why it is rated in kVA rather than kW; (2)

(d) explain why it may overheat if operated at a frequency lower than normal; (2)

(e) state how operation at a reduced frequency may be compensated to avoid overheating. (4)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 19 OCTOBER 2006

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. A relay coil has a resistance of 240Ω and an inductance of 0.4H. It is operated on a 36 Volt d.c. supply.

   Calculate EACH of the following:

   (a) the time constant for the coil; (2)

   (b) the final steady state current for the coil; (2)

   (c) the instantaneous value of the current 1mS after switching on; (4)

   (d) the time taken for the current to reach 50mA; (3)

   (e) the energy stored when the current is 50mA; (3)

   (f) the time taken for the current to reach its final steady state value. (2)

2. For the circuit shown in Fig Q2, calculate EACH of the following:

   (a) the current supplied by the 12 volt battery; (6)

   (b) the potential difference across the 4Ω resistor; (4)

   (c) the power dissipated in each of the 6Ω resistors. (6)

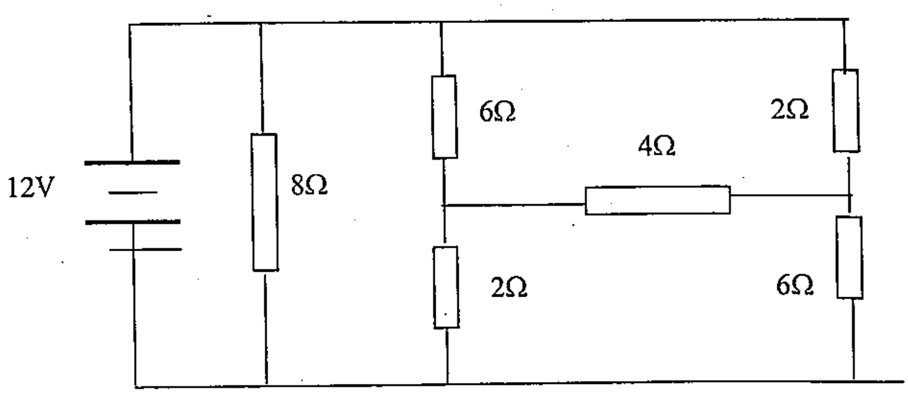

Fig Q2

[OVER

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

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

(a) the voltage between the emitter and the collector of the transistor; (6)

(b) the power dissipated in the emitter resistor; (5)

(c) the power dissipated in the transistor; (2)

(d) show the additional components needed to make the circuit suitable for amplifying small a.c. signals. (3)

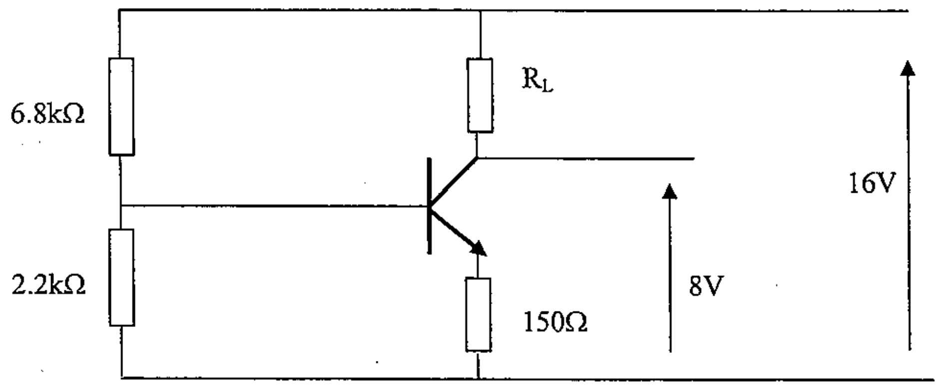

Fig Q3

4. A d.c series motor has an armature resistance of 0.4Ω and a field resistance of 0.1Ω. It operates on 240V and runs at 15 rev/sec when drawing a current of 30A. A diverter resistance of 0.2Ω is now placed in parallel with the field and the torque reduced by 50%.

(a) Calculate EACH of the following:

(i) the new motor current; (5)

(ii) the new speed; (5)

(b) Calculate EACH of the following, if the rotational losses (iron, windage and friction) for the motor total is 500W:

(i) the output torque at the new speed; (4)

(ii) the efficiency. (2)

5. An a.c. circuit comprises two parallel branches as shown in Fig Q5. It is connected to 240V 50Hz.

(a) Calculate EACH of the following:

(i) the total current drawn from the supply; (4)

(ii) the overall power factor; (3)

(iii) the power drawn by the circuit. (2)

(b) A third branch consisting of a capacitor is connected in parallel with the circuit to raise the power factor to unity.

Calculate EACH of the following:

(i) the value of this capacitor; (4)

(ii) the percentage reduction in the total current. (3)

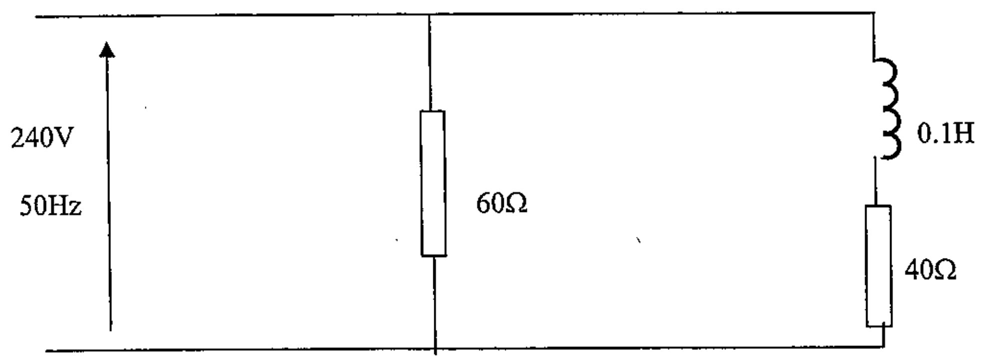

Fig Q5

6. A three phase star connected load is supplied from a four wire 380V 50Hz system. The current in the red line is 6A lagging by 30°, that in the yellow line is 5A in phase, and the current in the blue line is 7A leading by 15°.

Calculate EACH of the following:

(a) the current in the neutral conductor; (8)

(b) its phase angle relative to the red phase voltage; (4)

(c) the total power dissipated by the circuit. (4)

[OVER

7. (a) Describe the FOUR conditions which have ideally to be met before an alternator can be safely connected to live busbars. (8)

(b) Explain the process by which load can be taken up by a newly synchronised alternator. (2)

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

8. (a) State the conditions necessary to *turn on* and *turn off* a silicon controlled rectifier (thyristor). (4)

(b) Describe the operation of the trigger circuit shown in Fig Q8. (8)

(c) Sketch load circuit voltage waveforms for EACH of the following delay angles:

(i) 45° (2)

(ii) 120° (2)

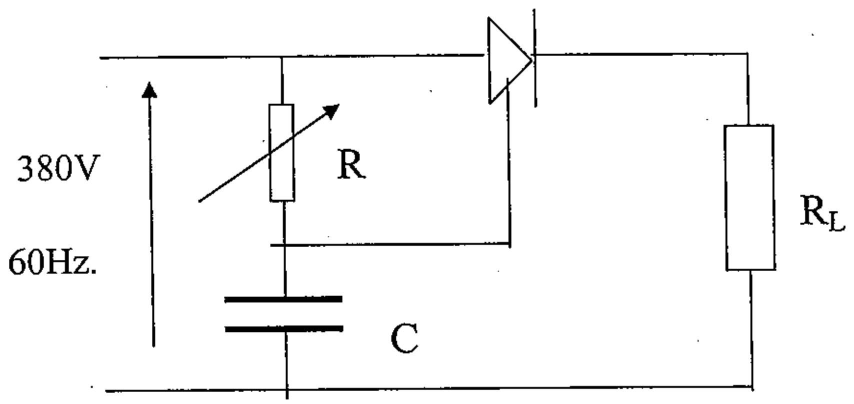

Fig Q8

9. (a) Explain the term *single phasing* when applied to a three phase induction motor. (6)

(b) Describe the probable effects of *single phasing* on a delta connected motor which continues to run at 75% full load. (5)

(c) Describe ONE method by which a motor can be protected against *single phasing* damage. (5)

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 20 JULY 2006

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 circuit shown in Fig Q1, calculate EACH of the following:

   (a) the load current; (14)

   (b) the p.d. across the load. (2)

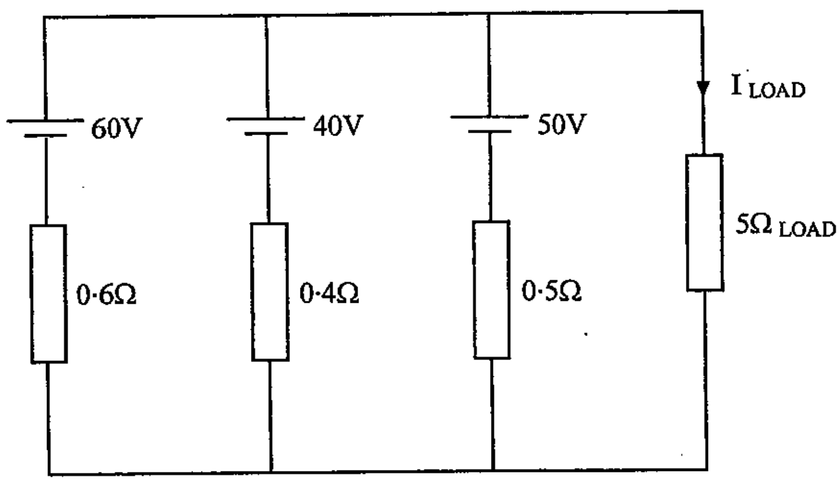

Fig Q1

2. A 120μF capacitor is charged through a resistor R from a 12V, d.c. supply. The time constant of the circuit is 564mS.

   (a) Calculate the value of the resistor R. (2)

   (b) Calculate the capacitor voltage after two seconds of charging. (4)

   (c) After 2.5 seconds of charging the d.c. supply is switched off and the capacitor is discharged through a 1.2 kΩ resistor.

   Calculate the capacitor voltage after 0.12 seconds of discharge. (5)

   (d) Calculate the energy stored in the capacitor after 0.12 seconds of discharge. (2)

   (e) Sketch a graph showing the capacitor voltage over its charge/discharge cycle. (3)

3. The p.d. across the base-emitter junction of the transistor shown in Fig Q3 is 0.65V and the output voltage is 5V. Assuming that the base current is negligible:

(a) calculate EACH of the following:

(i) the p.d. across the collector-emitter terminals of the transistor; (6)

(ii) the value of the load resistor R_L; (2)

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

(iv) the power taken from the 12V d.c. supply. (2)

(b) redraw the diagram Fig Q3 showing the additional components required to convert it to an a.c. voltage amplifier, indicating the input and output voltage waveforms. (4)

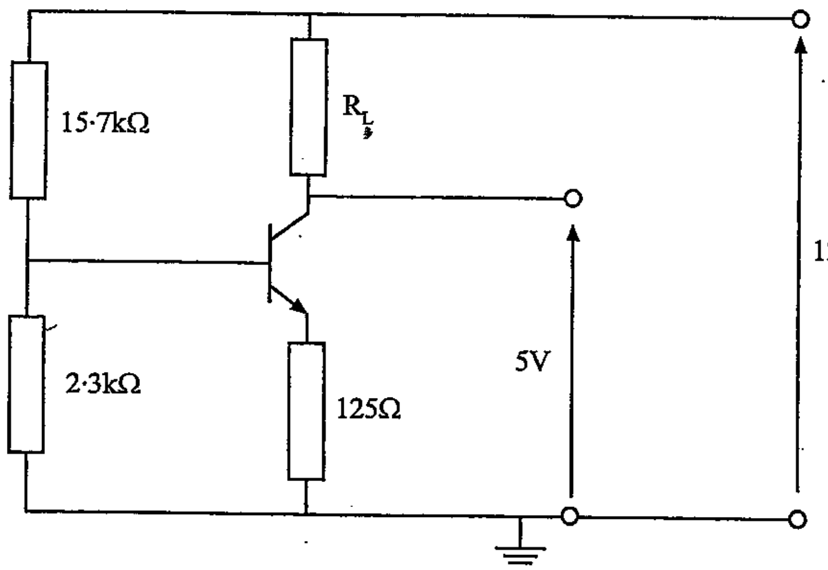

Fig Q3

4. A 440V, 3ph, 60hz, 6-pole star connected generator supplies a delta connected load, each phase of which has a resistance of 10Ω in series with an inductance of 25mH.

(a) Sketch the circuit diagram. (2)

(b) Calculate EACH of the following:

(i) the speed of the generator; (2)

(ii) the load current per phase; (4)

(iii) the generator current per phase; (2)

(iv) the kW load supplied by the generator; (3)

(v) the kVAR load supplied by the generator. (3)

5. Two 440V, 3-ph, a.c. generators supply the following loads:

- 1000kW at 0.9 power factor of lagging;
- 500kW at unity power factor;
- 555kVA at 0.9 power factor leading;
- 600kVAR at 0.8 lagging.

The load on number one generator is 1370kVA at a power factor of 0.95 lagging.

Determine EACH of the following:

(a) the kW load supplied by generator number two; (6)

(b) the power factor of generator number two; (6)

(c) the current supplied by generator number two; (2)

(d) the total load current. (2)

6. A 440/110V, 1-ph transformer takes a no load current of 8A at a power factor of 0.25 lagging. On full load the transformer supplies a current of 160A at a power factor of 0.8 lagging.

Calculate EACH of the following:

(a) the transformer primary current; (8)

(b) the primary power factor; (4)

(c) the transformer efficiency; (2)

(d) the power supplied to the load. (2)

7. A 3-ph, a.c. cage induction motor drives a constant load torque.

(a) Sketch a typical torque/speed characteristic showing the starting, running and pull out torque points; (4)

(b) Describe the changes occurring to the rotor e.m.f., speed and power factor during the starting period; (6)

(c) State the effects on the motor torque, speed, and current if the supply voltage falls by 10%. (6)

8. (a) Sketch a circuit diagram for a 3-ph, a.c brushless generator showing the principal components. (6)

(b) Describe the generator response to the starting of a large induction motor controlled by a direct-on-line starter. (6)

(c) Explain why automatic voltage regulation (A.V.R.) control of the generator is essential. (4)

9. (a) State the conditions necessary to turn-on and turn-off a silicon-controlled rectifier. (4)

(b) Describe the operation of the control circuit shown in Fig Q9. (8)

(c) Sketch load current waveforms for EACH of the following trigger delay angles:

(i) 40°; (2)

(ii) 150°. (2)

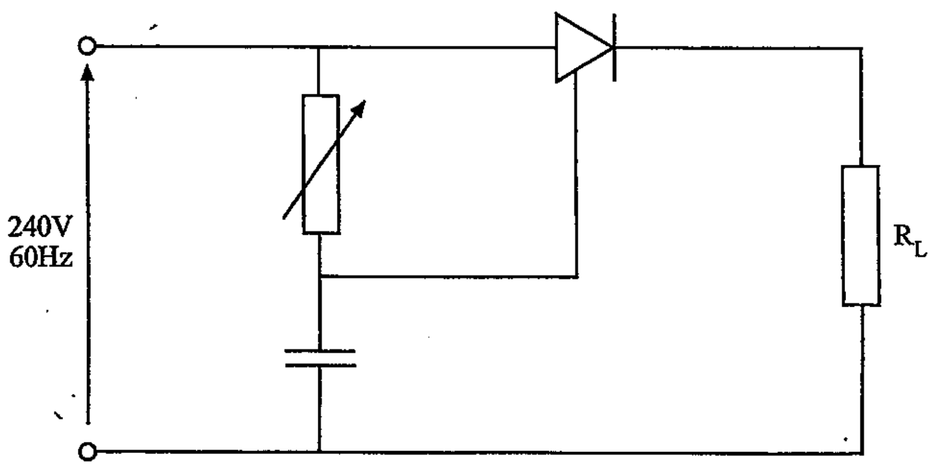

Fig Q9

CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

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STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 6 APRIL 2006

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

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Marks for each part question are shown in brackets.

1. (a) Calculate the currents I_1 and I_3, shown in Fig Q1. (12)

   (b) Calculate EACH of the following:

   (i) the p.d. across points A and E; (2)

   (ii) the p.d. across points C and E. (2)

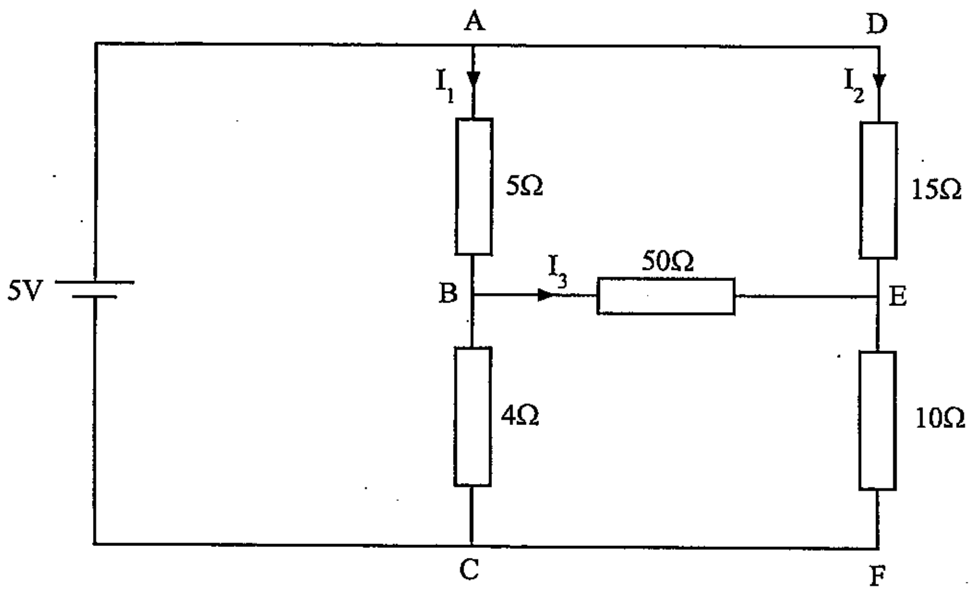

Fig Q1

2. Two 240V, 15W filament lamps are used as <u>earth lamps</u> on a 220V d.c. supply. The cable insulation of a lighting circuit is damaged, causing the insulation resistance to earth of the positive conductor to be reduced to 40Ω and 120Ω in two different positions.

   (a) Calculate the p.d. across EACH earth lamp. (8)

   (b) A man of resistance 600Ω accidentally touches an exposed part of the negative conductor.

   Calculate EACH of the following:

   (i) the new values of p.d. across each lamp; (6)

   (ii) the current passing through the man's body to earth. (2)

[OVER

3. An unstabilised d.c. power supply voltage which varies between 15V and 50V is connected across a stabiliser circuit comprising a 400Ω resistor in series with an 8.2V Zener diode. The Zener diode has a slope resistance of 10Ω and requires a minimum operating current of 1mA. The arrangement supplies a variable load of 0-30mA.

(a) Sketch a circuit diagram of the arrangement. (2)

(b) Calculate EACH of the following:

(i) the load voltage when the load current is zero and the supply p.d. is 15V; (4)

(ii) the load voltage when the load current is 30mA and the supply p.d. is 40V; (3)

(iii) the minimum value of the supply p.d. to give a stabilised load voltage for a load current of 30mA; (3)

(iv) the power dissipated in the Zener diode when the supply p.d. is 50V and the load current is 20mA. (4)

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

(a) the supply current; (12)

(b) the supply kW; (2)

(c) the supply kVAR. (2)

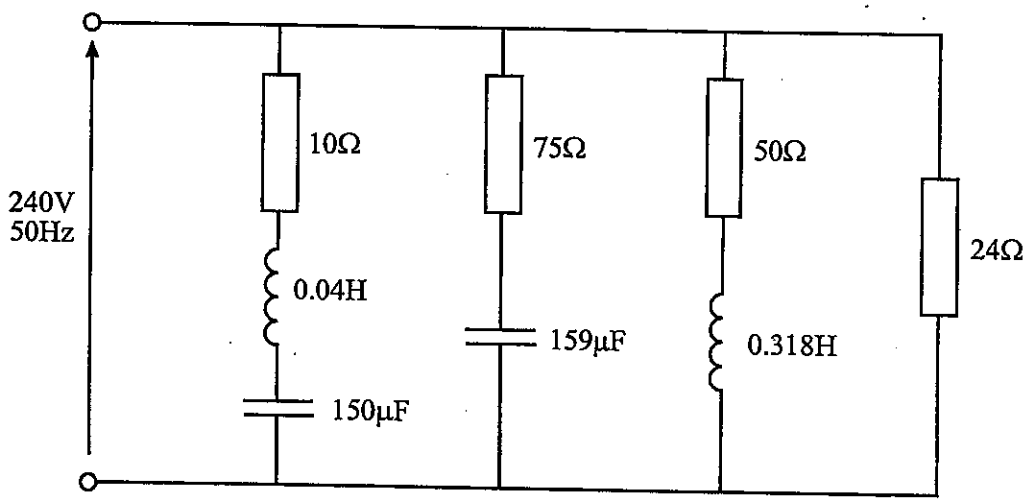

Fig Q4

5. A 3-ph, 440V a.c. generator supplies the following loads:

- a star connected load of 33kVA and power factor 0.9 leading
- a delta connected load of 40kW and power factor 0.85 lagging
- miscellaneous loads of 23kVA and power factor 0.8 lagging

(a) Determine the kVA supplied by the generator. (10)

(b) Calculate EACH of the following:

(i) the current supplied by the generator; (2)

(ii) the phase currents for the star and delta loads. (4)

6. A 240V d.c. series motor runs at 20 rev/sec with a supply current of 38A. The total resistance of the armature and field circuit is 1.2Ω. Additional resistance is to be added in series with the motor to reduce the speed to 12 rev/sec.

Assume the field flux is proportional to the field current.

Calculate the additional resistance required for EACH of the following, when the load torque is:

(a) constant; (5)

(b) proportional to the speed; (5)

(c) proportional to the $(\text{speed})^2$. (6)

7. With reference to a ship's a.c. electric propulsion system:

(a) sketch a basic circuit diagram of a prime mover/generator and a synchronous motor combination; (7)

(b) explain the operation of the system sketched in Q7(a) during ship manoeuvres in ahead and astern positions; (7)

(c) explain how unity power factor is achieved in the full-away condition. (2)

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8. (a) Sketch the V/I load characteristics for a 3-ph a.c. generator operating at constant speed with EACH of the following load power factors:

(i) unity; (2)

(ii) 0.8 lagging; (2)

(iii) 0.8 leading. (2)

(b) Two 3-ph,, a.c. generators are operating in parallel under normal load conditions. Explain what happens if EACH of the following occurs:

(i) a faulty automatic voltage regulator causes a total loss of excitation to one generator; (6)

(ii) a faulty governor causes a total loss of fuel to one generator. (4)

9. With reference to a 1-ph, a.c. 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 units; (2)

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

(e) state how operation at a reduced frequency may be compensated to avoid overheating. (3)