DC Machines Test
Philips 3 ed. (Ch. 13 & 14)

Time allowed – 2 Hours **17 Pages in this Question Booklet**

The results of my performance have been discussed and explained to me.			
Student:		**Date:**	
If you would like to request a review of your results or if you have any concerns about your results, contact your teacher or head teacher.			
Teacher:		**Date:**	

SECTION	Possible Marks	Actual Marks
A	25	
B	20	
C	20	
D	25	
TOTAL	90	

Aids to be supplied by Students: **Aids to be supplied by College:** None**.**
Pen, pencil, eraser, rule, calculator

Instructions to Students:

- **Electronic devices are to be turned off and removed from your person.** You cannot access an electronic device during this examination.
- All questions are to be answered in the space provided in this Question Booklet. Answers to Section A – Multi-choice Questions, are to be recorded on the Answer Sheet attached to this Question Booklet.
- You are not to use any reference book in this examination.
- The whole of this Question Booklet is to be handed to the Supervisor upon completion.

Aids permitted where indicated:

Standard Dictionaries	Bilingual Dictionaries	Technical Dictionaries	Programmable Calculators	Non-programmable Calculators	Mobile Phones	MP3 Players
No	**Yes**	**No**	**No**	**Yes**	**No**	**No**

SECTION A – (25 Marks)

INSTRUCTIONS:
In the following statements one of the suggested answers is the best. Place the letter corresponding to this answer on your answer sheet in the appropriate place.

1. A suitable formula for calculating Eg within a generator is:

   A. Eg = KΦIa
   B. Eg = Φnk
   C. Eg = Fr
   D. Eg = IaRa

   (1 Mark)

2. The law that states that the polarity of an induced voltage will be such that it opposes the voltage which caused it is:

   A. The electromagnetic Induction Law
   B. Fleming's Law
   C. Lenz's Law
   D. The Self Induction Law

   (1 Mark)

3. A shunt generator can only "build up" to its rated EMF once:

   A. a load is applied
   B. critical current is achieved
   C. critical speed is reached
   D. the main field is separately excited

   (1 Mark)

4. How many parallel paths are there in a wave wound armature

   A. 3
   B. 4
   C. 2
   D. 1

   (1 Mark)

5. A shunt connect generator is most suitable for:

   A. series lighting circuits
   B. battery chargers
   C. large traction loads
   D. regenerative braking

   (1 Mark)

6. One of the reasons DC motors require the starting current to be limited is because of the:

A. excessive field current
B. armature back EMF developing to fast
C. excessive armature current
D. disturbances to the electrical system

(1 Mark)

7. To decrease the speed of a shunt motor, using field control, the resistance of the field circuit is:

A. decreased
B. increased
C. open circuited
D. unaltered

(1 Mark)

8. The torque of a shunt motor for a given value of field flux:

A. is directly proportional to the armature current
B. remains constant
C. varies as the square of the current
D. is inversely proportional to armature current

(1 Mark)

9. A DC generator converts:

A. the interpole mechanical energy to electrical
B. mechanical energy to electrical
C. electrical energy to mechanical energy
D. pole pitch electrons into supply current

(1 Mark)

10. The starting current of a DC motor is limited by:

A. armature resistance
B. supply voltage and back EMF
C. armature resistance and back EMF
D. back EMF

(1 Mark)

11. The rated voltage appears at the terminals of a series DC generator when:

A. carrying full load current
B. its under ‘no load’ conditions
C. its open circuited
D. its connected to a variable resistor

(1 Mark)

12. A compound motor has an armature current of 55 amperes and a long shunt field current of 3 amperes. The current flowing in the series field is:

A. 58 amperes
B. 50 amperes
C. 52 amperes
D. 55 amperes

(1 Mark)

13. The current required by a DC motor, at starting is usually limited to approximately:

A. Full Load Current
B. 50% of full load line current
C. Rated current of the protective device
D. 150% of full load armature current

(1 Mark)

14. The terminal voltage of a shunt type generator may be altered by means of a variable resistor connected in:

A. series-parallel with the shunt field
B. series with the shunt field
C. parallel with the shunt field
D. parallel with the armature

(1 Mark)

15. The most common method of braking a DC motor is:

A. reactive braking
B. capacitive braking
C. dynamo braking
D. dynamic braking

(1 Mark)

16. A shunt generator is driven at constant speed. If the flux is reduced to 33% of its initial value, the generated EMF will be:

A. more than twice its initial value
B. reduced to one quarter of its initial value
C. reduced to one third of its initial value
D. increased to one third higher of its initial value

(1 Mark)

17. A compound generator in which the series field mmf opposes the shunt field mmf is called:

A. cumulatively compound
B. over compound
C. series compound
D. differentially compound

(1 Mark)

18. If a compound generator has a load current of 47 amperes and a shunt field current of 3 amperes the total current supplied by the armature would be:

A. 53 amperes
B. 47 amperes
C. 44 amperes
D. 50 amperes

(1 Mark)

19. The type of DC motor used for traction purposes is generally:

A. shunt connected
B. series connected
C. compound connected
D. differentially connected

(1 Mark)

20. The magnetic neutral axis position of a generator under load depends on:

A. the type of prime mover
B. generator temperature
C. generator load current
D. number of commutator segments on the armature

(1 Mark)

21. A separately excited generator has the field:

A. energy supplied from the armature
B. connected in series with the armature
C. connected in parallel with the armature
D. supplied from a source other than the armature

(1 Mark)

22. To reverse a DC motor you must :

A. reverse the armature and the field connections
B. reverse the supply
C. swap the brushes
D. reverse either the armature or the field connections

(1 Mark)

23. The core of a DC armature is laminated to:

A. reduce eddy currents
B. reduce hysteresis loss
C. simplify construction
D. strengthen pole cores

(1 Mark)

24. The torque of a DC motor is proportional to the product of:

A. flux and armature current
B. supply volts and current
C. flux and field current
D. armature current and field current

(1 Mark)

25. Armature reaction in a DC motor can be compensated for by the addition of:

A. rheostat
B. lap windings
C. interpoles
D. wave windings

(1 Mark)

SECTION B – (20 Marks)

INSTRUCTIONS:
In the spaces provided answer the following questions

1. Briefly explain when a motor has its greatest torque.

_____

_____

_____

(2 Mark)

2. Which coil would have a lower resistance, a series winding or a shunt winding?

_____

(1 Mark)

3. Which field coil has the smaller CSA, a series or shunt winding?

_____

(1 Mark)

4. What is the purpose of a commutator?

_____

(1 Mark)

5. Which type of motor has the greatest starting torque, shunt or series wound?

_____

(1 Mark)

6. Briefly explain what causes armature reaction?

_____

_____

_____

(3 Mark)

7. What are the **two** factors that cause the output voltage of a separately excited generator to be less at full load, than at no load?

_____

_____

(2 Marks)

8. State **two** methods of increasing the output voltage of a separately excited DC generator?

_____

_____

(2 Mark)

9. What would be the best type of generator to use if its located a long way from the load

_____

(1 Mark)

10. What is the difference between the series windings of a level compound and over compound generator?

_____

_____

(2 Marks)

11. What happens to the armature current if you stall (seize) a DC motor? Explain why it happens.

_____

_____

(2 Mark)

12. What are the **two** ways in which a shunt connected motor can be reversed, what are they?

_____

_____

(2 Marks)

SECTION C – (20 Marks)

1. For the motor circuits in Figure 1 indicate, on the diagram,
   - the direction of magnetic field around the conductors
   - the direction and route of the magnetic field between the poles
   - the resulting direction of force on the conductors

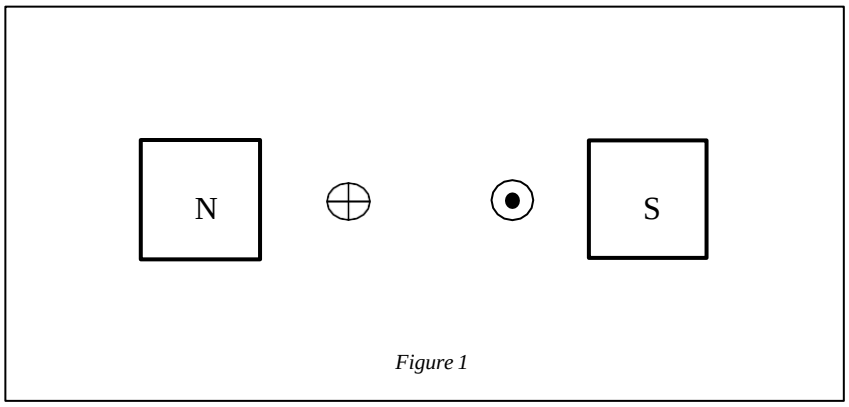


Figure 1

(3 Mark)

2. Identify the parts of the DC Machine in Figure 2.

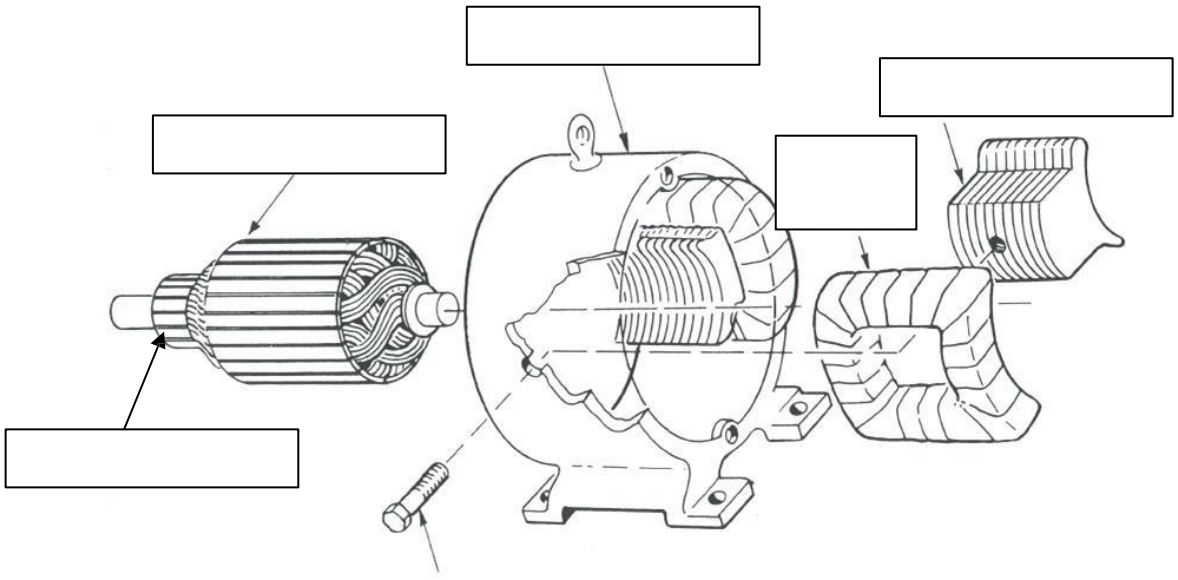
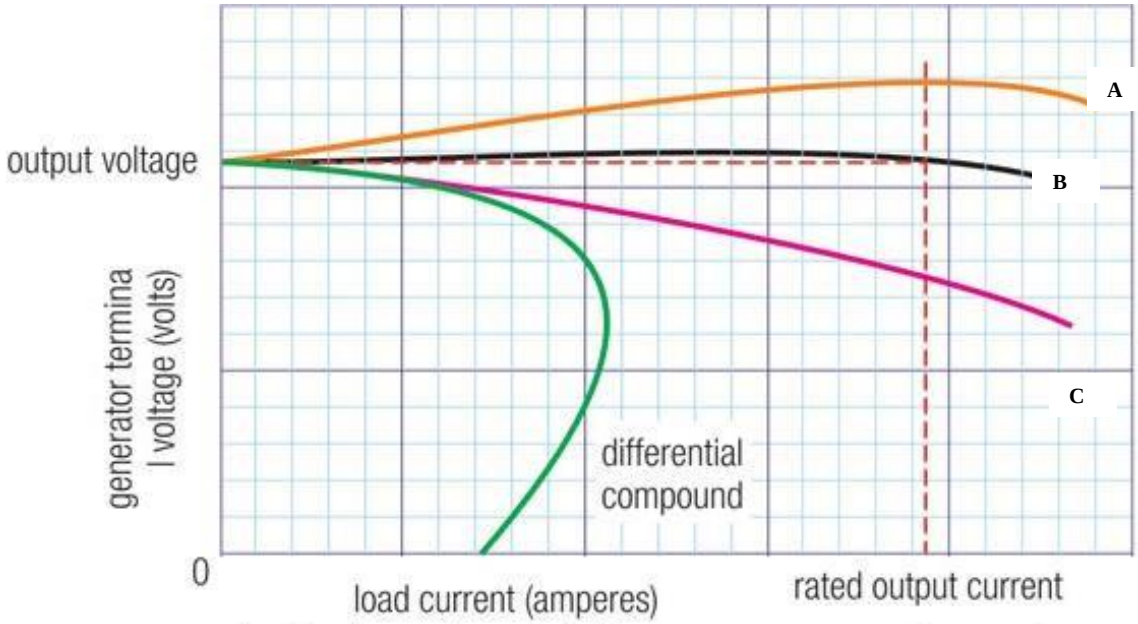


Figure 2

(5 Marks)

3. From the curves shown for a compound machine, identify which curve represents over, level and under compound.



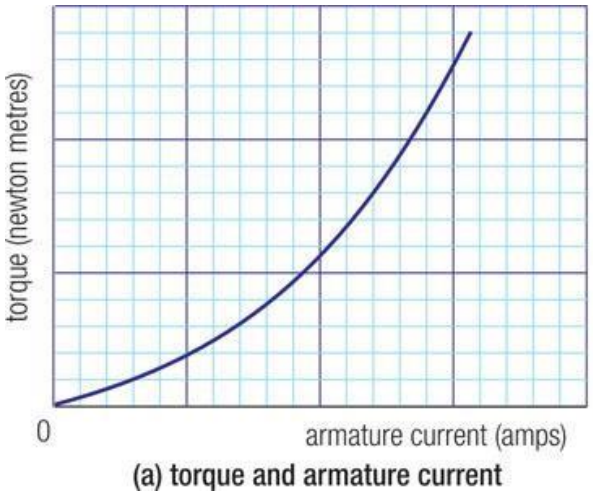
load voltage characteristic curves – compound generators

Curve A_____

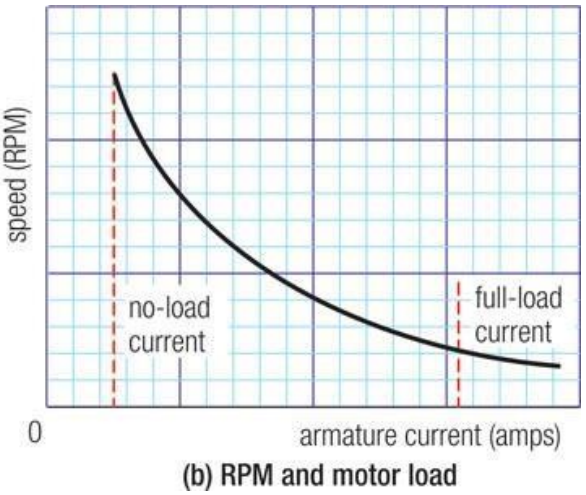
Curve B_____

Curve C_____ (3 Marks)

4. Name the DC motor which has the following characteristics



(a) torque and armature current

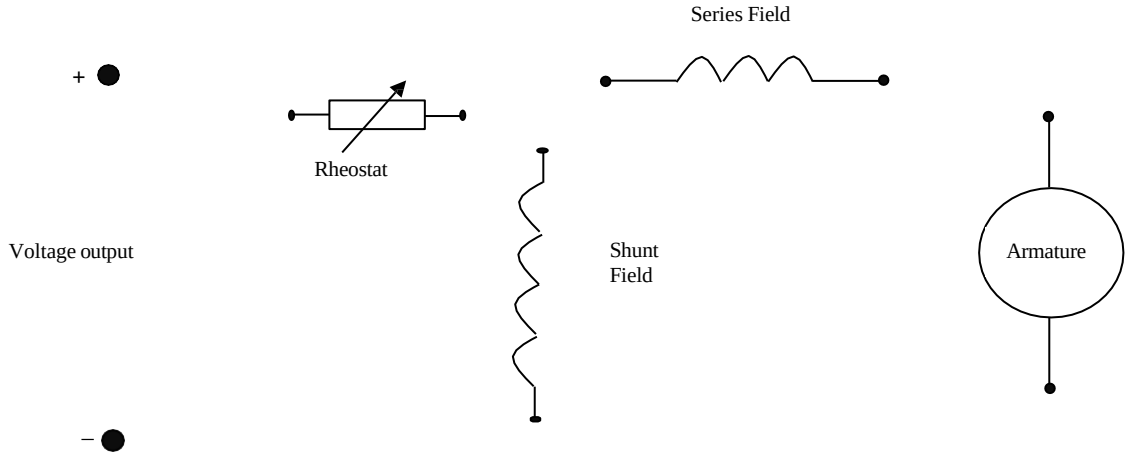


(b) RPM and motor load

Ans._____

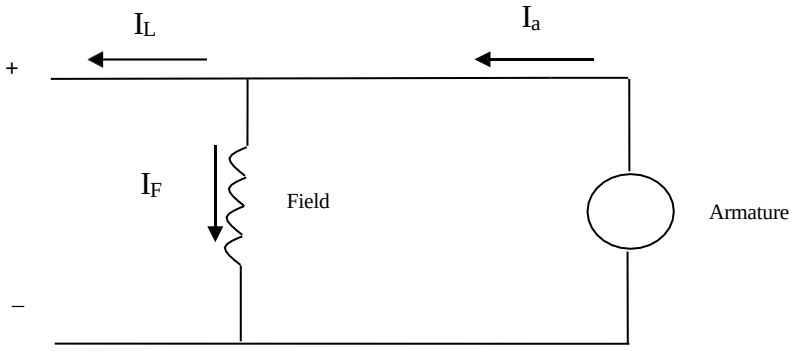
(2 Marks)

5. Connect the components below for a compound type generator



(5 Marks)

6. Identify the D.C machine from the circuit diagram



Machine Type (generator or motor)_____

Connection Method_____

(2 Marks)

SECTION D – (25 Marks) *Use engineering notation and correct units*

1. A separately excited generator has an effective field flux of 5.5mWb and is operated at a speed of 1000 rpm. Determine the generated voltage if the machine constant (k) is 20.

(3 Marks)

2. A 200 mm long armature with a radius of 15mm carries a current of 30 A at right angles to a magnetic field of 0.4 T. Calculate;

a. the force acting on the conductor.
b. and the torque produced.

(4 Marks)

3. A DC motor carries an armature current of 30 A, and operates with a field flux of 0.02 Wb/pole. Determine the torque developed if the motor has a machine constant of 60.

(3 Marks)

4. A 550 V, separately excited motor produces a back EMF of 528 V. If the motor has an armature circuit resistance of 0.35 Ω, determine the armature current.

(3 Marks)

5. A motor is producing a torque of 120Nm at a speed of 650RPM while taking a current of 32A from a 300V DC supply. Calculate:

a. Input Power
b. Output Power
c. Motor Losses

(5 Marks)

6. Determine the efficiency of a motor which draws 15kW of power while incurring losses of 1.5kW

(3 Marks)

7. The output voltage of a DC generator is 260V at no load, and 240V at full load. Determine the voltage regulation.

(2 Marks)

8. A series connected generator is producing 320V within its armature and providing a current of 40A to the load. The resistance of the armature is 0.24**Ω**. Calculate the terminal voltage.

(2 Marks)

Note: The symbols used on this sheet follow AS1046 pt 1. There are alternate recognised symbols in use. The list does not contain every equation used in the course. Transposition of equations will be necessary to solve problems

$$Q = It \qquad v = \frac{s}{t} \qquad a = \frac{\Delta v}{t}$$

$$F = ma \qquad W = Fs \qquad W = mgh$$

$$W = Pt \qquad \eta\% = \frac{output}{input} \times \frac{100}{1} \qquad I = \frac{V}{R}$$

$$P = VI \qquad P = I^2R \qquad P = \frac{V^2}{R}$$

$$R_2 = \frac{R_1 A_1 l_2}{A_2 l_1} \qquad R_h = R_c(1 + \alpha\Delta t) \qquad R = \frac{\rho l}{A}$$

$$R_T = R_1 + R_2 + R_3 \qquad V_T = V_1 + V_2 + V_3 \qquad \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$I_T = I_1 + I_2 + I_3 \qquad V_2 = V_T \frac{R_2}{R_1 + R_2} \qquad I_2 = I_T \frac{R_1}{R_1 + R_2}$$

$$R_x = \frac{R_A R}{R_B} \qquad C = \frac{Q}{V} \qquad \tau = RC$$

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \qquad C_T = C_1 + C_2 + C_3 \qquad C = \frac{A\varepsilon_o\varepsilon_r}{d}$$

$$F_m = IN \qquad H = \frac{F_m}{l} \qquad B = \frac{\Phi}{A}$$

$$\Phi = \frac{F_m}{S} \qquad S = \frac{l}{\mu_o\mu_r A} \qquad V = N\frac{\Delta\Phi}{\Delta t}$$

$$e = Blv \qquad L = \frac{\mu_o\mu_r AN^2}{l} \qquad L = N\frac{\Delta\Phi}{\Delta I}$$

$$V = L\frac{\Delta I}{\Delta t} \qquad \tau = \frac{L}{R} \qquad F = Bil$$

$$T = Fr \qquad E_g = \frac{\Phi ZnP}{60a} \qquad P = \frac{2\pi nT}{60}$$

$$t = \frac{1}{f} \qquad f = \frac{np}{120} \qquad V = 0.707V_{\max}$$

$$I = 0.707I_{\max} \qquad V_{ave} = 0.637V_{\max} \qquad I_{ave} = 0.637I_{\max}$$

$$v = V_{\max}\sin\phi \qquad i = I_{\max}\sin\phi \qquad I = \frac{V}{Z}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \qquad X_L = 2\pi fL \qquad X_C = \frac{1}{2\pi fC}$$

$$\cos\phi = \frac{P}{S} \qquad \cos\phi = \frac{R}{Z} \qquad S = \sqrt{P^2 + Q^2}$$

$$S = VI \qquad P = VI\cos\phi \qquad Q = VI\sin\phi$$

$$f_o = \frac{1}{2\pi\sqrt{LC}} \qquad V_L = \sqrt{3}V_P \qquad I_L = \sqrt{3}I_P$$

$$S = \sqrt{3}V_L I_L \qquad P = \sqrt{3}V_L I_L \cos\phi \qquad Q = \sqrt{3}V_L I_L \sin\phi$$

$$\tan\phi = \sqrt{3}\left(\frac{W_2 - W_1}{W_2 + W_1}\right) \qquad Q = mC\Delta t$$

$$V' = 4.44\Phi fN \qquad \frac{V_1}{V_2} = \frac{N_1}{N_2} \qquad \frac{I_2}{I_1} = \frac{N_1}{N_2}$$

$$N_{syn} = \frac{120f}{p} \qquad s\% = \frac{(n_{syn} - n)}{n_{syn}} \times \frac{100}{1} \qquad f_r = \frac{s\% \times f}{100}$$

$$V_{reg}\% = \frac{(V_{NL} - V_{FL})}{V_{FL}} \times \frac{100}{1} \qquad V_{reg}\% = \frac{(V_{NL} - V_{FL})}{V_{NL}} \times \frac{100}{1} \qquad T = \frac{\Phi ZIP}{2\pi a}$$

$$I_{ST} = \frac{1}{3} \times I_{DOL} \qquad T_{ST} = \frac{1}{3} \times T_{DOL} \qquad I_{ST} = \frac{V_{ST}}{V} \times I_{DOL}$$

$$T_{ST} = \left(\frac{V_{ST}}{V}\right)^2 \times T_{DOL} \qquad I_{motor\,st} = \frac{\%TAP}{100} \times I_{DOL} \qquad I_{line\,st} = \left(\frac{\%TAP}{100}\right)^2 \times I_{DOL}$$

$$E = \frac{\Phi_v}{A} \qquad E = \frac{I}{d^2} \qquad \eta_v = \frac{\Phi_v}{P}$$

$$V_L = 0.45V_{ac} \qquad V_L = 0.9V_{ac} \qquad V_L = 1.17V_{phase}$$

$$V_L = 1.35V_{line} \qquad PRV = \sqrt{2}V_{ac} \qquad PRV = 2\sqrt{2}V_{ac}$$

$$PRV = 2.45V_{ac} \qquad V_{ripple} = \sqrt{2}V_{ac} \qquad V_{ripple} = 0.707V_{phase}$$

$$V_{ripple} = 0.1895V_{line}$$

Student Name : _____

Class : _____

ANSWER SHEET

Section A (Multi-choice Questions)

Instructions:

Enter your personal details in the top right hand corner of this sheet.
Place an **X** in box of your choice. If you make a mistake, circle your answer ⊗ and choose again.

Question	A.	B.	C.	D.
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
Totals				

Question	A.	B.	C.	D.
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
Totals				

Total Marks Section A: _____