AC Test 3

Time allowed – Two Hours

17 Pages in this Question Booklet

TOTAL MARKS AVAILABLE

Aids to be supplied by College:

None

Aids to be supplied by Students:

Pen, pencil, eraser, rule, calculator

SECTION	Possible Marks	Actual Marks
A	20	
B	20	
C	22	
D	25	
TOTAL	87	

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 - (20 Marks)

INSTRUCTIONS:
Select the best answer for the following statements and place an X in the appropriate box on the Answer Sheet. Each question is worth 1 mark.

1. For the same power and voltage, three phase distribution is more economical than single phase because:

    a.) less conductor material is required for transmission.
    b.) the line voltage is greater than the phase voltage.
    c.) the line and phase currents are equal.
    d.) the line voltage is in phase with the line current.

2. If the line currents to a balanced three phase 4 wire load are 10 A, the neutral current is:

    a.) 20 A.
    b.) 10A.
    c.) 5 A.
    d.) 0 A.

3. The ratio of the line voltage to the phase voltage in a delta connected system is:

    a.) 1 : √2.
    b.) 1 : 1.
    c.) √3 : 1.
    d.) 1 : √3.

4. The resultant voltage around the closed loop of a correctly connected delta connected transformer is:

    a.) twice the phase voltage.
    b.) equal to the phase voltage.
    c.) half the phase voltage.
    d.) zero volts.

5. The minimum number of wattmeter's required to measure the total power drawn by a three phase 4 wire balanced load is:

    a.) 4.
    b.) 3.
    c.) 2.
    d.) 1.

6. If harmonics are present within a supply system the neutral conductor must:

    a.) be capable of carrying the maximum demand of the installation.
    b.) have its CSA increased to allow for the harmonic currents and maximum demand.
    c.) equal the CSA of the active conductor.
    d.) be fused to interrupt harmonic currents..

7. The neutral conductor of a four wire distribution system [at the load-end] is usually connected to:

    a.) earth via the MEN point at the switchboard.
    b.) 'C' phase.
    c.) 'B' phase.
    d.) earth via the Star point of the distribution transformer.

8. When capacitors are used to improve the power factor of an inductive load the power absorbed will:

    a.) decrease.
    b.) increase.
    c.) remain the same.
    d.) vary constantly.

9. If an induction motor is disconnected and then later reconnected to a three phase supply, it is important to maintain the original:

    a.) colour coding.
    b.) phase sequence.
    c.) load distribution.
    d.) earth leakage.

10. If the fundamental frequency was 50Hz, then the 3^{rd} harmonic would be:

    a.) 53Hz.
    b.) 300Hz.
    c.) 150Hz.
    d.) 200Hz.

11. The main advantage of a high power factor in a supply system is that:

    a.) larger conductors are used.
    b.) smaller currents are necessary for the same power.
    c.) the load power is smaller.
    d.) the wave shape of the emf changes from a sine waveform.

12. To correctly connect three windings (A1 – A2, B1 – B2, C1 – C2) in delta, the wiring connections would be:

    a.) A2 to B2 to C2.
    b.) A1 to B1 to C1.
    c.) A1 to B2, A1 to C2, C1 to A2.
    d.) A1 to B2, B1 to C2, C1 to A2.

13. The main purpose of the neutral conductor when a three phase supply is connected to an unbalanced load is to:

    a.) reduce the supply voltage.
    b.) provide an earth point.
    c.) carry out of balance currents.
    d.) provide a protective circuit.

14. An advantage of the star connected system compared to the single phase system is:

    a.) two different supply voltages are available.
    b.) higher line currents are used.
    c.) less individual phase windings are required.
    d.) higher phase voltages are used.

15. If the line voltage is 500 V and the phase voltage is 500 V, the system is connected in:

    a.) parallel.
    b.) series.
    c.) delta.
    d.) star.

16. Three heating elements were originally connected in star to a three phase 400 V, 50 Hz supply. If these elements are reconnected in delta and connected to the same supply, the total power consumed by the elements would be:

    a.) $\sqrt{2}$ times the star power.
    b.) $\sqrt{3}$ times the star power.
    c.) 3 times the star power.
    d.) the same as in star.

17. The power factor of a three phase load may be determined by the two wattmeter method provided:

    a.) the load is balanced.
    b.) the power factor is greater than 0.5.
    c.) the neutral is disconnected.
    d.) there is no current in the middle phases.

18. In a star connected system the phase angle between the line voltage and the phase voltage is:

    a.) 120°.
    b.) 90°.
    c.) 30°.
    d.) 00°.

19. The most likely load to cause harmonics currents would be:

    a.) incandescent lamps.
    b.) water heaters.
    c.) variable frequency speed drives.
    d.) three phase induction motors.

20. The line voltage of a star connected system is:

    a.) 0.707 times the phase voltage.
    b.) 1.414 times the phase voltage.
    c.) 1.73 times the phase voltage.
    d.) equal to the phase voltage.

Section B - (20 Marks)

In the spaces provided answer the following questions

1. What is the purpose of the neutral conductor when connected to an unbalanced load?

_____

_____ **(2)**

2. What is the resultant voltage in a correctly connected delta system?

_____

_____ **(1)**

3. What is the advantage of connecting a three phase motor in delta compared to star?

_____

_____ **(2)**

4. What meter can be used to determine if a delta connected transformer has a winding reversed?

_____

_____ **(1)**

5. What is the frequency of the 5^{th} harmonic?

_____

_____ **(1)**

6. State the a main disadvantage of having only one wattmeter installed on a 3 phase unbalanced load?

_____

_____ **(2)**

7. What is the term used to describe the order in which the phases reach their maximum values?

_____

_____ **(2)**

8. What type of power does a wattmeter indicate when measuring the power of a three phase AC circuit?

_____

_____ **(1)**

9. What happens to the phase voltages in a star connected system when the load is unbalanced and the neutral becomes open circuited?

_____

_____ **(2)**

10. Harmonics are classified into three grouped sequence components, name them.

_____

_____ **(3)**

11. If three 12 ohms resistors were connected in star, what would be the neutral current?

_____

_____ **(1)**

12. What would be the effect on the line current, if a three phase motor was reconnected from star to delta?

_____

_____ **(2)**

Section C - (22 Marks)

Draw all diagrams and circuits neatly and to scale

Question 1.

Drawing a phasor diagram to scale, determine the current in the neutral conductor if the following loads are connected to a three phase 4 wire 400 Volt supply. The phase sequence is A-B-C.

a.) phase A – 3 amps 0.5 lagging.

b.) phase B – 6 amps 0.866 lagging

c.) phase C – 7 amps 0.940 leading .

(5 Marks)

Question 2

A star connected generator supplies a 415V output to a balanced 26Ω resistive, delta connected load. Neatly draw the Star/Delta circuit configuration and insert the correct values in the attached table.

Star – Delta System

Star	V_P =	I_P =
Delta	V_L = 415V	I_L =

(5 marks)

Question 3

The following phase voltages were measured in a 415/240V star system with a neutral disconnection fault. V_A = 210V, V_B = 270V.

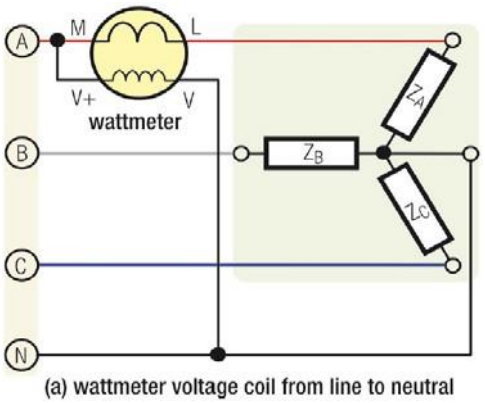
Draw a voltage phasor diagram to determine

a. Phase Voltage across V_C
b. The load star point neutral to earth voltage

(5 Marks)

Question 4

Fig 1 represents a single wattmeter connected via a neutral. Complete the diagram in fig 2 which allows the wattmeter to measure power in a 3-wire system (no neutral available)



(a) wattmeter voltage coil from line to neutral

Figure 1
4-wire system

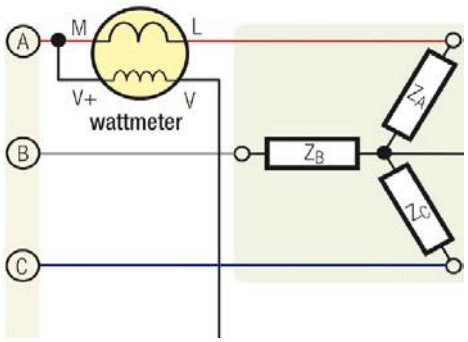


Figure 2
3-wire system

(3 Marks)

Question 5

A 10kW star connected motor was reconnected in delta and has a power factor of 0.766. Draw a power triangle which represents the delta connected motor.

(4 Marks)

Section D - (25 Marks)

Write the answers for the following calculations in the space provided. Show all working. Allocated Marks are shown adjacent to each question.

Question 1

A three phase, 415V, 50 Hz delta connected heater draws a full load line current of 18 A. determine the: $V_{P,}$ $V_{L,}$ $I_{P,}$ I_{L}

(4 marks)

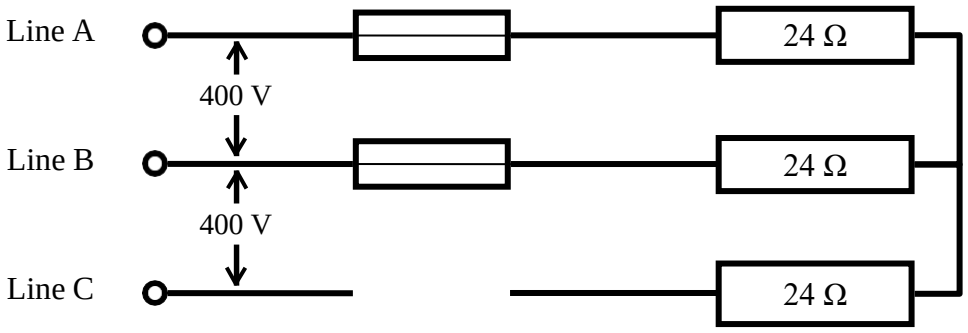
Question 2

A three phase, 400V, 50 Hz star connected machine draws a full load line current of 14 A. Determine the:$V_{P,}$ $V_{L,}$ $I_{P,}$ I_{L}

(4 Marks)

Question 3

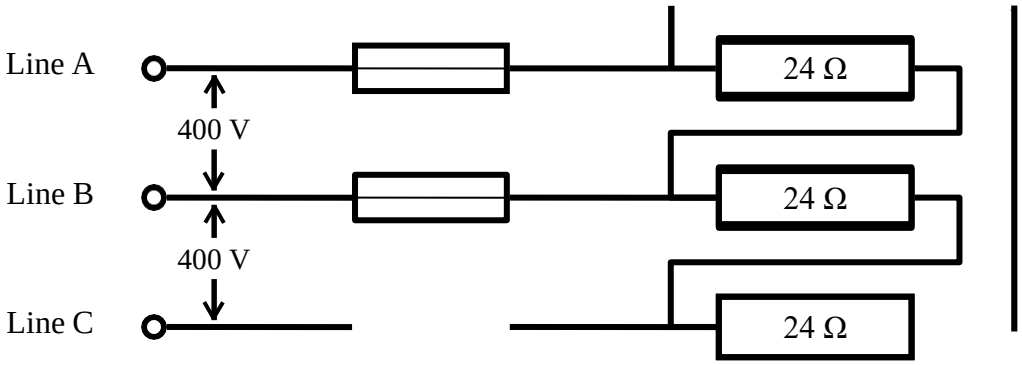
Determine the load phase voltages and the line currents in a three phase 400 Volt system which has a balanced, star connected load of 24Ω resistive heating elements if Line C has a blown fuse.



(3 Marks)

Question 4

Determine the current in each element of a three phase 400 Volt system which has a balanced, delta connected load of 24Ω resistive heating elements if Line C has a blown fuse.



(3 Marks)

Question 5

A three phase load draws a current of 25 A at a power factor of 0.8 lagging from a 400V, 50Hz supply. Calculate the:

a.) Apparent Power.

_____

b.) True Power.

_____

c.) Reactive Power.

_____

(3 Marks)

Question 6

A three phase circuit draws 70 kVA with a power factor of 0.8 lagging from a 415V supply. Calculate the

a.) True power (1 Mark)

b.) Line current. (2 Marks)

(3 marks)

Question 7

The input power to a three phase 400 V induction motor is measured by the two Watt meter method. W1 indicates 15 kW and W2 indicates' 4 kW. Calculate the:

A. input power and (2 marks)
B. motor's power factor. (3 marks)

(5 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\cos\phi = \frac{P}{S}$$

$$\cos\phi = \frac{R}{Z}$$

$$S = \sqrt{P^2 + Q^2}$$

$$S = VI$$

$$P = VI\cos\phi$$

$$Q = VI\sin\phi$$

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

$$V_L = \sqrt{3}V_P$$

$$I_L = \sqrt{3}I_P$$

$$S = \sqrt{3}V_L I_L$$

$$P = \sqrt{3}V_L I_L \cos\phi$$

$$Q = \sqrt{3}V_L I_L \sin\phi$$

$$\tan\phi = \sqrt{3}\left(\frac{W_2 - W_1}{W_2 + W_1}\right)$$

$$Q = mC\Delta t$$

$$V' = 4.44\Phi f N$$

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

$$\frac{I_2}{I_1} = \frac{N_1}{N_2}$$

$$N_{syn} = \frac{120f}{p}$$

$$s\% = \frac{(n_{syn} - n)}{n_{syn}} \times \frac{100}{1}$$

$$f_r = \frac{s\% \times f}{100}$$

$$V_{reg}\% = \frac{(V_{NL} - V_{FL})}{V_{FL}} \times \frac{100}{1}$$

$$V_{reg}\% = \frac{(V_{NL} - V_{FL})}{V_{NL}} \times \frac{100}{1}$$

$$T = \frac{\Phi ZIP}{2\pi a}$$

$$I_{ST} = \frac{1}{3} \times I_{DOL}$$

$$T_{ST} = \frac{1}{3} \times T_{DOL}$$

$$I_{ST} = \frac{V_{ST}}{V} \times I_{DOL}$$

$$T_{ST} = \left(\frac{V_{ST}}{V}\right)^2 \times T_{DOL}$$

$$I_{motor\,st} = \frac{\%TAP}{100} \times I_{DOL}$$

$$I_{line\,st} = \left(\frac{\%TAP}{100}\right)^2 \times I_{DOL}$$

$$E = \frac{\Phi_v}{A}$$

$$E = \frac{I}{d^2}$$

$$\eta_v = \frac{\Phi_v}{P}$$

$$V_L = 0.45V_{ac}$$

$$V_L = 0.9V_{ac}$$

$$V_L = 1.17V_{phase}$$

$$V_L = 1.35V_{line}$$

$$PRV = \sqrt{2}V_{ac}$$

$$PRV = 2\sqrt{2}V_{ac}$$

$$PRV = 2.45V_{ac}$$

$$V_{ripple} = \sqrt{2}V_{ac}$$

$$V_{ripple} = 0.707V_{phase}$$

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

Student Name: _____

Class: _____

Date: _____

ANSWER SHEET - Section A (Multiple 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				
14				
15				
16				
17				
18				
19				
20				
Totals				

Total Marks Section A: _____