AC Circuits

PHILIPS Test 1A (Chapters 15-17)

Time allowed – Two Hours plus *10 Minutes reading time*

19Pages in this Question Booklet

TOTAL MARKS AVAILABLE

Aids to be supplied by College:

None

Aids to be supplied by Students:

SECTION	Possible Marks	Actual Marks
A	20	
B	20	
C	23	
D	23	
TOTAL	86	

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 either A, B, C or D from the options and write the letter in the numbered box provided for each question. Each question is worth one mark.

1. The value of line voltage which is used on appliance rating plates for a AC supply is the:

   A. rms value
   B. instantaneous value
   C. average value
   D. peak value

2. The average power consumed by a purely inductive circuit is:

   A. high
   B. low
   C. variable
   D. zero

3. The inductive reactance of a coil is directly proportional to the:

   A. circuit impedance
   B. circuit current
   C. Frequency
   D. supply voltage

4. The current in a circuit, consisting of resistance and inductance in series:

   A. Lags the voltage between 0^o and 90^o
   B. Leads the voltage by 90^o
   C. Leads the voltage between 0^o and 90^o
   D. Lags the voltage by 90^o

5. The capacitive reactance of a capacitor is inversely proportional to the circuit:

   A. Frequency
   B. Resistance
   C. Current
   D. Voltage

6. The equivalent circuit of a practical inductor consists of:

   A. inductance and resistance
   B. inductance and capacitance
   C. inductance only
   D. resistance only

7. The form factor of a wave is the ratio of its:

   A. RMS value to the average value
   B. average value to the maximum value
   C. maximum value to the RMS value
   D. maximum value to the average value

8. A CRO can be used to measure:

   A. resistance
   B. phase shift
   C. rms values of voltage and current
   D. rms power

9. You are using a CRO to measure a waveform. The VOLTS/DIV switch is set to 4 volts, the probe is set to times 1 position, and the display shows a peak to peak value of eight divisions. The actual peak value is:

   A. 16 volts
   B. 4 volts
   C. 8 volts
   D. 32 volts

10. At lower frequencies, capacitors:

    A. are like an open circuit
    B. take more current
    C. have a lower impedance value
    D. have a high impedance value

11. The unit of capacitive reactance is the:

    A. Ohm
    B. Ampere
    C. Henry
    D. Farad

12. Current in a purely inductive circuit lags the voltage by:

    A. 180 degrees
    B. 0 degrees
    C. 90 degrees
    D. 45 degrees

13. The ratio of the adjacent side to the hypotenuse side of a right angle triangle is the:

A. cotangent of the angle
B. tangent of the angle
C. sine of the angle
D. cosine of the angle

14. Inductors are used to control current in an AC circuit because they:

A. have a low value of inductance reactance
B. are cheaper than resistors
C. have a good power factor
D. have a low power loss

15. The frequency of the power wave in an AC circuit is:

A. is the average power value
B. half that of the voltage and current frequency
C. there is no power waveform
D. twice that of the voltage and current frequency

16. The value of an AC waveform that has the same heating effect as the equivalent value of DC is the:

A. rms value
B. peak value
C. average value
D. peak to peak value

17. If the frequency to an inductive AC circuit was increased the phase angle between the voltage and current will:

A. Decrease
B. go to zero degrees
C. remain the same
D. Increase

18. AC series resonance can produce:

A. dangerous voltages
B. high frequencies
C. low noise
D. low current

19. When resonance occurs in a series RLC circuit, the impedance is equal to the:

A. inductive reactance
B. resistance
C. capacitive reactance
D. total impedance of the circuit

20. The frequency of a sinewave which has a period of 20mS is:

A. 100Hz
B. 25Hz
C. 50Hz
D. 1000Hz

SECTION B – (20 Marks)

INSTRUCTIONS:
Write your answer in the space provided for each question on the answer sheet. Each question is allocated 2 marks.

1. What is the name given to the time taken for one complete cycle of an alternating waveform?

_____

_____

2. When does resonance occur in an RLC series circuit?

_____

_____

3. If the resistive component of a series RL circuit is decreased, what effect will this have on the circuit phase angle?

_____

_____

4. What would happen to the circuit phase angle, of a series RC circuit if the frequency was increased?

_____

_____

5. What is the opposition to current referred to in a purely capacitive circuit?

_____

_____

6. Do ‘ideal’ or ‘pure inductors’ exist? Explain your answer

_____

_____

7. What is the effect on the impedance of a purely resistive A.C. circuit if the frequency is decreased?

_____

_____

8. What is the direction of rotation of a phasor diagram?

_____

_____

9. What would happen to the circuit phase angle of a series RLC circuit if the resistance value was increased?

_____

_____

10. What type of AC circuit has the voltage and current waveforms in phase?

_____

_____

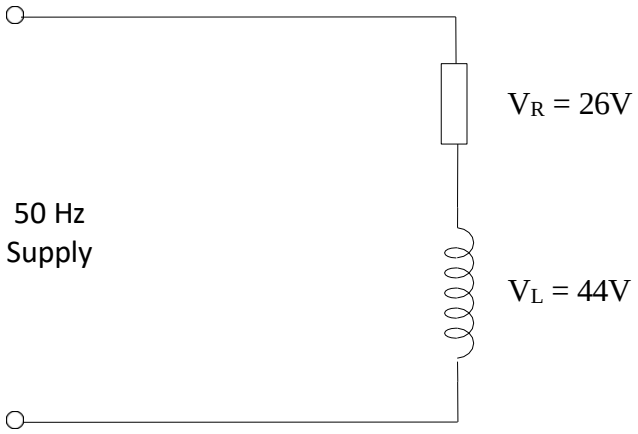
SECTION C –Drawings and Diagrams (23 Marks)

INSTRUCTIONS:

NO CALCULATIONS REQUIRED. DRAW, MEASURE & SCALE

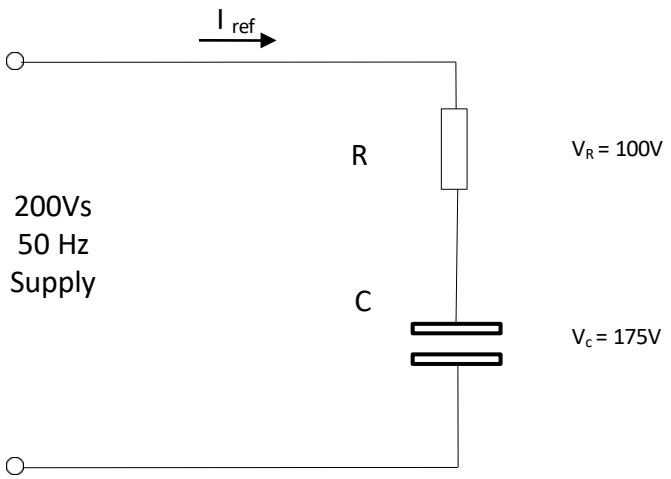
1. For the circuit below accurately draw a voltage phasor diagram to scale and *measure*

   a. the circuit phase angle
   b. the supply voltage



(5 Marks)

2. Draw to scale the phasor diagram for the following circuit. Include phasors for V_R, V_C, and V_S. ***Measure*** and state the circuit phase angle.



(4 marks)

3. The voltage drops across an RLC series circuit measure, V_R = 55V, V_L = 70V and V_C = 120V. (Assume IDEAL components)

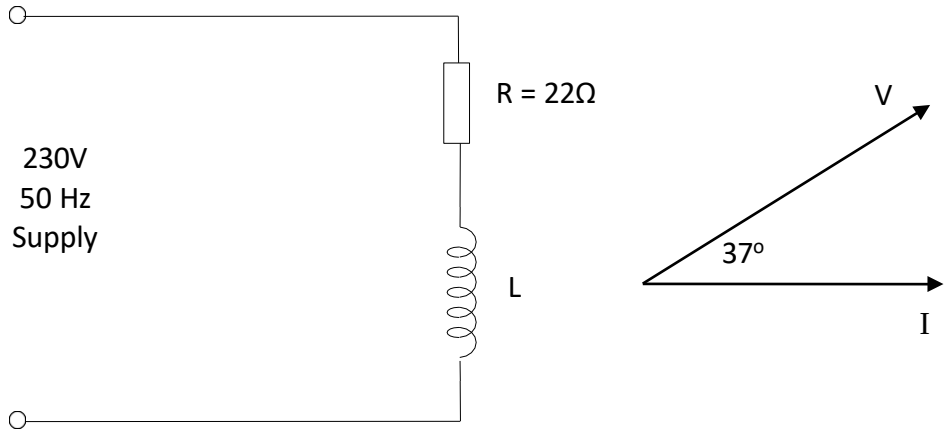
a. Draw to scale the phasor diagram representing the phase relationship between the supply voltage and current (3marks)
b. Measure and state the supply voltage from your phasor. (1 mark)
c. Measure the circuit phase angle (1 mark)

(5Marks)

4. Examine the following circuit and phasor diagram and;

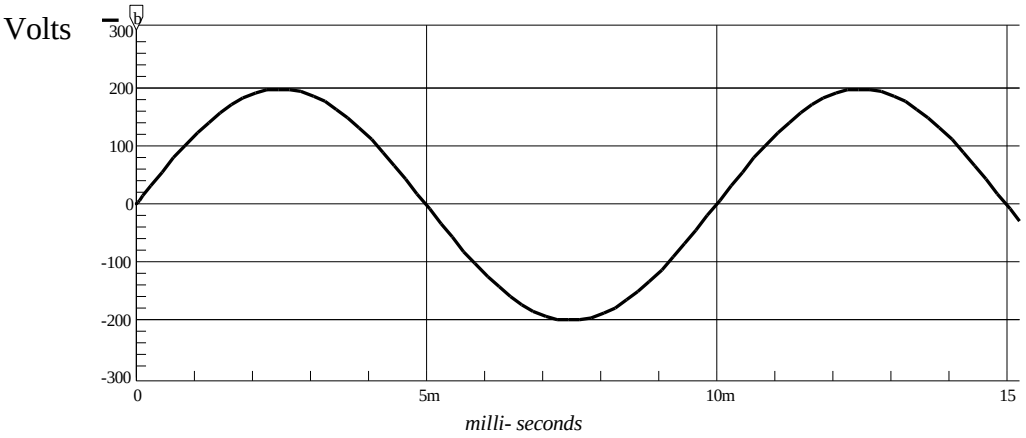
a. draw its *impedance* triangle to scale and label all sides: (3 marks)
b. measure and state the value of impedance (1 mark)
c. measure and state the value of reactance (1 mark)

Note: (*show your scale*).



(5Marks)

5. Examine the following waveform, determine the: (*Calculations required*)



A. peak voltage

B. frequency

C. peak to peak value

D. average voltage of the positive half waveform

(4 Marks)

SECTION D calculations – (23 Marks)

INSTRUCTIONS:
Answer the following questions showing all formulas and calculations used. (*Marks will be **deducted** for incorrect engineering notation and units*)

1. A single phase motor winding has a measured resistance of 20 Ω and inductance of 180mH. When connected to 230 V 50 Hz supply, determine the;

    a. Inductive reactance
    b. Impedance
    c. Supply Current
    d. Circuit phase angle

(4 Marks)

2. A 16 μF capacitor is connected to a 230 V 50 Hz supply. Determine the:

    a. capacitive reactance
    b. circuit impedance
    c. current drawn from the supply

(3 Marks)

3. A capacitive reactance of 300Ω and resistor of 67Ω are connected in series across a 230V, 50Hz supply. Calculate the;

    a. current through the components
    b. voltage across the capacitor
    c. voltage across the resistor

(4Marks)

4. An ideal inductor draws a current of 3A when connected to a 150V, 50Hz supply. Determine the inductance value of the coil. *(Assume coil resistance is zero)*.

(2 Marks)

5. An RLC series circuit contains a 22Ω resistor, with a capacitive reactance of 70Ω, and an inductive reactance of 165Ω. If the circuit was connected to a 230V 50Hz supply calculate;

    a. the circuit impedance
    b. the circuit current
    c. the circuit phase angle
    d. the volt drop across each component

(6 Marks)

6. A series circuit where R=30Ω, L = 900mH and C = 20μF, is connected to a 120V, variable frequency supply. Calculate the;

    a. Resonant frequency
    b. Circuit current at resonance
    c. Voltage across the capacitor at resonance

(4 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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				
Totals				

Question	A.	B.	C.	D.
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
Totals				

Total Marks Section A: _____