REVISION QUESTIONS FOR A.C CIRCUITS

1. (a) (i) Distinguish between peak value and root mean square value of alternating current. (3 marks)

(ii) Derive the relationship between the two terms in (i) above and show that peak value of current, $I_0 = 1.4142 I_{rms}$ (4 marks)

(b) (i) Define the terms *reactance* and *impedance* of an a.c. circuit. (2 marks)

(ii) Derive an expression for capacitive reactance of a pure capacitor of capacitance C, when connected across an alternating voltage $V = V_0 \sin(2\pi f t)$. (4 marks)

(c) Explain why alternating current apparently flows through a capacitor while direct current does not. (4 marks)

(d) A capacitor is connected across a 200 Hz alternating supply with a peak of 100 V, the maximum amount of charge on the capacitor in each cycle is 500 μC. Find the;

(i) reactance of the capacitor. (2 marks)
(ii) peak value of current in the circuit. (2 marks)
(iii) State the advantage of using a capacitor instead of a resistor in an electrical network. (1 mark)

2. (a) Define resonant frequency in an ac circuit. (1 mark)

(b) An alternating current I = 2.0 sin 120πt is passed through a *pure inductor* of inductance 0.4 H.

(i) What is the meaning of the term *pure inductor*? (1 mark)
(ii) Find the reactance of the inductor. (3 marks)
(iii) Determine the root mean square voltage of the inductor. (3 marks)

(c) With the aid of a labelled diagram describe how an attraction type of moving iron ammeter can be used to measure current. (5 marks)

(d) (i) A current $I = I_o \sin 2\pi ft$ is passed through a resistor of resistance R ohms. Derive an expression for the average power expended in the device. (3 marks)

(ii) The current in (i) is subjected to a series combination of a pure capacitor of capacitance C and a pure inductor of inductance L, and the circuit resonates at frequency f_o. Derive the expression for f_o.

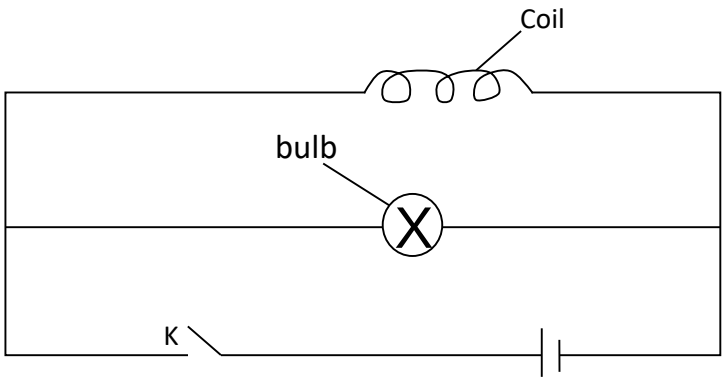
(2 marks)

(iii) Sketch using the same axes, graphs of reactance against frequency for both inductor and capacitor in (ii) above. (2 marks)

3(a) (i) Define the term **root-mean-square** value and **peak value** of an alternating current. (2 marks)

(ii) A sinusoidal alternating current I = 3 sin $(120\pi t)$ amperes flows through a resistor of resistance 2.5Ω. Find the power dissipated in the resistor and sketch a graph of voltage and current through the resistor on the same axes against time. (4 marks)

(b) A coil of wire is connected in parallel with an electric bulb to a d.c source as shown in the figure below.



i)At the instant switch K is closed, the bulb flashes briefly for a short time and then goes off. Explain the observation. (4 marks)

ii) Explain what is observed when the d.c source is replaced by an a.c source. (03 marks)

(c) (i) Define the term **reactance.** (1 mark)

(ii) In an experiment to measure the reactance of a capacitor, the r.m.s current is measured to be 10mA. The peak to peak voltage is measured to be 16V. If the frequency is 10Hz; find the capacitance of the capacitor. (3 marks)

(d) (i) With the aid of a diagram, describe the structure and action of a moving-iron meter of repulsion type. (5 marks)

(ii) State **one** advantage of this type of meter over an ordinary ammeter.

(1 mark)

4. a) i) Define the terms root-mean square value of alternating voltage and frequency as applied to a.c [2]

ii) A sinusoidal voltage is applied to a resistor and a pure inductor. Draw a vector diagrams for a resistor and a pure inductor [2]

iii) A coil of inductance 0.8H is connected in series with a pure capacitor of 20μF across an a.c source. Find the resonant frequency. [3]

b) A current of 2sin (100πt) amperes is maintained in a heating coil immersed in 60kg of water. If the resistance of the coil is 5Ω. Find the temperature rise obtained in 1.5minutes. State any assumption made [4]

c) (i) Describe the structure and mode of operation of a hot wire meter [5]

(ii) state one advantage of a moving iron meter over a moving coil galvanometer

e) A sinusoidal alternating voltage of 20Vrms and frequency 60Hz is applied across a coil of the wire of inductance 0.2H and negligible resistance. Calculate the rms value of the current that passes through the coil. [3]

5(a) (i) what is meant by peak value of a sinusoidal current? (01 mark)

(ii). A source of sinusoidal voltage of amplitude, v_0, and frequency, f is connected across a capacitor of capacitance, C. Derive an expression for the instantaneous current which flows. (03 marks)

(iii). With reference to the circuit in (a)(ii), sketch using the same axes, graphs to show the variation of voltage,V and current I with time. (02 marks)

(b) (i) show that energy stored in an inductor carrying current is given by $E = \frac{1}{2}LI_0^2$. (04 marks)

(ii) A coil with a resistance of $6.0\,\Omega$ and an inductance of $30mH$ is connected to a 12V supply, what is the energy stored in the coil when the current has reached its equilibrium value. (03 marks)

(c) In the circuit below, A and B are identical bulbs.

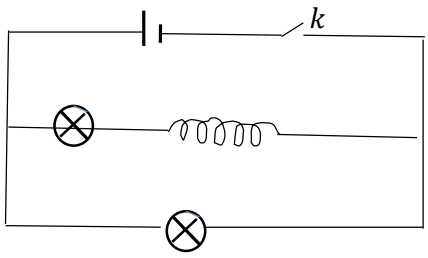


Fig. 3.

(i) Sketch using same axes the time variation of current through each bulb when switch, K is closed. (02 marks)

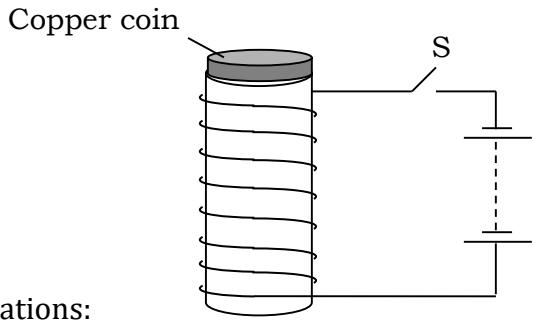
(ii) Explain the features of the curves in (i). (02 marks)

(d) Describe how you a thermocouple meter is used in measurement of a.c (03 marks)

6. (a) (i) Distinguish between ***root mean square value*** and ***peak value*** of an alternating current. (2)

(ii) What is the peak value of the voltage from a 220V a.c. mains. (2)

(b) The figure below shows a copper coin resting on a solenoid



Explain these observations:

(i) On closing switch S the coin jumps up and settles back. (3)

(ii) When the d.c. source is replaced by a high-frequency alternating voltage and S is closed, the coin remains in position but gets heated up. (3)

(c) (i) What is meant by the term ***capacitive reactance***? (1)

(ii) Derive an expression for the reactance of an inductor of inductance L when a sinusoidal varying a.c. of frequency, f passes through it. (5)

(iii) A sinusoidal alternating voltage, **$10 \sin 20\pi t$,** is applied to a coil of inductance 0.5 H. Assuming that the coil has negligible resistance, calculate the root mean square value of the current. (3)

7. What is meant by rectification. (1 mark)

ii) With the aid of sketch graphs, differentiate between half wave and full wave rectification (2 marks)

Hint: Full wave rectification is a process of converting alternating current to direct current where both halves of every cycle of the a.c. input are rectified each time using a pair or two pairs of rectifiers (or diodes).

b) Describe how full wave rectification is achieved using a set of four diodes (bridge rectifier). (5 marks)

ii) What are the advantages of a.c. over d.c during transmission. (2 marks)

c) When is a diode (rectifier) said to be

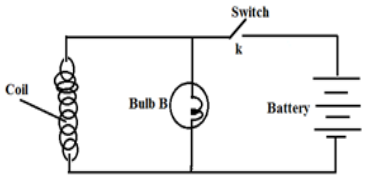
i) Reverse biased (1 mark)

ii) Forward biased. (1 mark)

d) Describe how a rectifier together with a moving coil meter can be used to measure a.c. (3 marks)

ii) Sketch a graph for the current which flows in d(i) above (2 marks)

(e) A coil of many turns of wire is connected to an electric bulb B to a d.c. supply as shown below:



Explain the observations made:

(i) When switch k is first closed and then kept closed. (3)

(ii) When switch k is opened. (3)

8. (a) (i) Distinguish between root mean square value and peak value of an alternating current. (2)

(ii) Draw a sketch graph showing the phase difference between applied p.d. and current for a pure capacitor a.c circuit. (1)

(b)(i) Explain why a capacitor apparently conducts alternating current. (2)

(ii)The instantaneous value of a sinusoidal alternating voltage is given by, $V = 200\sin 60\pi t$ volts. Calculate the r.m.s. voltage and the frequency. (4)

(c) (i)With the aid of a labelled diagram, describe how a repulsion – type moving iron meter operates. (4)

(ii) Give two advantages of the moving iron meter over the moving coil meter. (2)

(d) A 240V supply with a frequency of 50Hz causes a current of 3.0A to flow through an inductor of negligible ohmic resistance. Calculate:

(i) Reactance of the inductor. (3)

(ii) Inductance of the inductor. (2)

7. (a) (i) Distinguish between the root mean square value of an alternating current and its peak value. *(02marks)*

(ii) What is the peak value of the voltage from a 240V a.c supply? *(02marks)*

(b)

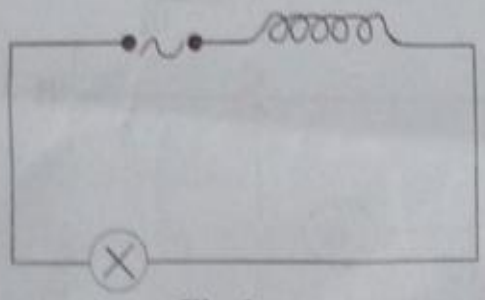


Fig.1

An air cored coil, a bulb and an alternating current source are connected in series forming a closed circuit as shown in figure **1**. When a solid iron core is introduced into the coil, the bulb becomes dimmer and the core hot. Explain this observation.

(06marks)

(c) (i) What is meant by the term **inductive reactance**? *(01mark)*

(ii) Derive an expression for the inductive reactance of an inductor of inductance, L, when a sinusoidal a.c. voltage of frequency, f, passes through it. *(06marks)*

(iii) A sinusoidal a.c voltage of $6.0V_{r.m.s}$ and frequency of 1 kHz is applied to a coil of inductance 0.5H. Assuming the coil has negligible resistance, calculate the r.m.s value of the current. *(03marks)*

Qn 10

(a) (i) Define the term *inductive reactance*. (1 mark)

(ii) Derive an expression for the reactance of a pure inductor when a sinusoidal current is passed through it. (3 marks)

(b) (i) Sketch using the same axes graphs of current and voltage against time for an inductor having a current, $I = I_0 \sin(2\pi ft)$ flowing through it and comment on their phase relationship. (3 marks)

(ii) Explain why voltage leads current in an inductor. (3 marks)

(c) (i) An alternating voltage $V = 340\sin(100\pi t)$ is connected across a capacitor of 10 μF. Determine the peak value of the current flowing in the circuit. (3 marks)

(ii) Draw a phasor diagram for the capacitor in (i) above. (1 mark)

(d) Figure 5 shows graphs of resistance, **R**, reactance **X** and impedance **Z** of a series circuit containing a capacitor a pure inductor and a resistor.

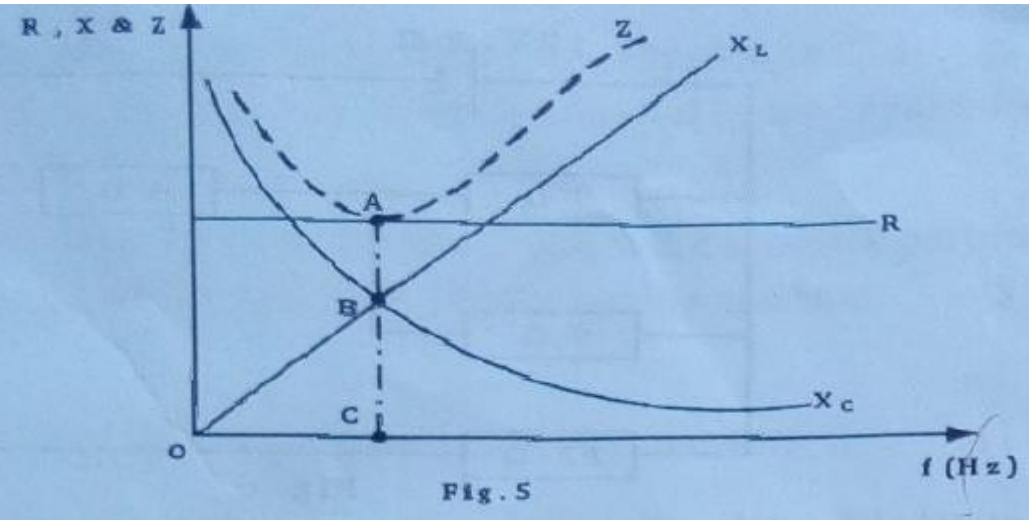


Fig. 5

(i) Identify significance of points A, B and C. (3 marks)

(ii) A variable air capacitor used in a reactive circuit having a pure inductor of self-inductance 5.0 mH connected in series with is tuned to receive a resonant signal of frequency 60.0 Hz. Determine the capacitance of the capacitor. (3 marks)

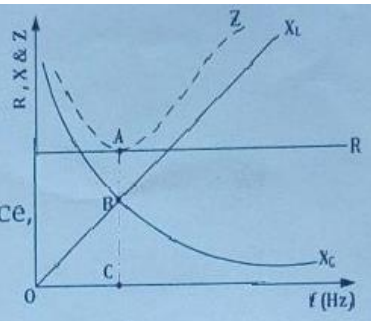
(Ans: 140.7uF)

Ans for d(i)

(d) (i) At point A, the ***impedance Z***, of the circuit is at its **minimum value** i.e $Z_{min} = R$ ✓

Resonance is attained at ***point B***, where Capacitive reactance equals inductive reactance, ie $X_c = X_L$ ✓

At ***point C***, the ***frequency***, f of the circuit is ***at resonance*** i.e $f = f_0$ ✓ when $X_c = X_L$ ie $f_0 = \frac{1}{2\pi\sqrt{LC}}$ **[03]**



QN. 11 The circuit in figure 6 shows an electric bulb having a filament of resistance 5 Ω connected in series with a pure inductor of self-inductance 0.2 H

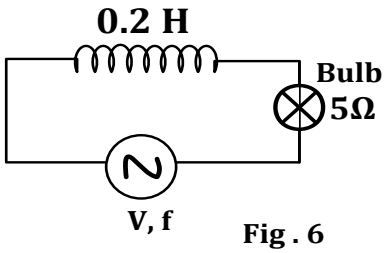


Fig . 6

If a current, I = 68 sin 100πt amperes flows in the circuit. Determine the:

(i) average power rating of the bulb. (Ans: 11560 W) *(3 marks)*

(ii) Root mean square value of the applied voltage. (Ans: 3030.6 V) *(3 marks)*

(iii) The impedance of the circuit. (Ans: 63.03 Ω) *(2 marks)*

iii) Phase angle between the current and voltage. (Ans: 85.5°) (1 marks)

b) Explain why the average power dissipated by a capacitor is Zero, when it is connected across an a.c source. (5 marks)

c) Explain why capacitors are preferred to resistors for use in a.c circuits (02 marks)

d) A coil with a resistance of 10 ohms and unknown self-inductance, L is connected to an a.c supply unit. The supply unit produces a peak pd 10V at 50Hz across the coil terminals. An ammeter in series with the coil and supply unit gives a r.m.s current of 0.40A.

a) Calculate the self-inductance of the coil.(Ans: 46.4mH) (04 marks)

b) Determine the power dissipated in the coil. (Ans: 1.62W) (02 marks)