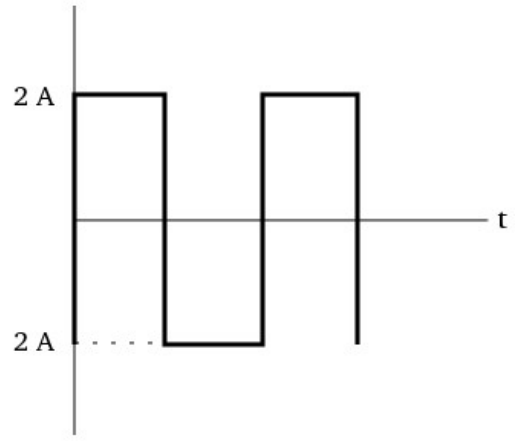
AC July 2013

Q1 – Q8: 1 mark each, Q9 – Q14: 2 marks each, Q15 – Q19: 3 marks each, Q20: 5 marks

Total Marks: 40 (Maximum Time: 90 minutes)

1. Find the rms value of the alternating current graph shown in figure.



2. An effective value of current in an ac circuit is $\sqrt{3}$ A. If the frequency of ac is 50 Hz, what will be the current 1/300 s after it is zero?
3. A 100 Ω resistor is connected to a 220 V, 50 Hz ac supply.
    1. What is the rms value of current in the circuit?
    2. What is the power consumed over a full cycle.
4. An air-core inductor is connected in series with a light bulb, and this circuit is plugged into an electrical outlet. What happens to the brightness of the bulb when a piece of iron is inserted inside the inductor? Give a reason for your answer.
5. Can a capacitor of suitable capacitance replace a choke coil in an ac circuit? Explain.
6. A radio-frequency choke coil is air-cored whereas an audio-frequency choke is iron-cored. Give reason for this difference.
7. A 5.0 mH inductor is connected to an ac voltage source whose rms voltage is 24 V. The rms current flowing in the ciruit is 1.2 A. What is the frequency of the voltage source.
8. A pure resistor is connected across an ac source. Draw phasor diagram and show that current and voltage are in same phase.
9. In India, domestic power supply is at 220 V-50 Hz, while in the United States of America, it is 110 V-50 Hz. Give one advantage and one disadvantage of 220 V supply over 110 V supply.
10. A lamp is connected in series with a capacitor. Predict your observations for dc and ac connections. What happens in each case if the capacitance of the capacitor is reducted?
11. Is it possible for two series *LCR* circuits to have the same resonant frequencies and yet have
    1. different *R* values and
    2. difference *C* and *L* values? Justify your answers.
12. 7.4 A 15.0 μF capacitor is connected to a 220 V, 50 Hz source. Find the capacitive

reactance and the current (rms and peak) in the circuit. If the frequency is doubled, what happens to the capacitive reactance and the current?

13. Observe the resonant frequency ω_r of a series *LCR* circuit with $L = 2.0$ H, $C = 32$ μF, and $R = 10$ Ω. What is the *Q* value of this circuit?
14. At an airport, a person is made to walk through the doorway of a metal detector, for security reasons. If she/he is carrying anything made of metal, the metal detector emits a sound. On what principle does this detector work?
15. A 80 V-800 W heater is to be operated on a 100 V-50 Hz ac supply. Calculate the inductance of the choke required.
16. A resistor of 200 Ω and capacitor of 15.0 μF are connected in series to a 220 V, 50 Hz ac source.
    1. Calculate the current in the circuit and
    2. the voltage (rms) across the resistor and the capacitor.
       Is the algebraic sum of these voltages more than the source voltage? If yes, resolve the paradox.
17. A series *LCR* circuit with $L = 0.12$ H, $C = 480$ nF, $R = 23$ Ω is connected to a 230 V variable frequency supply.
    1. What is the source frequency for with current amplitude is maximum. Obtain this maximum value.
    2. What is the source frequency for which average power absorbed by the circuit is maximum. Obtain this maximum power.
    3. What is the *Q*-factor of the given circuit?
18. Distinguish between the terms “average value” and “rms value” of an alternating current. The instantaneous current from an ac source is $I = 5 \sin(314\ t)$ ampere. What are the average and rms values of the current?
19. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series *LCR* circuit in which $R = 3\ \Omega$, $L = 25.48$ mH, and $C = 796$ μF. Find
    1. the impedance of the circuit,
    2. the phase difference between the voltage across the source and the current,
    3. the power dissipated in the circuit, and
    4. the power factor.
20. A series *LCR* circuit is connected to a source having voltage $V = V_m \sin \omega t$. Derive the expression for the instantaneous current *I* and its phase relationship to the applied voltage. Obtain the condition for resonance to occur. Define “power factor”. State the conditions under whith it is (a) maximum and (b) minimum.