PHYSICS

BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

AC CIRCUITS AND ELECTRIC CIRCUITS

Example

1. (a) The peak voltag3e of an a.c. supply is 300 V. What is its r.m.s voltages?

(b) The r.m.s value of current in an ac circuit is 10 A. What is the peak current ?

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2. The electric mains in a house are marked 220V-50Hz. Write down the equation for instantaneous voltage.

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3. The peak value of an alternating voltage applied to a 50ω resistance is 10V. Find the rms current. If the voltage frequency is 100 Hz, write the equation for the instantaneous current.

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4. An electric bulb operates at 12 V d.c. If this bulb is connected to an a.c. source and gives

normal brightness, what would be the peak value of the source ?

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5. Find the time required for a 60 Hz alternating current to reach its peak value starting from zero.

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6. If the effective value of current in 50 Hz a.c. circuit is 5.0 A, What is (i) peak value or current (ii) mean value of current over half a cycle (iii) value of current $1/300$ s after it was zero ?

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7. The instantaneous value of an alternating voltage in volts is given by the expression $\varepsilon_t = 140 \sin 300t$ where t is in second what is (i) peak value of the voltage

(ii) Its rms value and

(iii) frequency of the supply? Take $\pi = 3\sqrt{2} = 1.4$

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8. A 100 Hz a.c. is flowing in a 14 mH coil. Find its reactance.

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9. Find the value of current through an inductance of 2.0 H and negligible resistance, when connected to an a.c. source of $150V, 50Hz$.

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10. Find the maximum value of current when an inductance of one henry is connected to an a.c. source of 200 volts, 50 Hz

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11. A coil has an inductance of 1 henry. (a) At what frequency will it have a reactance of 3142 ohm? (b) What should be the capacity of a condenser which has the same reactanc at frequency ?

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12. An a.c. circuit consists of only an inductance of2 H. If the current is represent by a sine wave of amplitude 0.25 A and frequency

60 Hz. Calculate of effective potential across the inductor.

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13. Alternating e.m.f. of $E = 220 \sin 100\pi t$ is applied to a circuit containing an inductance of $(1/\pi)$ henry. Write equation for instantaneous current through the circuit. What will be the reading of a.c. galvanometer connected in the circuit ?

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14. What is the capacitive reactance of a $5\mu F$ capacitor when it is a part of a circuit whose frequency is

(i) 50 Hz

(ii) 10^6 Hz ?

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15. A $1.5\mu F$ capacitor has a capacitive reactance of 12Ω. What is the frequency of the

source ? If frequency of source is double, what will be the capacitative reactance ?

16. A $60\mu F$ capacitor is connected to a 110 V, 60 Hz a.c. supply Determine the r.m.s value of current in the circuit.

17. An inductor $(L = 200mH)$ is connected to an AC source of peak emf $210V$ and frequency $50Hz$. Calculate the peak current. What is the instantaneous voltage of the source when the current is at its peak value?

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18. Determine the impedance of a series LCR - circuit if the reactance of C and L are 250Ω and 220Ω respectively and R is 40Ω

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19. An inductive coil has resistance of 100Ω. When an ac signal of frequency $1000Hz$ is fed to the coil. The applied voltage leads the current by 45°. What is the inductance of the coil?

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20. A coil of resistance 300Ω and inductance 1.0 henry is connected across an voltages

source of frequency $300/2\pi Hz$. The phase difference between the voltage and current in the circuit is

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21. When 100 V dc is applied across a coil, a current of 1A flows through it and when 100 V ac of 50 Hz is applied to the same coil, only 0.5 flows

The inductance of coil is

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22. A 60 V - 10 W electric lamp is to be run on 100 V - 60 Hz mains. Calculate the inductance of the choke coil required. If a resistor is to be used in place of choke coil to achieve the same result, calculate its value.

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23. A 100 V, 50 Hz a.c. source is connected to a series combination of an inductance of 100

mH and a resistance of 20Ω Calculate the magnitude and phase of the current.

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24. A coil of inductance $0.50H$ and resistance 100Ω is connected to a $240V, 50Hz$ ac supply. What are the maximum current in the coil and the time lag between voltage maximum and current maximum?

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25. A circuit containing a 20Ω resistor and $0.1\mu F$ capacitor in series is connected to 230 V a.c. supply of angular frequency $100 rads^{-1}$ What is the impedance of the circuit?

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26. What is the value of current in the a.c. circuit containing $R = 10\Omega, C = 50\mu C$ in series across 200 V, 50 Hz a.c. source?

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27. An alternating current of 1.5 mA and angular frequency $\omega = 300\ radian/\sec$ flows through $10k\Omega$ resistor and a $0.50\mu F$ capacitor in series. Find the r.m.s. voltages across the capacitor and impedance of the circuit.

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28. A 20 V - 5 W lamp is to run on 200 V- 50 Hz a.c. mains. Find the capacitance of a capacitor required to run the lamp.

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29. A resistor of 50 ohm, an inductor of $(20/\pi)$ H and a capacitor of $(5/\pi)\mu F$ are connected in series to an a.c. source 230 V, 50 Hz. Find the current in the circuit.

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30. A $25.0\mu F$ capacitor, 0.10 henry inductor and a 25.0Ω resistor are connected in series with an a.c. source whose emf is given by

$\varepsilon = 310 \sin 314t$

(i) What is the frequency of the emf?

(ii) Calculate (a) the reactance of the circuit,

(b) the impedance of the circuit, and

(c) the current in the circuit.

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31. A series LCR- circuit with $L = 0.12HC = 4.8 \times 10^{-7}F, R = 23\Omega$ is connected to a variable frequency supply At what frequency is the current maximum ?

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32. A series LCR circuit consists of a resistance of 10Ω a capacitor of reactance 60Ω and an inductor coil. The circuit is found to resonate when put across 300 V, 100 Hz supply. Calculate

(i) the inductance of the coil

(ii) current in the circuit at resonance.

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33. An inductor coil joined to a $6V$ battery draws a steady current of $12A$. This coil is connected to a capacitor and an AC source of rms voltage $6V$ in series. If the current in the circuit is in phase with the emf, find the rms current.

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34. A transmitter transmits at a wavelength of $300m$. A condenser of capacitance $2.4\mu F$ is

being used. The value of the inductance for the resonant circuit is approximately

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35. Obtain the resonant frequency and Q-factor of a series LCR circuit with $L = 3.0H, C = 27\mu F,$ and $R = 7.4\Omega.$ How will you improve the sharpness of resonance of the circuit by a factor of 2 by reducing its full width at half maximum?

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36. In a series LCR circuit, the resonance frequency is 800 Hz. The half power points are obtained at frequencies 745 and 855 Hz. Calcualte the Q factor of the circuit and the band width.

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37. An alternating voltage $\varepsilon = 200 \sin 300$ t is applied across a series combination of $R = 10\Omega$ and an inductor of 800 mH.

Calculate :

(i) impedance of the circuit

(ii) peak value of current in the circuit

(iii) power factor of the circuit.

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38. A Sinusoidal voltage V = 200 sin 314 t is applied to a resistor of 10 ohm. Calculate (i) rms value of voltage (ii) rms current (iii) power dissipated as heat.

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39. When a series combination of inductance and resistance are conneted with a 10 V, 50 Hz a.c. source, a current of 1 A flows in the circuit. The voltage leads the current by a phase angle of $\pi/3$ radian. Calculate the values of resistance and inductance.

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40. A coil has an inductance of 0.1 H and resistance 12Ω It is connected to 220 V, 50 Hz

line. Find the impedance, power factor and power.

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41. An emf $E = 100 \sin 314t V$ is applied across a pure capacitor of $637 \mu F$. Find

(a) the instantaneous current I

(b) the instantaneous power P

(c) the frequency of power

(d) the maximum energy stored in the capacitor.

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42. A circuit containing an $80mH$ inductor and a $60\mu F$ capacitor in series is connected to a $230V - 50Hz$ Supply. The resistance in the circuit is negligible .

(a) Obtain the current amplitude and rms currents.

(b) Obtain the rms values of voltage across inductor and capacitor.

(c) What is the average power transferred to the inductor and to the capacitor?

(d) What is the total power absorbed by the circuit?

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43. Suppose the circuit in Exercise 7.18 has a resistance of 15Ω Obtain the average power transferred to each element of the circuit, and the total power absorbed.

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44. A series LCR circuit with $L = 0.12H, C = 480nF,$ and $R = 23\Omega$ is connected to a $230V$ variable frequency supply.

(a) What is the source frequency for which current amplitude is maximum? Find this maximum value.

(b) What is the source frequency for which average power absorbed by the circuit is maximum? Obtain the value of maximum power.

(c) For which frequencies of the source is the

power transferred to the circuit half the power at resonant frequency?

(d) What is the Q-factor of the circuit?

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45. A $100\mu F$ capacitor is charged with a 50 V source supply. Then source supply is removed and the capacitor is connected across an inductor, as a result of which 5 A current flows through the inductance. Calculate the value of inductance.

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46. A power transmission line feeds input power at 2300 V to a step down trnasformer with it primary windings having 4000 turns. What should be the number of turns in the seconday windings in order to get output power at 230 V?

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47. An a.c. voltage of 200 V is applied to the primary of a transformer and voltage of 2000 V is obtained from the secondary . Calculate the ratio of currents through primary and secondary coils.

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48. The ratio of the number of turns in the primary and the secondary coils of a step down transformer is $1:200$. It is connected to

a.c. mains of 200 V. Calculate the voltage developed in the secondary. Determine the value of maximum current in the secondary, when a current of 2.0 A flows through the primary.

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49. A transformer of 100 % efficiency has 200 turns in the primary and 40,000 turns in the secondary. It is connected to a 200 V a.c. mains and the secondary feeds to a $100k\Omega$

resistance. Calculate the output potential difference per turn and the power delivered to the load.

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50. An a.c. source of internal resistance 9000Ω is to supply current to a load resistor of 10Ω. How should the source the matched to the load and what is then the ratio of the currents passing through the load and the source ?

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51. A 10 kW transformer has 20 turns in the primary and 100 turns in the secondary circuit. As a.c. voltage $\varepsilon_1 = 600 \sin 314t$ is applied to the primary. Find (i) the maximum value of flux and (ii) the maximum value of the secondary voltage.

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52. A step down transformer is used to reduce the main supply of 200 V to 11 V. If the primary

draws a current of 5 A and the secondary 90 A, what is the efficiency of the transformer ?

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53. When a voltage of 120 V is impressed across the primary of a transformer, the current in the primary is 1.85 mA. Find the voltage across the secondary, when it delivers 150 mA. The transformer has an efficiency of 95 %.

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54. (i) The primary of a transformer has 400 turns while the secondary has 2000 turns. If the power output from the secondary at 1100 V is 12.1 kW, calculate the primary voltage. (ii) If the resistance of the primary is 0.2Ω and that of the secondary is 2.0Ω and the efficiency of the transformer is $90\,\%$, calculate the heat losses in the primary and the secondary coils.

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55. At a hydroelectric power plant, the water pressure head is at a height of 300 m and the water flow available is $100 m^3 s^{-1}$. If the turbine generator efficiency is 60%, estimate the electric power available from the plant $(g = 9.8 m s^{-2})$.

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56. A small town with a demand of 800 kW of electric power at 220 V is situated 15 km away

from an electric plant generating power at 440 V. The resistance of the two line wires carrying power is 0.5Ω per km. The town gets power from the lines through a 4000-220 V step down transformer at a substation in the town.

Estimate the line power loss in the form of heat.

(b) How much power must the plant supply. assuming there is negligible power loss due to leakage?

(c) Characterize the step up transformer at the plant.

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57. An a.c. generator consists of a coil of 50 turns and area $2.5m^2$ rotating at an angluar speed of 60 $rads^{-1}$, in a uniform magnetic field B = 0.30 T between two fixed pole pieces. The resistance of the circuit including that of coil is 500Ω.

(a) What is the max. current drawn form the generator?

(b) What is the flux through the coil when the current is zero ? What is the flux when the

current is max. ?

(c) Would the generator work if the coil were statinary and instead pole pieces rotated together with the same speed as above ?

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58. The brush potential of a separately excited generator, when it is delivering 5 A is 125 V. When the generator dilivers 15 A, the potential difference across the brushes fall to 122 V.

What are the induced e.m.f. and the resistance of armature ?

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59. A small d.c. motor operating at 200 V draws a current of 5.0 amp.at its full speed of 3000 r.p.m. The resistance of the armature of the motor is 8.5Ω. Determine the back e.m.f. of the motor. Obtain the power input, power output and efficiency of motor.

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60. A motor having an armature of resistance 2.0Ω operates on 220 V mains. At full speed, it develops a back emf of 210 V. Find the current in the armature just when the motor is switched on (assuming that no starter is used) and when running at full speed. Also fined the efficiency of the motor at full speed.

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Problem

1. An a.c. source of angular frequency ω is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of the source is changed to $\omega/3$ (but maintaining the same voltage), the current in the circuit is found to be halved. calculate the ratio of reactance to resistance at the original frequency ω.

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2. An $L-C-R$ series circuit with 100Ω resistance is connected to an AC source of $200V$ and angular frequency $300rad/s$. When only the capacitance is removed, the current lags behind the voltage by 60°. When only the inductance is removed the current leads the voltage by 60°. Calculate the current and the power dissipated in the $L-C-R$ circuit

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3. A current of 4 A flows in a coil when connected to a 12 V dc source. If the same coil is connected to a $12V, 50rads^{-1}$ ac source, a current of 2.4 A flows of the coil in the circuit. The power developed in the circuit of a $2500(\mu)F$ capacitor that is connected in series with the coil is

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4. An LCR circuit has $L = 10mH$. $R = 3$ ohm and $C = 1\mu F$ connected in series to a source is $15\cos\omega t$ volt. What is average power dissipated per cycle at a frequency that is $10\,\%$ lower than the resonant requency?

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5. Inductance (L), capacitance (C) and resistance (R) are constained in a box. When 250 V DC is applied to the terminals of the

box, a current of 1.0A floes in the circuit. When an AC source of $250V_{rms}$ at $2250rad\,\sec^{-1}$ is connected, a current of $1.25A_{rms}$ flows. It is observed that the current rises with frequency and becomes maximum at $4500rad\,\sec^{-1}$. find the values of L,C and R. draw the circuit diagram.

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6. A series LCR- circuit containing a resistance of 120Ω has angular resonance frequency

$4 \times 10^5 rads^{-1}$. At resonance the voltages across resistance and inductance are 60 V and 40 V respectively. Find the values of L and C. At what frequency the current in the circuit lags the voltage by 45°?

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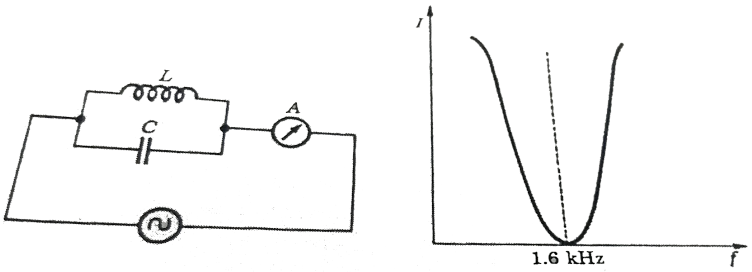
7. An LC- circuit (inductance 0.01 H and capacitance $1\mu F$) is connected to a variable a.c. source as shown in fig. 14.8. Draw rough sketch of the current -variation as the

frequency is changed from 1 kHz to 2 kHz.



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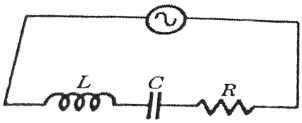
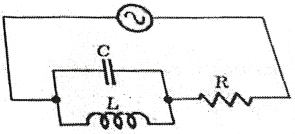
8. An a.c. source is connected to two circuit as shown in fig. 14.10. Obtain the current through the resistance R at resonance in both the

circuits.



(a)



(b)

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9. The current in a coil of self-inductance 2.0 H is increasing according to $I = 2\sin t^2$ ampere. Find the amount of energy spent during the period when the current charges from zero to 2A.

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10. Two coil have self-inductances $L_1 = 8mH$ and $L_2 = 2mH$. In both of them currents are increased at the same constantt rate. At a certain instant the power given to the two coils is the same. If, at that instant, I_1, V_1, U_1 and I_2, V_2, U_2 be the currents, induced voltages and energies stored in the two coils respectively, then ltbr. (a) $I_1 / I_2 = 1/4$ (b) $I_1 / I_2 = 4$ (c) $W_2 / W_1 = 4$ (d) $V_2 / V_1 = 1/4$.

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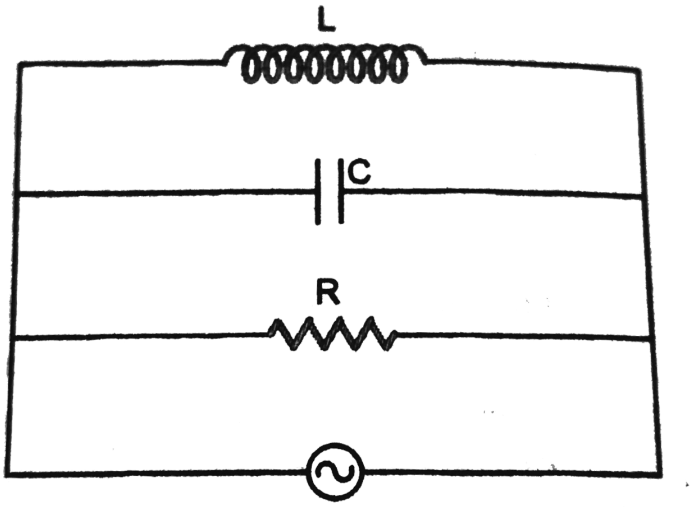
11. Keeping the source of frequency equal to the resonating frequency of the series LCR circuit, if the three elements L, C and R in are arranged in parallel , show that the total current in the parallel LCR circuit is a minimum at this frequency. Obtain the r.m.s. value of current in each brach of the circuit for the elements and source specified in for this

frequency.



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12. What will be the instantaneous voltage for an a.c. supply of 230 V and 50 Hz?

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13. The instantaneous emf an a.c. source is given by $\varepsilon = 300 \sin 314t$. What is the rms value of the emf?

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14. The emf an source is given by the expression $\varepsilon = 300 \sin 314t$. Write the value of peak voltage and frequency of the source.

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15. An alternative current in amperes us given by $I = 50\sin(400\pi t + \phi)$. Find the frequency and the rms value of the current

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16. An alternating emf of peak value 350 V is applied across an a.c. ammeter of resistance 100Ω. What is the reading of the ammeter?

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17. The effective value of current in a 50 cycle a.c. circuit is 5 A. what is the value of current $1/300$ second after it was zero?

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18. The peak value of an alternating current of frequency 50 Hz is 14.14 A. Find its rms value. How much time will the current take in reaching from 0 to maximum value.

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19. A 100Ω iron is connected to a 220 V, 50 cycles wall plug. What is (i) peak potential difference (ii) average potential difference and (iii) rms current?

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20. The equation of a.c. in a circuit is $I = 50 \sin 100\pi t$. Find (i) frequency of a.c., (ii) mean value of a.c. over positive half cycle, (iii)

rms value of current and (iv) the value of current $1/300$ second after it was zero.

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21. A resistance of 500Ω is connected to a source of emf, $\varepsilon = 10\sin 120\pi t$ volt, time t is in second. Calculate (i) peak current (ii) virtual current and (iii) instantaneous current at $t = \frac{1}{360}$ th of a second.

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22. What is the inductive reactance of a coil if current through it is $800mA$ and the voltage across it is 40 V?

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23. A 44 mH inductor is connected to 220 V, 50 Hz a.c. supply. Determine rms value of current in the circuit.

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24. An inductance of negligible resistance, whose reactance is 22 ohm at 200 Hz is connected to a 220 V V, 50 Hz power line. What is the value of inductance and reactance ?

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25. A capactior of $1\mu F$ is connected ot an a.c. source of e.m.f $E = 250 \sin 100\pi t$. Write an equation for instantaneous current through the circuit and given reading of a.c. ammeter connected in the circuit.

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26. A capacitor has a reactance of 100Ω at 50 Hz What will be its reactance at 125 Hz ?

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27. The virtual current in the a.c. circuit shown in fig, 14.15 is 1.0 A. Find (i) virtual coltage across the coil L (ii) impendance of the circuit and (ii) reactance of the coil.

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28. A $0.21H$ inductor and a $12ohm$ resistance are connected in series to a $220V$. $50Hz$ ac source. Calculate the current in the circuit and the phase angle between the current and the source voltage.

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29. An e.m.f. $E = 200 \sin 377t$ volt is applied across an inductance L having a resistance of 1.0 ohm. The maximum current is found to be 10 A. Find the value of L.

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30. A circuit consists of a resistance 10 ohm and a capacitance of $0.1 \mu F$ If an alternating e.m.f. of 100 V. 50 Hz is applied, calculate the current in the circuit.

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31. A 20 watt, 50 V lamp is connected in series to a.c. mains of 250 V, 50 Hz. Calculate to value of capacitor to run the lamp.

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32. A resistor of 50 ohm, an inductor of $(20/\pi)$ H and a capacitor of $(5/\pi)\mu F$ are connected in series to an a.c. source 230 V, 50 Hz. Find the current in the circuit.

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33. A 40 ohm resistor, 3 mH inductor and $2\mu F$ capacitor are connected in series to a 110 V, 5000 Hz a.c. source. Calculate the value of current in the circuit.

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34. A $50\mu F$ capacitor, 0.05 H inductor and 48Ω resistor are connected in series with an a.c.

source of e.m.f. $E = 310 \sin 314t$. Calculate reactance of the circuit. What is its nature ? What is phase angle between current and applied e.m.f. ?

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35. An LCR series circuit with $L = 100mH, C = 100\mu F, R = 120\Omega$ is connected to an AC source of $emf\varepsilon = (30V)\sin\left(100s^{-1}\right)t$. Find the

impedane, the peak current and the resonant frequency of the circuit.

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36. A capacitor, resistor of 5Ω, and an inductor of $50mH$ are in series with an a.c. source marked $100V, 50Hz$. It is found that voltage is in phase with the current. Calculate the capacitance of the capacitor and the impedance of the circuit.

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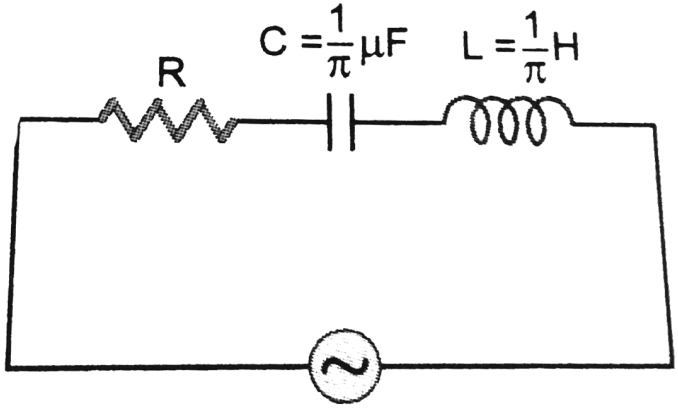
37. In the a.c. circuit shown in fig, the main supply hs constant voltage but variable frequency. For what frequency will the voltage across the resistance R be maximum ?



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38. An a,c, source of frequency 50 hertz is connected to a 50 mH inductor and a bulb. The bulb glows with some brightness. Calculate the capacitance of the capacitor to be connected in series with the ciruit, so that the bulb glows with maximum brightness.

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39. A $200km$ long telegraph wire has capacitance of $0.014\mu F/km$ If it carries an alternating current of 50×10^3 Hz what

should be the value of an inductance required to be connected in series in series so that impedance isw minimum .

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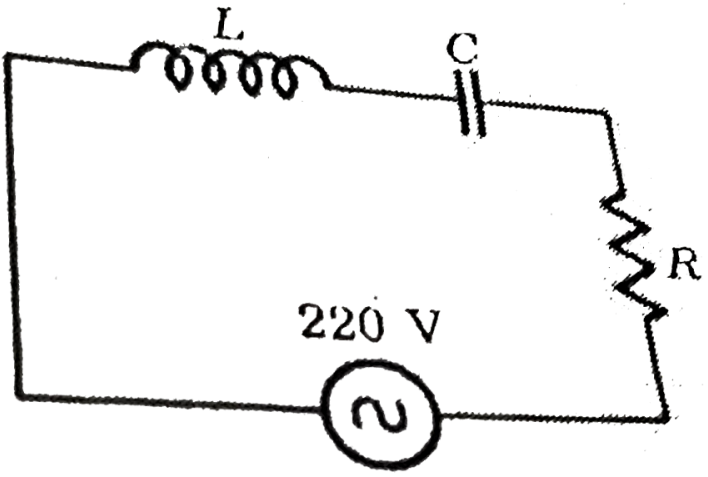
40. Fig 14.18 shows a series LCR circuit connected to a variable frequency 200 V source:

$L = 4.0H, C = 100\mu F$ and $R = 40\Omega$.

(i) Calculate the resonant frequency of the circuit.

(ii) Obtain the impedance of the circuit and the amplitude of the current at resonating frequency.

(iii) Determine r.m.s. potential drop across L.



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41. A 100 mH inductor, a $20\mu F$ capacitor and a 10 ohm resistor are connected in series to a $100V, 50Hz$ a.c. source. Calculate : (i) Inpendance of the circuit at resonance (ii) Current at resonance (iii) Resonant frequency.

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42. Compute the resonant frequency and the Q factor of a series LCR circuit having $L = 4.0H, C = 36\mu F$ and $R = \frac{10}{3}\Omega$. How

can sharpness of resonance of the circuit be improved by a factor of 2 by reducing its full width at half maximum ?

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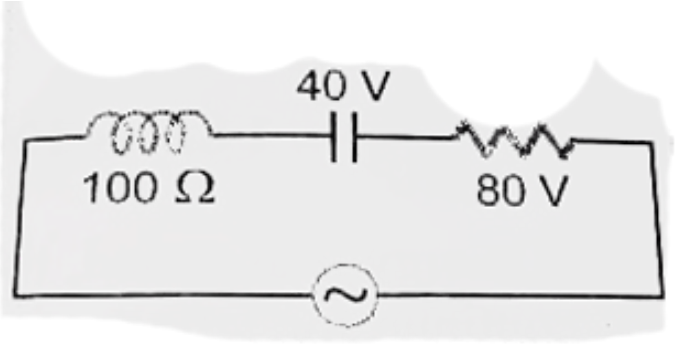
43. In the circuit shown in fig. potential diff. across L, C and and R are given. Find the e.m.f. of the source and calculate power factor of

the circuit.



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44. A 60 cycle AC circuit has a resistance of 200Ω and inductance of 10 mH. What is the power factor? What capacitance placed in the circuit will make the power factor unity?

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45. A transformer has 300 primary turns and 2400 secondary turns: If the primary supply voltage is 230 V, what is the secondary voltage ?

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46. A transformer has 200 primary turns and 150 secondary turns. If the operating voltage for the load connected to the secondary is

measured to be 300 V, what is the voltage supplied to the primary ?

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47. The turns ratio of a transformer is 12.5. If its primary is connected with a.c. mains of 220 V, determine the voltage obtained across the secondary.

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48. A step-up transfomer operates on a 220 volt line and supplies to load, a current of 2A. The ratio of primary and secondary winding is 1 : 25. Calculate secondary voltage, primary current and power output, if efficiency is 80%`

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49. In a stepup transformer, the ratio of number of turns in primary and secondary coils is $1:10$. What voltage will develop in the

secondary if the primary is connected to 220 V mains ? If the current drawn from the secondary is 2A, calculate the current through the primary

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50. Calculate current drawn by primary coil of a transformer, Which steps down 200 V to 20 V to operate a device of 20 ohm resistance. Assume efficiency of transformer 80 %.

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51. The output voltage of an ideal transformer, connected to a 240 V ac. when this transformer is used to light a bulb with rating 24 V, 24 W, calculate the current in the primary coil of the circuit.

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52. A step down transformer is used at 220 V to provide a current of 0.5 A to a 15 W bulb. If the secondary has 20 turns, find the number

of turns in primary coil has current that flows in primary coil.

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53. A step down transformer converts transmission line voltage from 2200 V to 220 V. Primary coil is having 5000 turns. Efficiency of transformer is 90% and output power is 8 kW. Evaluate number of turns in secondary coil and input power.

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54. The number of turns in the primary and secondary coils of an ideal transformer are 2000 and 50 respectively. The primary coil is connected to a main supply of 120 V and secondary to a night bulb of 0.6Ω. Calculate

(i) Voltage across the secondary. (ii) Current in the bulb, (iii) Current in primary coil, (iv) Power in primary and secondary coils, (iv) Power in primary and secondary coils.

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55. The primary of a transformer has 200 turns and secondary has 1000 turns. The power output from secondary at 1000 V is 9 kW. Calculate primary voltage and heat loss in primary. Take resistance of primary coil 0.2Ω and efficiency of transformer = 90%.

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56. An a.c generator consists of a coil of 50 turns and area $2.5m^2$ rotating at an angular speed of $60rad/s$ in a uniform magnetic field

of 0.30 T. The resistance of the circuit is 500 ohm. What is the maximum current drawn from the generator? What is the flux through the coil, when current is zero and when current is maximum ?

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57. A generator develops an e.m.f. of 120 V and has a terminal potential difference of 115 V, when the amature current is 25 A. What is the resistance of the armature ?

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