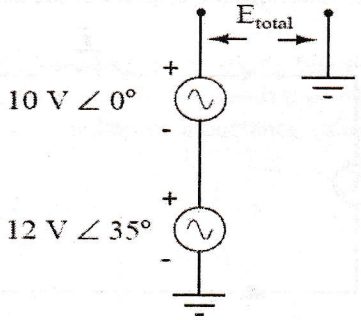
SUBJECT: ELECTRICAL ENGINEERING: PAPER-I (SET - A)

Time: 3hours | Full Marks: 200

Note: Answer question No.1 and any four from the rest. All questions carry equal marks.

1. Answer any 10 (ten): 10X4=40

(a) Two capacitors of 100μF each are connected in series. What will be the total energy stored in the capacitors if a D.C. supply of 200 volts is connected across the series combination?
(b) Draw the block diagram of a CRO and label the blocks.
(c) Two PN junctions are doped with same doping concentration. One of the PN junctions is made up of Silicon and the other one is Germanium. Which one will have a higher leakage current and why?
(d) Define work function and electron affinity.
(e) Determine the total voltage E_{total} in the following circuit and draw the phasor diagram.



(f) Two 100 watts, 230 volts bulbs are connected in series. The series combination is connected across a 230 volts supply. Find out the total power consumption.
(g) In an un-doped silicon μ_e =1350 cm^2/ V-Sec, μ_h = 480 cm^2/ V-Sec and intrinsic carrier concentration is $1.5x10^{10}$ cm^{-3}. Find out the conductivity.
(h) Explain loading effect.
(i) Explain how to convert a voltage source into a current source.
(j) State the relation between cartesian and cylindrical coordinate system.
(k) What is drift current and convection current?
(l) Mention two properties of uniform plane wave.

2. Attempt any 8 (eight): 8X5=40

(a) State the superposition theorem. On what kind of circuit this theorem can be applied? Enunciate the steps involved in using this theorem for analysis of a circuit.
(b) Explain how a Δ-network can be converted into a Y-network.
(c) State and explain the Millman's theorem.
(d) What is Lorentz Force? How it is responsible for generation of Hall voltage?
(e) What is Fermi energy? How does the Fermi energy level in a semiconductor change with value and type of doping concentration?
(f) What is a Time Base Generator in a CRO? Explain. Draw an ideal Time Base Waveform of a CRO.
(g) Draw the circuit diagram of a Wheatstone bridge and establish the condition at balance condition.
(h) Draw the Kelvin double bridge and find out the balanced condition.
(i) What is a spectrum analyzer? Explain its operation using a block diagram.
(j) What are the types of error in electrical measurements? Explain each of them.

3. Attempt any 5 (five): 5X8=40

(a) Find out the electric field due to an infinite line charge distribution.

(b) Write down the Poisson's equation for a semiconductor diode and establish the general expression of electric field on each side of the junction.

(c) In a silicon diode, the acceptor doping concentration is $10^{18}cm^{-3}$ and donor doping concentration is $10^{15}cm^{-3}$. Find out the built in potential at T=300K, if the intrinsic carrier concentration is $1.5x10^{10}\,cm^{-3}$.

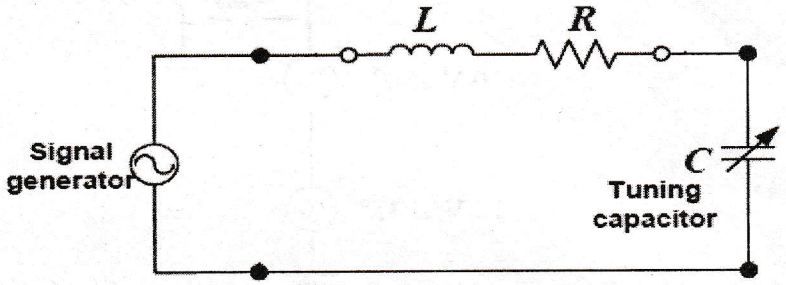
(d) What is a VTVM? What are its components? Mention three advantages and three disadvantages of VTVM.

(e) A P-type silicon semiconductor is connected across a 12 volts battery along its length. The physical dimension of the semiconductor is as follows

length=width=height =10mm

The mobility of electron is μ_e =1350 cm^2/ V-Sec, and hole is μ_h = 480 cm^2/ V-Sec. Find out the current through the semiconductor.

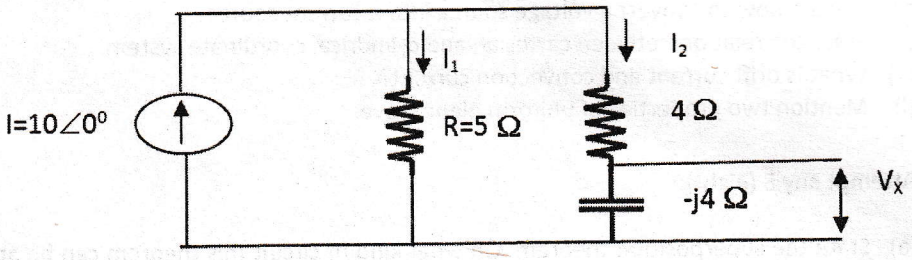
(f) When the following circuit is in resonance, the voltage across the capacitor is V = 100 mV, R = 5 Ω, and $X_L = X_C$ = 100 Ω. Calculate the Q factor of the coil.



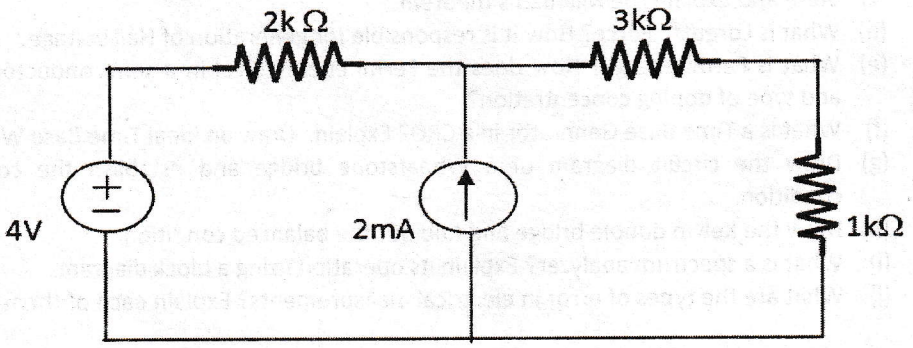
(g) Draw the block diagram of a digital ramp type voltmeter and state the function of each block.

4. Answer any 4 (four): 4X10=40

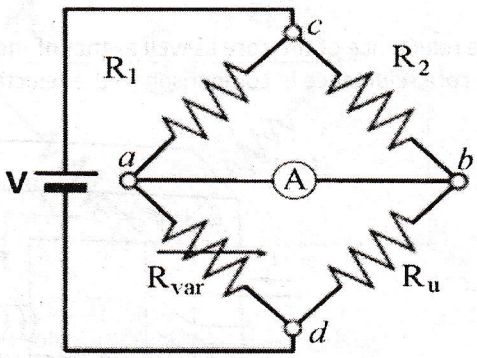
(a) Verify the reciprocity theorem for the following network



(b) Find the Thevenin and Norton equivalent circuits faced by the 1kΩ resistor in the following circuit.



(c) A circuit consists of two resistors with resistances $R_1 = 6\ \Omega$ and $R_2 = 1.5\ \Omega$, a variable resistor, the resistance R_{var} of which can be adjusted, a resistor of unknown value R_u and 9.0 volt battery connected as shown in the following figure. When R_{var} is adjusted to 12 Ω, there is zero current through the ammeter. What is the unknown resistance R_u?



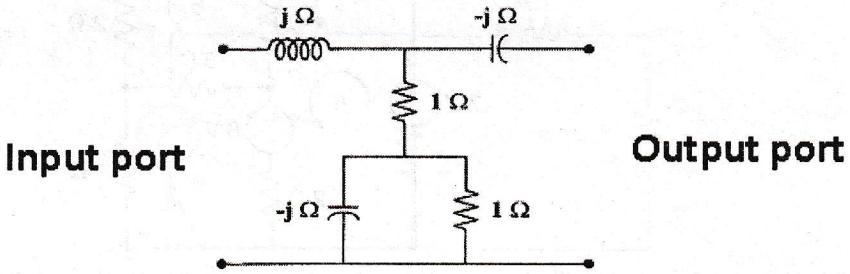
(d) What are extrinsic semiconductors? What are its types? Explain donor energy level, acceptor energy level and extrinsic Fermi energy levels with the help of a neat energy band diagram.

(e) Derive the expression for an unknown inductance using the balance equations of a Maxwell bridge.

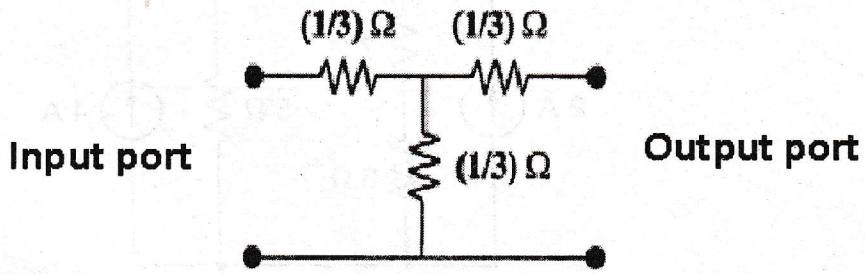
5. Answer any 2 (two): 2X20=40

(a)

i. Determine the Z-parameter of the following circuit

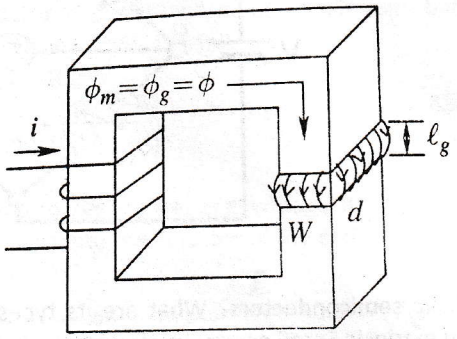


ii. Determine the Y-parameter of the following circuit



(b) In the following structure all the flux lines are assumed to cross the air gap. The structure dimensions are as follows
Cross sectional area of the core $A_m=20cm^2$, mean path length l_m= 40 cm, l_g=2 mm and number of turns=75. In the linear region, the core permeability can be assumed to be constant with μ_r=4500. The coil current i=30 Amps, is below the saturation level. Ignore fringing effect. Calculate the flux density in the air gap

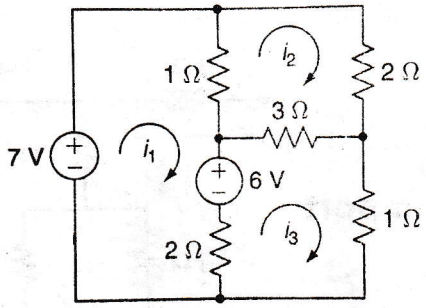
i. Including the reluctance of the core as well as that of the air gap.
ii. Ignoring the core reluctance in comparison to the reluctance of the air gap.



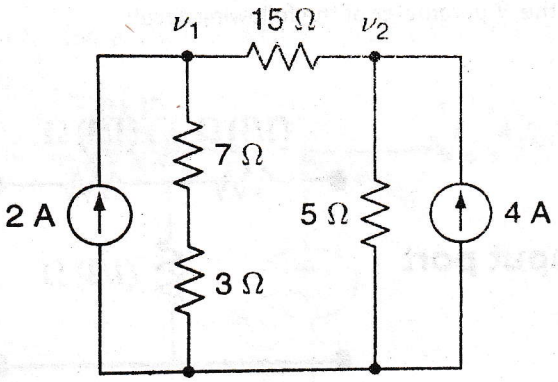
(c) Draw the circuit diagram of a Schering Bridge and
i. Derive the expression for the unknown resistance and capacitance.
ii. Draw the phasor diagram.

6. Answer any 4 (four): 4X10=40

(a) Use mesh analysis technique to determine three mesh currents in the following circuit.

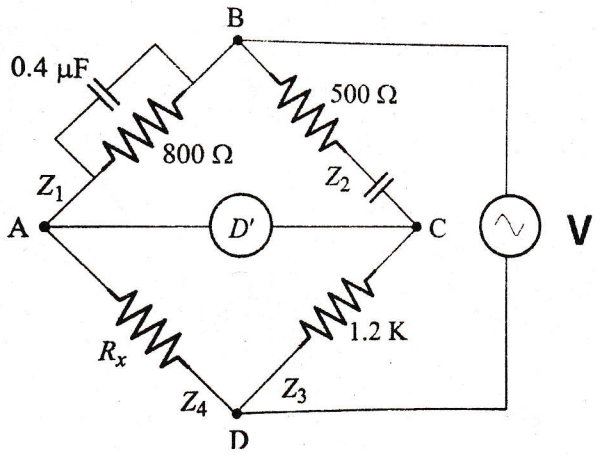


(b) Use nodal analysis technique to determine the current flowing from left to right through the 15 ohm resistor.

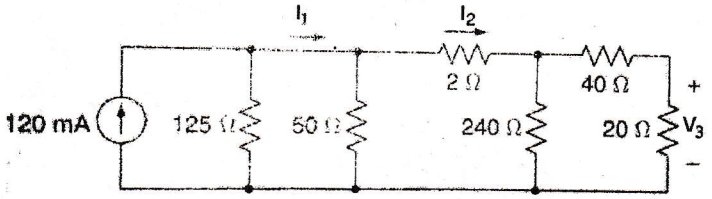


(c) Draw the block diagram of a Servo balancing Potentiometric Recording Instrument and explain its operation mechanism.
(d) An A.C. bridge shown in the following figure. Find out
i. Frequency for which the bridge is balance.

ii. The value of R_x to produce a balance.



(e) Find out the currents i_1, i_2 and voltage v_3 in the following circuit.

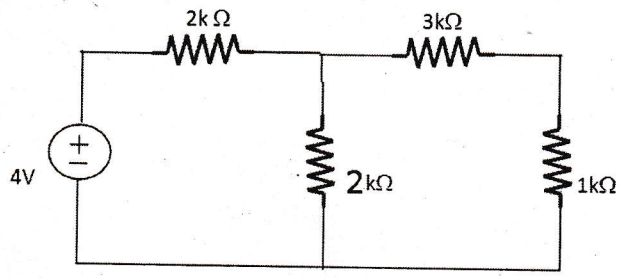


7. Answer any 2 (two): 2X20=40

(a) Use Thevenin's theorem in the following circuit to find

i. Current through the 1 KΩ resistor.

ii. Power dissipated in the 1 KΩ resistor.



(b) Draw the Hay Bridge. Find out the balance equation and hence, derive the expression for the unknown inductance and resistance. Draw the phasor diagram under balanced condition.

(c) Find out the step response of the following circuits

i. RL series circuit.

ii. LC series circuit.
