2021

ELECTRICAL ENGINEERING

PAPER-I

Time Allowed — 3 Hours *Full Marks — 200*

If the questions attempted are in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and the remaining ones ignored.

*Answer may be written either in **English** or in **Bengali** but all answers must be in one and the same language.*

All symbols have their usual significance.

Group-A

Answer *any three* questions.

1. (a) Use superposition theorem to find the value of voltage 'v' in the network of Fig-1. 10

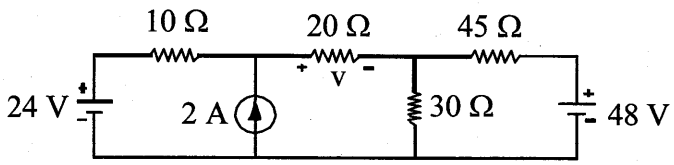
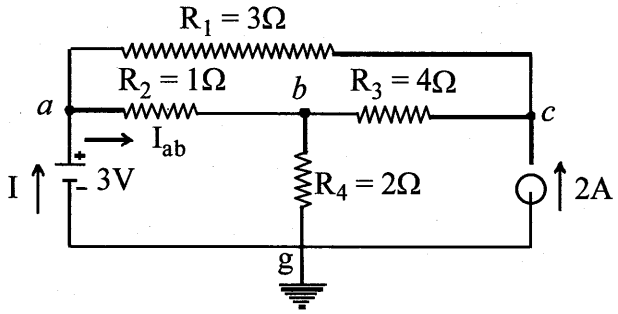
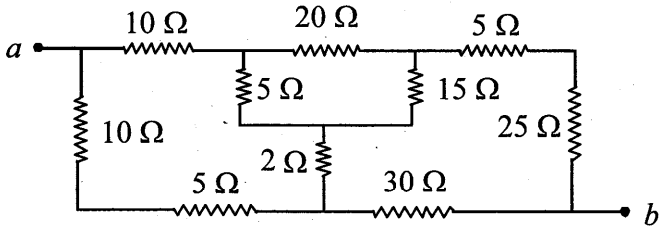


Fig-1

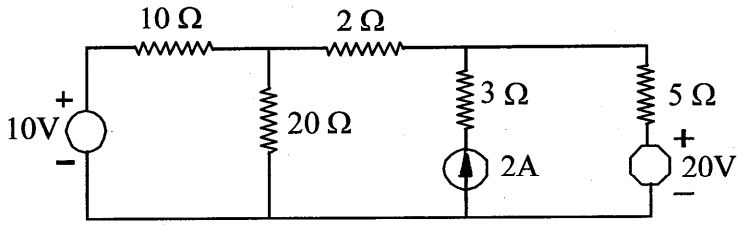
(b) Find the current through branch '*ab*' (I_{ab}) and voltage (V_{cg}) across the current source using node voltage method. 10



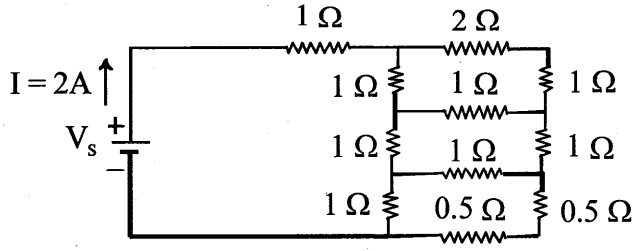
(c) Determine the resistance between terminals '*ab*' of the network shown below. Deduce the formula you have used. 20



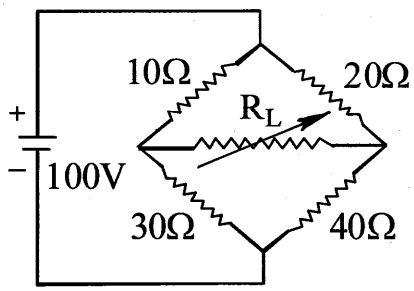
2. (a) Find the voltage across 2Ω resistor by using superposition theorem for the network shown below. 10



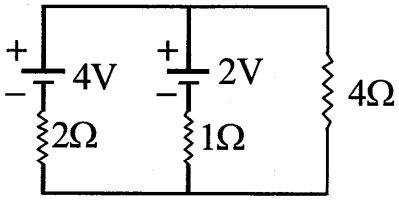
(b) Find the value of the voltage source (V_s) that delivers 2 Amps current the circuit shown below. 10



(c) Determine the load resistance R_L, shown in the circuit below, to receive maximum power from the source; also find the maximum power delivered to the load. 15



(d) Using Norton's theorem determine the current flowing through the 4Ω resistance as shown in the network below. 5



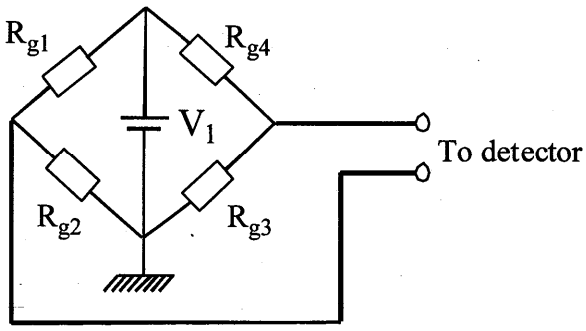
3. (a) A voltage of 120V at 50Hz is applied to a resistance, R in series with a capacitance C. The current drawn by the combination is 2A and the power loss in the resistance is 100W. Calculate the values of resistance and capacitance. Draw the phasor diagram. 7+3=10

(b) A constant voltage of frequency, 1MHz is applied to a lossy inductor in series with a variable capacitor C. The current drawn is maximum when C = 400 pF; while current is reduced to $(1/\sqrt{2})$ of the above value, when C = 450 pF. Find the values of resistance and inductance of the inductor. Also calculate the quality factor of the coil and bandwidth of the coil. 10

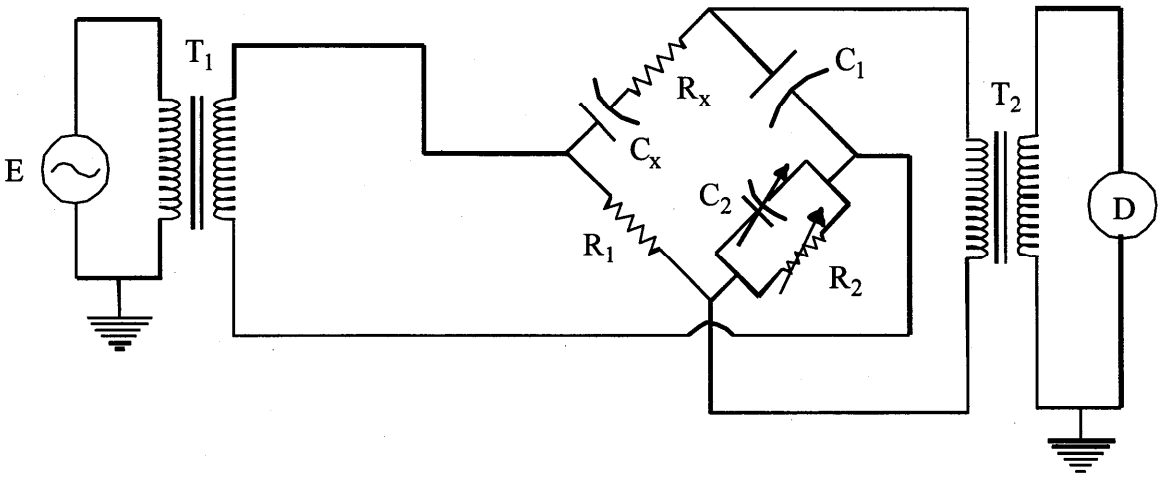
(c) Three loads are delta connected to a symmetrical three phase, 440V system frequency 50Hz. Load A takes 25kW at unity power factor, load B takes 40 kVA at power factor 0.9 leading and load C takes 45 kVA at power factor 0.7 lagging. Calculate the line currents and the readings of two watt meters connected to measure the power input. The current coil of W_1 is connected in line R to the junction of A and C, the current coil of W_2 in line Y to the junction of A and B. Phase sequence RYB. 20

4. (a) Explain the operation of a successive approximation type A/D converter with flowchart. 10

(b) Find the bridge sensitivity for Wheatstone bridge arrangement based strain measurement system with four identical active strain guages (i.e. guage resistances $R_{g1} = R_{g2} = R_{g3} = R_{g4}$) as shown in figure below. 10



(c) What is the use of Schering bridge? For the following circuit diagram explain bridge balance equation. 10



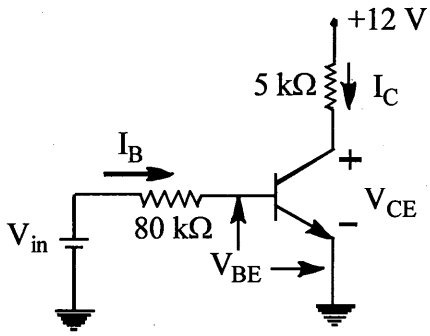
(d) Why the CRO probes are to be designed properly for accurate signal representation? Explain with the help of a diagram. 10

5. (a) Determine the minimum value of current gain β required to put the transistor, shown in figure, in saturation when 10

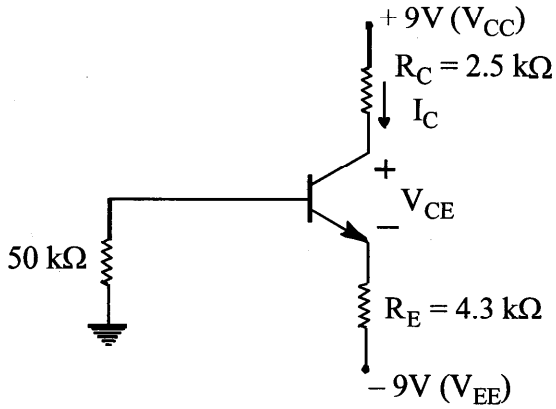
V_{in} = + 5V

Assume, $V_{BE(sat)}$ = 0.8V,

$V_{CE(sat)}$ = 0.12V



(b) Find the operating point current I_{CQ} and voltage V_{CEQ} in the circuit shown below. Given V_{BE} = 0.7V, β of transistor is 200. 10



(c) Simplify the following Booleen function:

F(A, B, C) = πM (0, 1, 5, 7, 8, 9, 15) 10

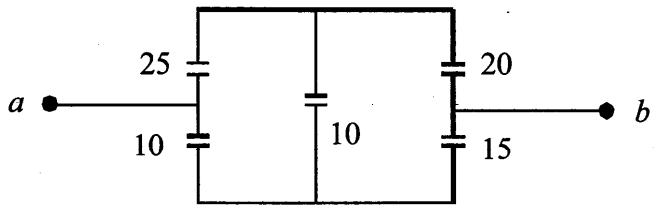
(d) Design all the gates i.e. NOT, AND, OR, NAND, NOR, XOR and XNOR using 2 : 1 multiplexer. 10

Group-B

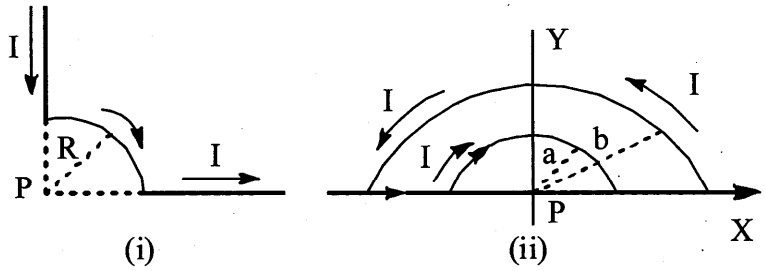
Answer *any two* questions.

6. (a) Three charges q_1, q_2 and q_3 lie on the x-axis at $x = x_1$, x_2 and x_3 respectively. Find the flux produced by all the three charges through a circle of radius a, normal to the x-axis with its centre at the origin (0, 0, 0). 10

(b) Determine the capacitance of the combination between terminals *a* and *b* as shown in figure below. All the values of the capacitances are in microfarads. 10



(c) Calculate the magnetic field at point P due to the following current distributions. 10



(d) Inductance of a closely wound coil is such that when the current changes by 5A per second, it induces electromotive force of 3mv. Furthermore, a steady current of 8A generates in each loop of the coil a magnetic flux of 40 μwb.

(i) Calculate the inductance of the coil.

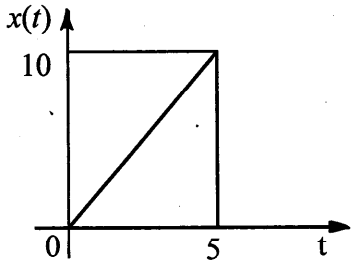
(ii) Determine the number of loops of the coil. 10

7. (a) Check whether the following signal is a power signal or energy signal 5

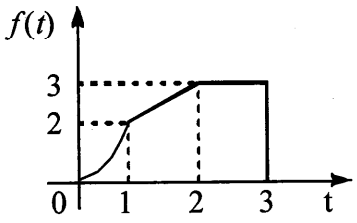
$x(t) = e^{-\alpha t}$, $t > 0$, $\alpha > 0$

$= 0$, elswhere

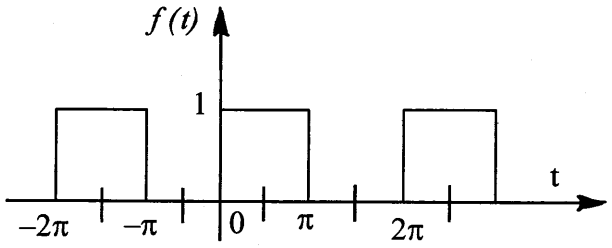
(b) Resolve $x(t)$ into even and odd components. 5



(c) Express following function in terms of singularity functions: 10



(d) Find Fourier coefficients, Amplitude and Phase spectra for the following signal $f(t)$. 20



8. (a) A unity feedback system with the following forward path transfer function oscillates at 2 rad/sec.

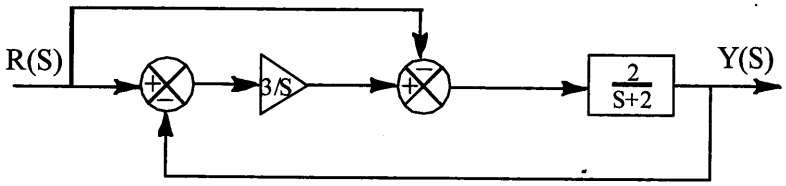
$$G(s) = \frac{K(s+1)}{s^3 + as^2 + 2s + 1}$$

Find the values of K and a. 12

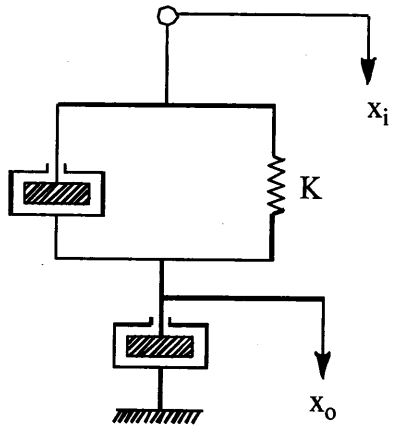
(b) Obtain the transfer function for the system describe by the state-space equations of the form. $\dot{x} = Ax + Bu,\ y = Cx$

with $A = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$ 8

(c) Obtain the steady state error for the system shown in figure below, when subjected to a unit step input. 12



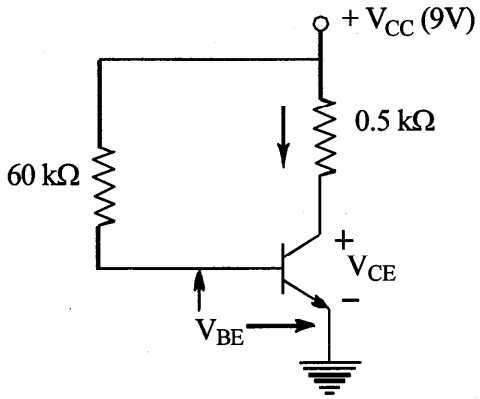
(d) Consider the mechanical system shown in figure below. Obtain the transfer function of the system taking the displacement x_i as the input and x_o as the output. Comment whether it is a mechanical load network or lag network. 8



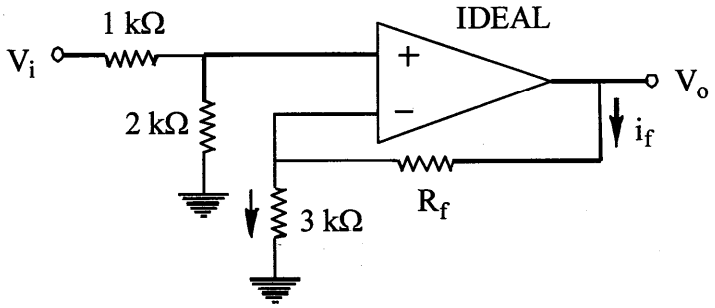
9. (a) The fixed bias circuit shown in figure below is a silicon transistor with $V_{BE} = 0.7V$.

(i) Find the collector current, I_C and voltage V_{CE}, if β of transistor is 60.

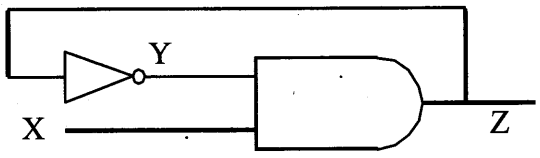
(ii) Find I_C and V_{CE} if β changes to 80. State what conclusion may be drawn. 15



(b) For the ideal op-amp shown, what should be the value of resistor R_f to obtain a gain of 5? 5



(c) Assume that the inverter in the network below has a propagation delay of 5 ns and the AND gate has a propagation delay of 10 ns. Draw a tuning diagram for the network showing X, Y and Z. Assume that X is initially 0, Y is initially 1, X becomes 1 for 80 ns and then X is 0 again. 10



(d) Write an assembly language program for 8085 microprocessor to multiply two eight bit numbers, the result may contain sixteen bits. 10