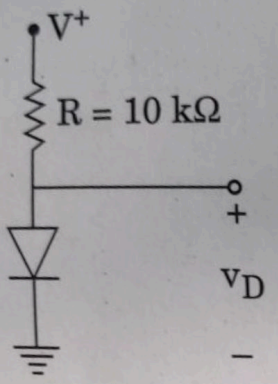
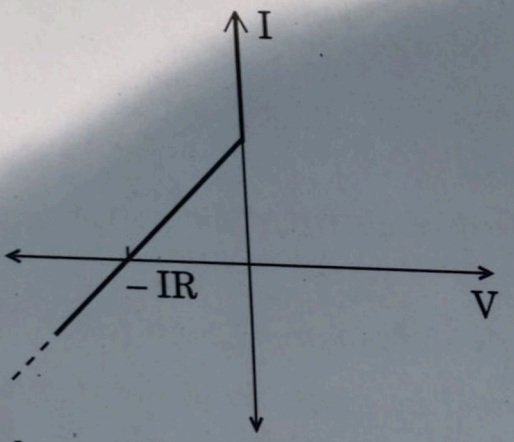
SECTION A

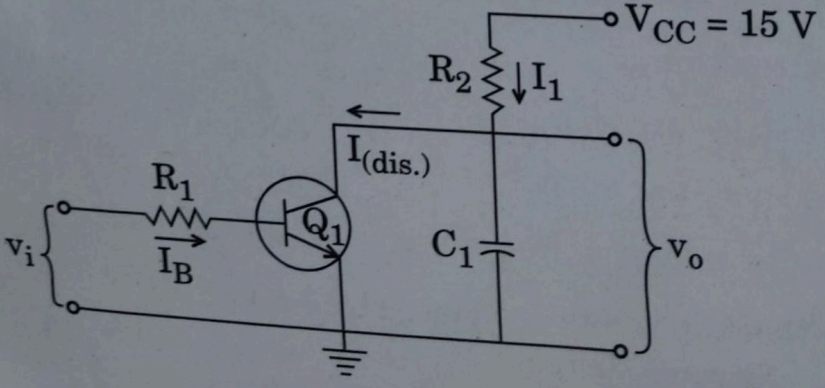
Q1. (a) (i) Consider the circuit shown below. The power supply V^+ has a dc value of 10 V on which is superimposed a 60 Hz sinusoid of 1 V peak amplitude, i.e. has a power supply ripple. Calculate both the dc voltage of the diode and the amplitude of the sine-wave signal appearing across it, assuming a 0·7 V drop across it at 1 mA current. *6*



(ii) For the V-I characteristics as shown below, draw the circuit model using an ideal diode. *6*



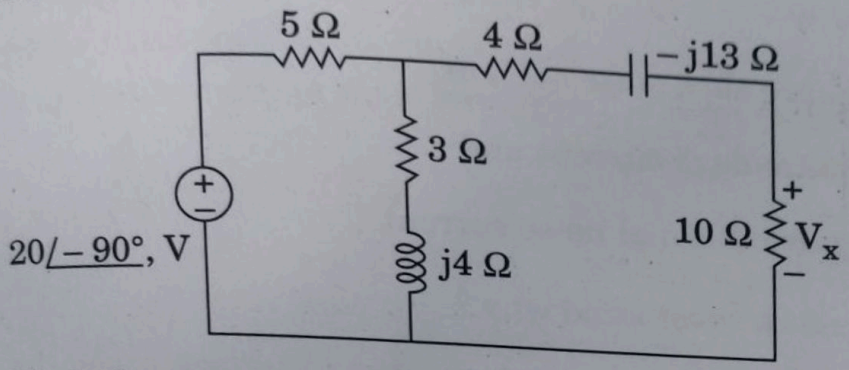
(b) The circuit shown below is to be used as ramp generator to produce a 1 V ramp output when the input is 3 V, 0·1 ms pulse with a 1 ms interval between pulses. The supply voltage is 15 V and a load resistance of 100 kΩ is connected at the output terminals. Assume Q_1 has $h_{FE(min)} = 50$. Determine values of R_1, R_2 and C_1. *12*



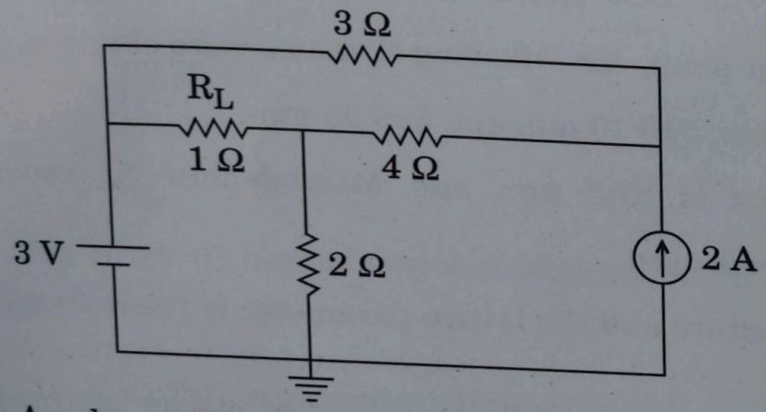
(c) A 40 μF capacitance is charged to store 0·2 J of energy. An uncharged, 60 μF capacitance is then connected in parallel with the first one through perfectly conducting leads. What is the final energy of the system ? *12*

(d) Identify magnitude of the Burgers vector for a material having cubic crystal structure, if the density, atomic weight and lattice constant are 7870 kg/m^3, 55·85 g/mol and 2·86 Å, respectively. *12*

(e) Calculate V_x in the circuit shown in the figure using the method of source transformation. *12*



Q2. (a) Find the current through the load resistance 'R_L' using Thevenin's theorem and hence calculate the voltage across the current source for the circuit shown in figure. *20*



(b) An abrupt Si p-n junction ($A = 10^{-4}$ cm^2) has the following properties at 300 K :

p-side	n-side
$N_a = 10^{17}$ cm^{-3}	$N_d = 10^{15}$ cm^{-3}
$\tau_n = 0{\cdot}1$ μs	$\tau_p = 10$ μs
$\mu_p = 200$ $cm^2/V\text{-}s$	$\mu_n = 300$ $cm^2/V\text{-}s$
$\mu_n = 700$ $cm^2/V\text{-}s$	$\mu_p = 450$ $cm^2/V\text{-}s$

Take $n_i = 1{\cdot}5 \times 10^{10}$ cm^{-3}.

The junction is forward biased by 0·5 V. Find

(i) forward current

(ii) current at a reverse bias of – 0·5 V. *20*

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Q1. (c) An InGaAs pin photodiode has the following parameters at a wavelength of 1300 nm :

$I_D = 4$ nA; $\eta = 0{\cdot}90$; $R_L = 1$ kΩ; $P_{in} = 300$ nW

where P_{in} is incident optical power. The receiver bandwidth is 20 MHz. Assume surface leakage current is negligible.

Determine

(i) mean-square shot noise current,

(ii) mean-square dark current and

(iii) mean-square thermal noise current.

Which noise is more severe and why ?

Q3. (a) The entry point and exit point of X-rays on a power pattern taken from a cubic crystal material could not be distinguished. Assuming one of the points to be the exit point, the following S values were obtained :

S values : 311·95 mm, 319·10 mm and 335·05 mm.

The camera radius is 57·3 mm and Molybdenum K_α radiation of wavelength 0·7 Å was used.

Determine the structure and the lattice parameter of the material.

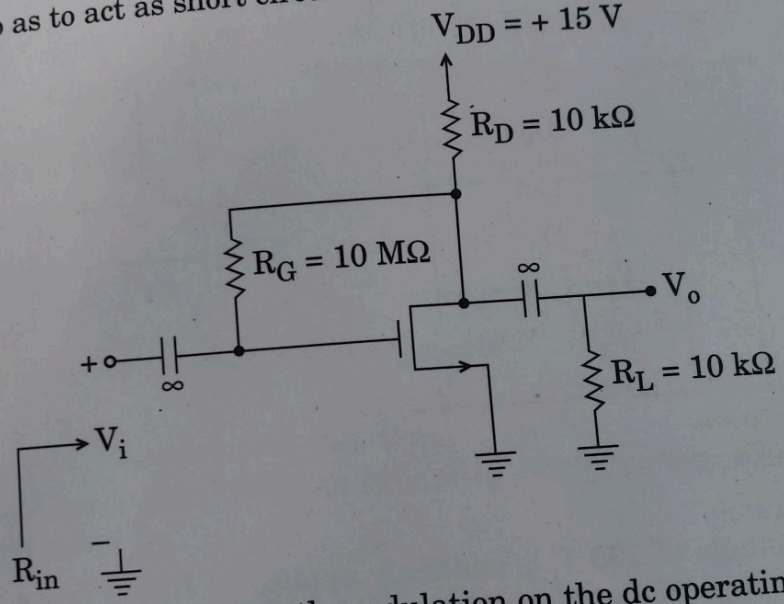
(b) (i) Obtain the exact equivalent circuit (per phase) of three-phase induction motor.

(ii) A 6-pole, 3-phase, 50 Hz induction motor takes 50 kW power at 940 rpm. The stator copper loss is 1·4 kW, stator core loss is 1·6 kW, and rotor mechanical losses are 1 kW. Find the motor efficiency.

(c) An industrial consumer is operating a 50 kW induction motor at a lagging p.f. of 0·8. The source voltage is 230 V rms. In order to obtain lower electrical rates, the customer wishes to raise the p.f. to 0·95 lagging. Specify a suitable solution.

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Q4. (a) Figure below shows a discrete MOSFET amplifier utilizing a drain-to-gate resistance R_G. The input signal V_i is coupled to the gate via a large capacitor, and the output signal at the drain is coupled to load resistance R_L via another large capacitor. Analyze this amplifier circuit to determine its small signal voltage gain, its input resistance, and the largest allowable input signal. Assume V_t = 1·5 V, K'_n (W/L) (process transconductance parameter) = 0·25 mA/V^2, and V_A = 50 V, where V_A is the intercept on the V_{DS} axis of the $i_D - V_{DS}$ characteristics when extrapolated. Assume that coupling capacitors are sufficiently large so as to act as short circuit at the frequencies of interest.



The effect of channel length modulation on the dc operating point can be neglected. 20

(b) (i) Define nanomaterials and classify nanomaterials on the basis of number of dimensions. What are the different approaches for the preparation of nanomaterials ? Discuss any one method of preparation of nanomaterials from each approach. 10

(ii) Explain how dislocation density increases on cold working. 10

(c) (i) The Burgers vector of a mixed dislocation line is $\frac{1}{2}[1\ 1\ 0]$. The dislocation line lies along the $[1\ 1\ 2]$ direction. Find the slip plane on which this dislocation lies. 10

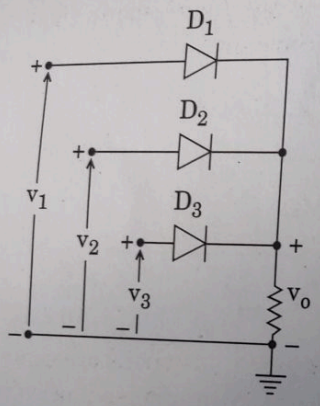
(ii) Explain, why end centered tetragonal geometry does not exist. 10

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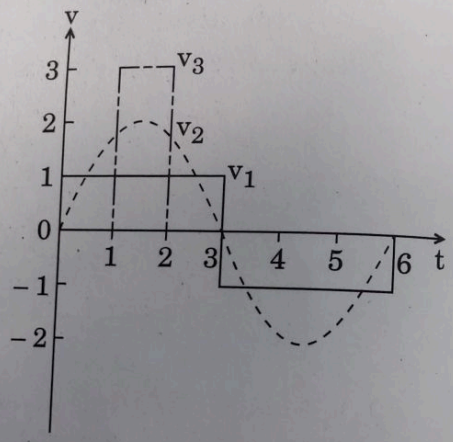
SECTION B

Q5. (a) (i) Sketch the circuit of a one-shot using a 555 timer to provide one time period of 20 μs. If $R_A = 7{\cdot}5$ kΩ, what value of C is needed ? Also sketch the input and output waveforms, when triggered by a 10 kHz clock for $R_A = 5{\cdot}1$ kΩ and C = 5 nF. 6

(ii) The logic OR gate can be used to fabricate composite waveforms. Sketch the output v_o of the gate of figure (a) shown below if the three signals as shown below in (b) are impressed on the input terminals. Assume the diodes are ideal. 6

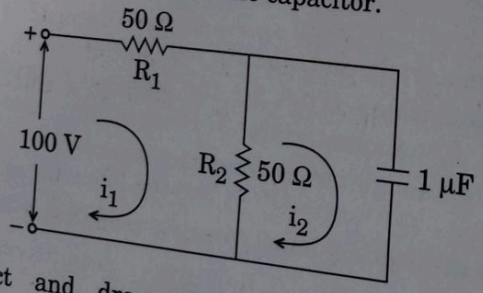


(a)



(b)

(b) A dc voltage of 100 V is suddenly applied in the network shown in the figure. Find the transient currents in both the loops and obtain the transient voltage across the capacitor. 12



(c) Predict and draw the crystal structure of MgO and compute its theoretical density. (Give Ionic radius of Mg^{++} ion, $r_{Mg^{++}} = 0{\cdot}72$ Å and ionic radius of O^{--} ion, $r_{O^{--}} = 1{\cdot}40$ Å; atomic masses of 'Mg' and 'O' are 24·31 g/mol and 16·00 g/mol, respectively, Avogadro's Number = $6{\cdot}023 \times 10^{23}$ g/mol) 12

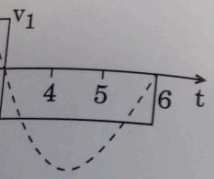
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5 timer to provide one
value of C is needed ?
, when triggered by a

6

mposite waveforms.
shown below if the
essed on the input

6



(b)
shown in the
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l compute
+ = 0·72 Å
Mg' and 'O'
Avogadro's

12

(d) A digital ramp A/D converter has the following values :

Clock frequency, $f_c = 1$ MHz

Threshold voltage, $V_T = 100\ \mu V$

D/A-$V_{ref.}$ = 10·24 V and Number of input bits = 10

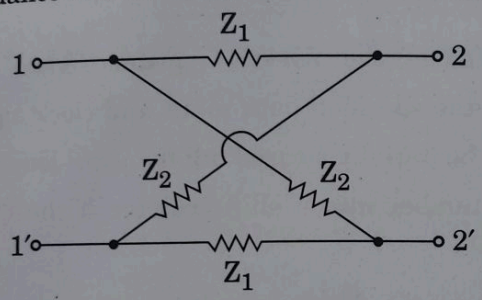
Determine :

(i) Digital/equivalent representation for $V_{in} = 4{\cdot}872$ V

(ii) Resolution of the A/D converter and

(iii) Conversion time required by this digital ramp A/D converter. *12*

(e) For the lattice two port network of the figure shown, find the image impedance and the image transfer constant. *12*



Q6. (a) A first-order thermometer was dipped in a temperature-controlled water bath maintained at 100°C and the following time-temperature readings were obtained :

Time (s)	0	4	8	12	16	20
Temperature (°C)	15	50	70	85	90	95

Estimate the time constant of the thermometer. Determine the steady state error when the thermometer is required to measure the temperature of a liquid which is being heated at a constant rate of 0·1°C/s . *20*

(b) A quartz Piezoelectric Transducer (PZT) has the following specifications : Area = 1 cm^2; Thickness = 2 mm; Young's modulus = 9×10^{10} Pa; Charge sensitivity = 2 pC/N; Relative permittivity = 5 and Resistivity = 10^{12} Ω-cm. A 10 pF capacitor and a 100 MΩ resistor are connected in parallel across the electrodes of the PZT. If a force $F = 0{\cdot}02 \sin (10^3 t)$ N is applied, determine

(i) the peak-to-peak voltage generated across the electrodes and

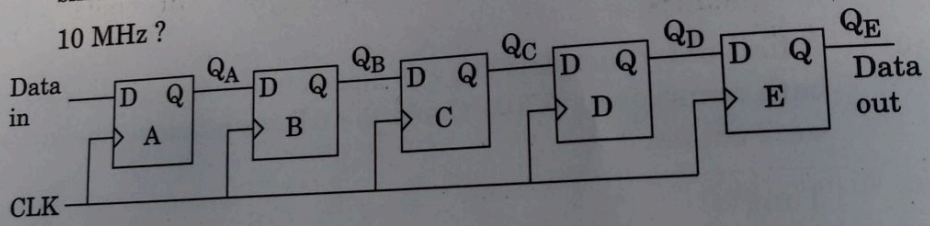
(ii) the maximum change in crystal thickness. *20*

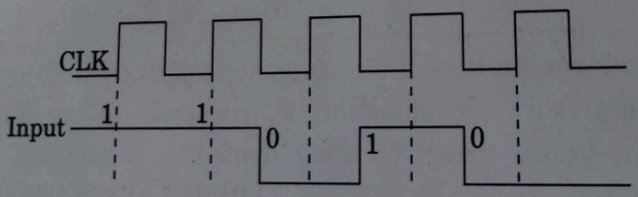
(b)

(c) (i) Generate the logic function given in the table below using IC74151 8-to-1 MUX. 10

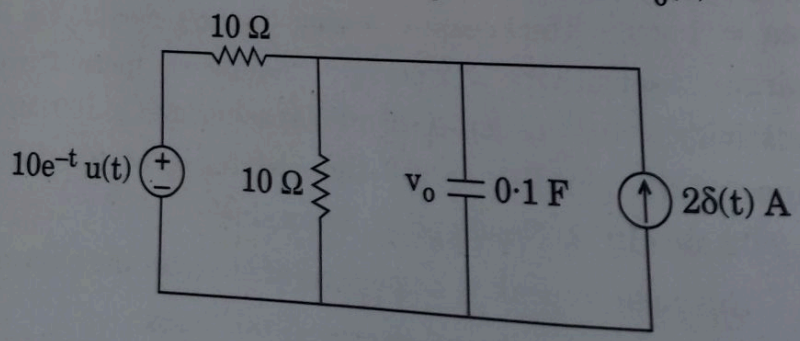
Inputs			Output
C	B	A	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(ii) Show the states of the five-bit register shown below using waveforms, for the specified data input and clock signal. Assume the registers to be initially cleared (all 0s). How long will it take to shift an 8-bit number into a shift register if the clock is set to 10 MHz ? 10





Q7. (a) Find $v_o(t)$ in the circuit shown in the figure. Assume $v_o(0) = 5$ V. 20



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(b) (i) In a cathode-ray tube, the electron beam is displaced vertically by a magnetic field of flux density 2×10^{-4} Wb/m^2. The length of the magnetic field along the tube axis is same as that of electrostatic deflection plates. The final anode voltage is 1 kV. Determine the voltage which should be applied to the y-deflection plates 10 mm apart to return the spot back to the centre of the screen. Take

Mass of electron = $9{\cdot}107 \times 10^{-31}$ kg and

Charge on electron = $1{\cdot}6 \times 10^{-19}$ C. *10*

(ii) A moving coil milli-ammeter having a resistance of 20 Ω gives full scale deflection when a current of 10 mA is passed through it. Describe how this instrument can be used for measurement of

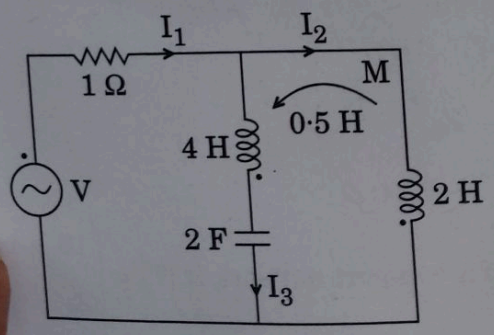
Current up to 1A and

Voltage up to 5 V. *10*

(c) (i) Draw the oriented graph of a network with fundamental cutset matrix as shown below : *10*

Twigs				Links		
1	2	3	4	5	6	7
1	0	0	0	−1	0	0
0	1	0	0	1	0	1
0	0	1	0	0	1	1
0	0	0	1	0	1	0

(ii) For the network shown in the figure, draw the oriented graph, obtain the cutset matrix and find the number of links. *10*



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Q8. (a) (i) For the network in the figure shown below, determine

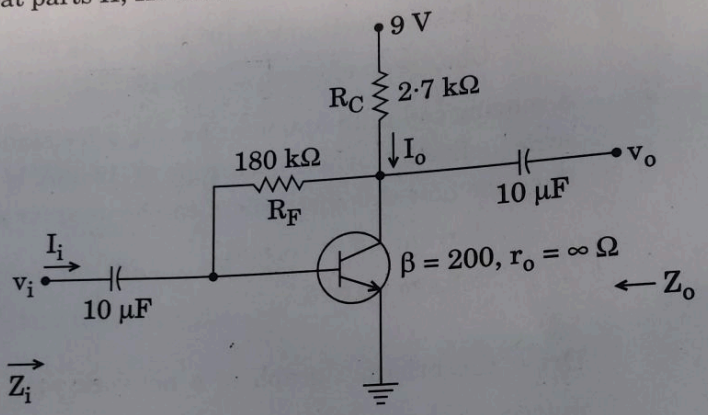
I. r_e

II. Z_i

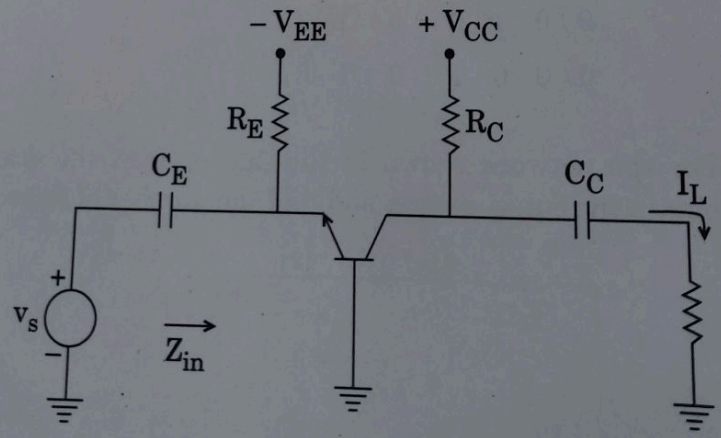
III. Z_o

IV A_v

Repeat parts II, III and IV with $r_o = 20\ k\Omega$ and compare results. *10*



(ii) Draw the equivalent circuit (hybrid-π high frequency model) of the CB amplifier shown below. Find an expression for the high-frequency voltage-gain ratio. Also describe the high-frequency behaviour of this amplifier. *10*



(b) Find [z] and [g] of a two-port network if $[T] = \begin{bmatrix} 10 & 1{\cdot}5\ \Omega \\ 2s & 4 \end{bmatrix}$. *20*

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(c) For the circuit shown below, identify the logic function performed by it. Also determine the high level fan-out, if R_P (pull-up resistor) = 10 kΩ. Compute the maximum value of R_P for a fan-out of 5. Assume that input diode has a leakage current of 100 μA.

Given : V_T = 0·7 V, V_D (forward voltage drop) = 0·8 V, V_{BE}(cut-in) = 0·5 V, V_{CE}(sat) = 0·2 V. Transistor leakage current is negligible. 20

