Q. P. Code : 37078

(3 Hours) **[Total marks : 80**

Note : -
1) Question number **1** is **compulsory.**
2) Attempt any **three** questions from the remaining **five** questions.
3) **Figures** to the **right** indicate **full** marks.

Q.1 a) Evaluate $\int_0^\infty e^{-2t} sin^2 2t\, dt$. 05

b) Find an analytic function $f(z) = u + iv$ where $u + v = e^x(\cos y + \sin y)$. 05

c) Obtain Fourier series of $x \cos x$ in $(-\pi, \pi)$. 05

d) Evaluate $\int_C \bar{F} \cdot d\bar{r}$ where $\bar{F} = x^2\, i + xy\, j$ from $(0,0)$ to $(1,1)$ along the parabola $y^2 = x$. 05

Q.2 a) Find half-range cosine series for $f(x) = e^x,\ 0 < x < 1$. 06

b) Prove that 06
$\bar{F} = (x + 2y + az)\, i + (bx - 3y - z)\, j + (4x + cy + 2z)\, k$
is solenoidal and determine the constants a, b, c if $\bar{F}$ is irrotational.

c) Prove that $w = i\left(\frac{z-i}{z+i}\right)$ maps upper half of the $z-$plane into the interior of the unit circle in the $w-$plane. 08

Q. 3 a) Prove that $J_n(x)$ is an even function if n is even integer and is an odd function if n is odd integer. 06

b) Find the inverse Laplace transform of 06
$\frac{s^2+2s+3}{(s^2+2s+5)(s^2+2s+2)}$.

c) Obtain the complex form of Fourier series for $f(x) = e^{ax}$ in $(0, a)$. 08

Q. 4 a) Prove that $\nabla f(r) = f'(r)\frac{\bar{r}}{r}$ and hence, find f if $\nabla f = 2r^4\bar{r}$. 06

b) Prove that $4J''_n(x) = J_{n-2}(x) - 2J_n(x) + J_{n+2}(x)$. 06

c)

(i) Find the Laplace transform of $e^{4t}\ sin^3 t.$ 04

(ii) Find the Laplace transform of $t\sqrt{1+\sin t}.$ 04

Q. 5 a) Prove that $\int x \cdot J_{\frac{2}{3}}\left(x^{\frac{3}{2}}\right) dx = -\frac{2}{3}\, x^{-\frac{1}{2}} J_{-\frac{1}{3}}\left(x^{\frac{3}{2}}\right).$ 06

b) Find p if $f(z) = r^2 \cos 2\theta + i\, r^2 \sin p\theta$ is analytic. 06

c) If $f(x) = \begin{cases} \pi x, & 0 \le x \le 1 \\ \pi(2-x), & 1 \le x \le 2 \end{cases}$ with period 2, show that 08

$f(x) = \frac{\pi}{2} - \frac{4}{\pi} \sum_{n=0}^{\infty} \frac{1}{(2n+1)^2} \cos(2n+1)\pi x.$

Q. 6 a) Show that the set of functions $\cos nx,\ n = 1, 2, 3, \ldots$ is orthogonal on $(0, 2\pi)$. 06

b) Use Stoke's theorem to evaluate $\int_C \bar{F} \cdot d\bar{r}$ where $\bar{F} = (2x - y)\, i - yz^2\, j - y^2 z\, k$ and S is the surface of hemisphere $x^2 + y^2 + z^2 = a^2$ lying above the xy −plane. 06

c) Use Laplace transform to solve 08

$\frac{d^2y}{dt^2} + y = t$ with $y(0) = 1, y'(0) = 0.$

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Time: 3 Hours **Marks: 80**

N.B.: (1) Question No. 1 is compulsory.
(2) Attempt any 3 out of remaining
(3) Figures on the right indicate full marks.
(4) Assume suitable data if necessary.

Q.1 Answer the following. (Any FIVE) 20

a) Classify transducers with suitable example.
b) Define a) Accuracy b) Sensitivity
c) What is the principle of working of capacitive transducers? How can we use them for level measurement?
d) Find seebeck voltage for a thermocouple with proportionality constant of $40\mu V/^{\circ}C$ If the junction temperature are 40°C and 80°C.
e) A thermistor has a resistance temperature coefficient of -5% over a temperature range of 25 °C to 50°C. If the resistance of the thermistor is 100 ohms at 25°C, what is the resistance at 35°C?
f) Explain different types of errors.

Q.2

a) Draw and explain working of LVDT. What causes residual voltage to occur? 10

b) A linear resistance potentiometer is 50mm long and is uniformly wound with a wire having resistance of 10,000 Ω under normal condition. The slider is at the center of the pot. Find the linear displacement when the resistance of pot is measured by Wheatstone's bridge for two cases (i) 3850 Ω (ii) 7560 Ω. Are the two displacements in the same direction? 10

Q.3

a) Explain any five static characteristics of transducer with suitable examples. 10

b) What is the need of lead wire compensation? How it is to be done in RTD? What is self heating effect in RTD? 10

Q.4

a) For a certain thermistor β =3140 K and at 27°C is known to be 1050 Ω. The thermistor is used for temperature measurement and the resistance measured is as 2330 Ω. Find the measured temperature. 10

b) Draw set up and explain the working of air purge method of level measurement. 10

Q.5

a) Explain in detail radioactive type level detector. 10

b) A capacitive transducer uses two quartz diaphragm of area 750 mm^2 separated by a distance of 3.5 mm. A pressure of 900 KN/m^2 when applied to top diaphragm produces a deflection of 0.6 mm. The capacitance is 370 pF when no pressure is applied to the diaphragm. Find the value of capacitance after the application of pressure 900 KN/m^2. 10

Q.6 Write short notes 20

a) Optical pyrometer

b) Rotary encoder

c) Metrology & need of inspection

d) Temperature measuring Scales

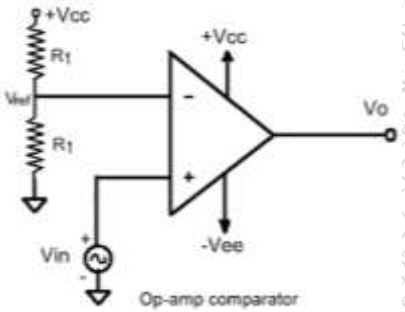
Duration: 03 Hours **Total Marks: 80 Marks**

Instruction to candidate:-
1. Question 1 is compulsory.
2. Attempt any three from remaining five questions.
3. All questions carry equal marks.
4. Assume suitable data wherever necessary.

Q1. Attempt any four [20 Marks]

Q1.a Define slew rate. For an op-amp having a slew rate of SR = 2.4 V/µs, what is the time taken for output to change from -15 V to +15 V.

Q1.b Explain operation of following comparator circuit. Consider input as sine wave of 10 V and supply voltage of 15 V.

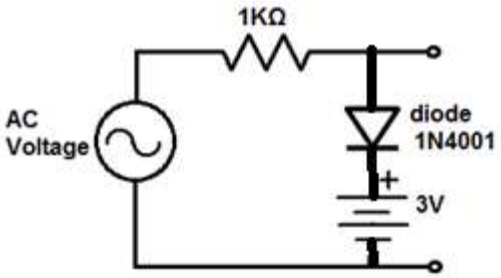


Q1.c With example, explain operation of transistor as a switch.

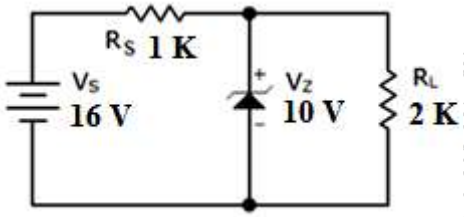
Q1.d Gate current is effectively zero for an FET, justify.

Q1.e Explain bridge rectifier.

Q2.a Determine output voltage. Assume, input to be sine wave of 5 V peak. Draw waveform considering ideal and practical diodes. [10 Marks]



Q2.b For the Zener diode network, determine V_L, V_R, I_Z, and P_Z. [10 Marks]



Q3.a BJT transistor with voltage divider bias circuit has following values, V_{CC} = 20 V, R_1 = 40 K, R_2 = 4 K, R_C = 10 K, R_E = 1.2 K, β = 140. Determine operating point and V_{BC}. [8 Marks]

Q3.b Determine operating point and V_{DS} for an FET self biasing circuit with V_{DD} = 18 V, R_D = 1.5 K, R_S = 750, R_G = 1 M, I_{DSS} = 10 mA and V_P = -4V [8 Marks]

Q3.c Explain E-MOSFET. [4 Marks]

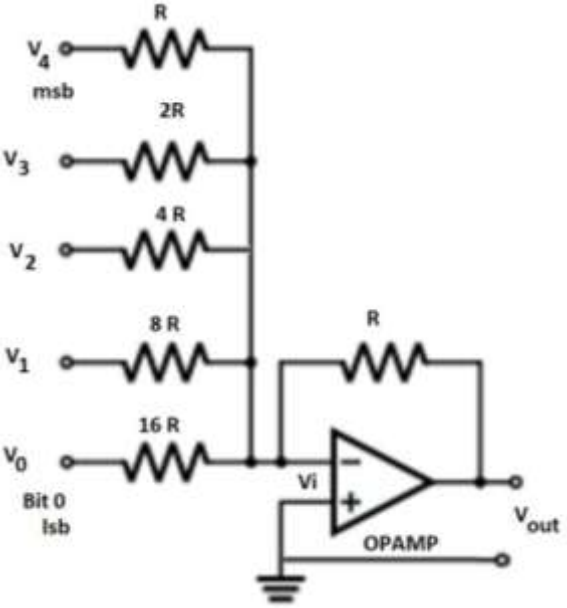
Q4.a Derive the expression of stability factor for voltage biasing circuit. [10 Marks]

Q4.b Draw and explain series voltage regulator. [10 Marks]

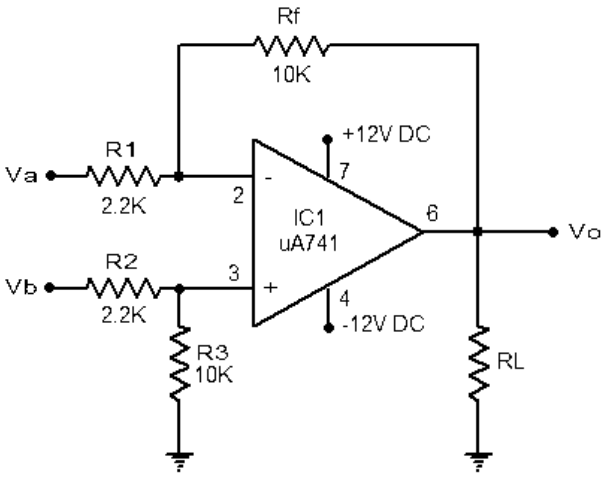
Q5.a Draw the circuits for integrator and differentiator. Derive the necessary equation. Draw the frequency response of these circuits. [10 Marks]

Q5.b Explain three OpAmp instrumentation amplifier. [10 Marks]

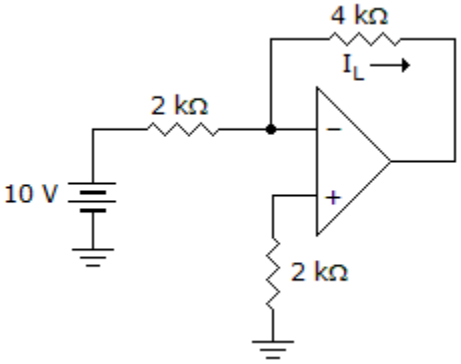
Q6.a Derive output equation and calculate output voltage if, $V_0 = V_2 = V_4 = 5$ V and $V_1 = V_3 = 0$ V. [5 Marks]



Q6.b Derive output equation and calculate output voltage if, $V_a = V_b = 700$ mV, $R_1 = R_2 = 2.2$ K, $R_3 = R_f = 10$ K. [5 Marks]



Q6.c Identify the circuit diagram. Calculate I_L for this circuit. [5 Marks]



Q6.d Explain RC phase shift oscillator using OpAmp. [5 Marks]

(3 HOURS) TOTAL MARKS - 80

N. B.: (1) Question No. 1 is compulsory.
(2) Attempt any 3 questions from remaining 5 questions
(3) Figure to the right indicate full marks.
(4) Assume suitable data if required.

Q1 Solve any 4 20

a) The reduced incidence matrix of an oriented graph is

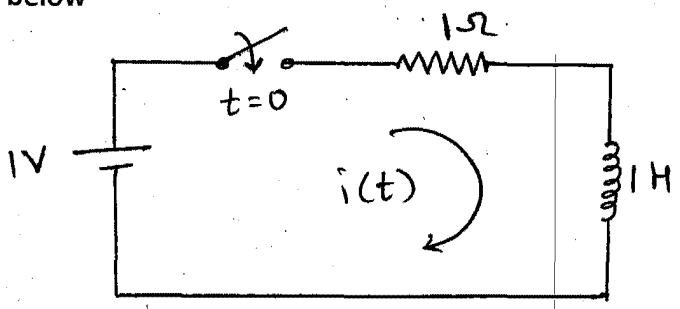
$$A = \begin{bmatrix} 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & -1 & -1 & -1 \\ -1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Draw the graph. How many Trees are possible for this graph?

b) Explain the maximum power transfer theorem

c) Explain the properties of Hurwitz polynomial

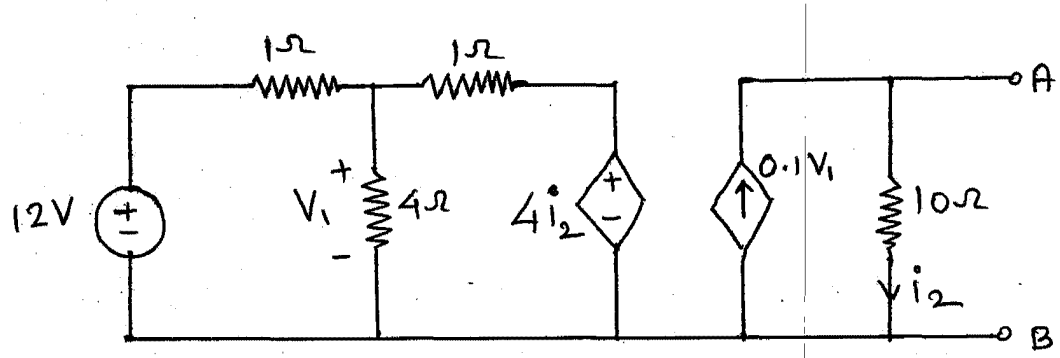
d) Plot the output response of i(t) with respect to time for the given network shown below



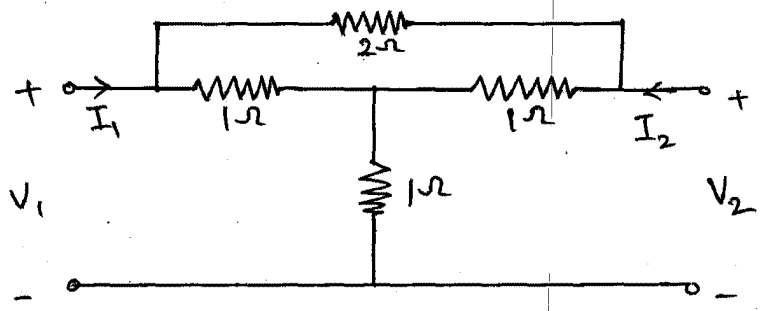
e) Using the relation Y = Z^{-1} , show that $|Z| = \frac{1}{2}\left[\frac{Z_{22}}{Y_{11}} + \frac{Z_{11}}{Y_{22}}\right]$

Q2

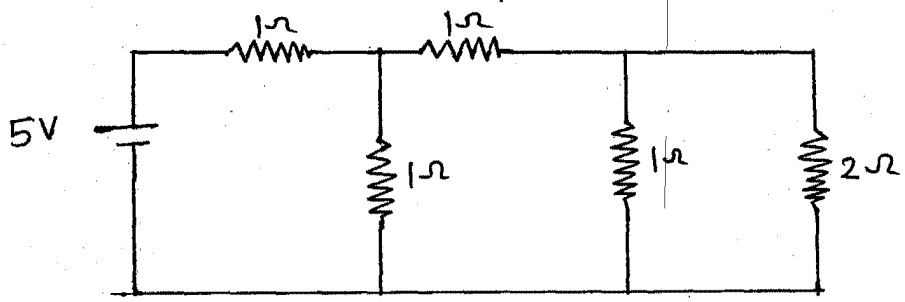
a) Find the Thevenin's equivalent circuit for the given network 10



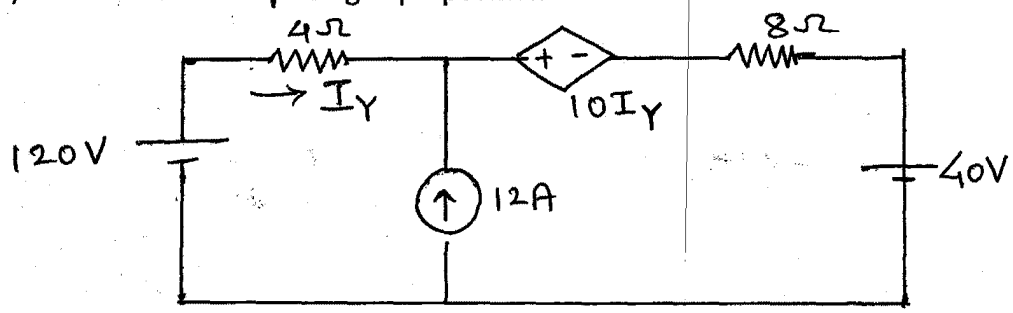
Q2 b) Find the Y parameter and Z parameter for the given network 10



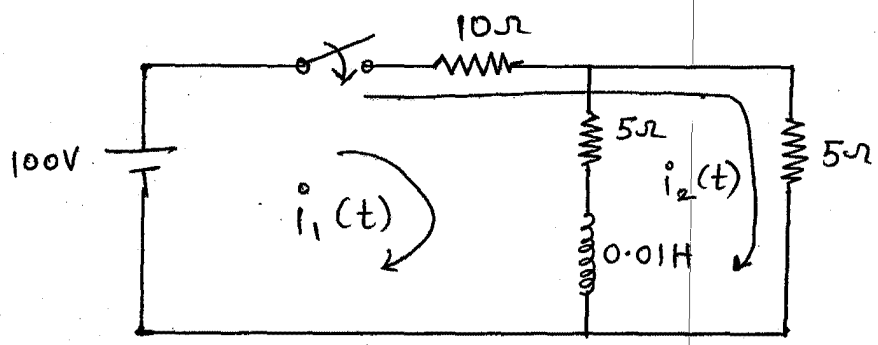
Q3 a) Draw the graph of the network shown in figure, select a suitable tree to write Tieset matrix. Then find the loop currents. 10



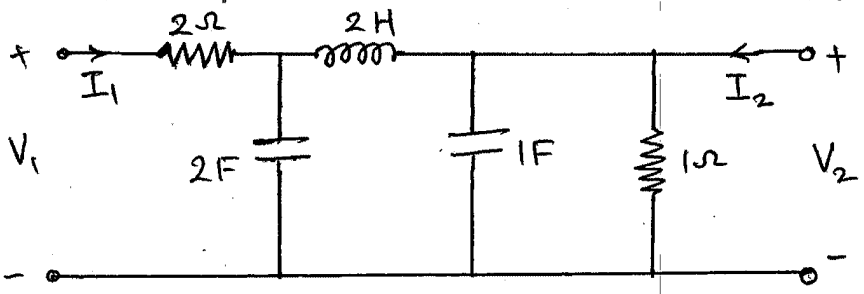
Q3 b) Find the current I_Y using Superposition 10



Q4 a) In the network shown ; determine current $i_1(t)$ and $i_2(t)$ when the switch is closed at t=0 10



Q4 b) Determine ABCD parameters for the ladder network shown in the figure 10



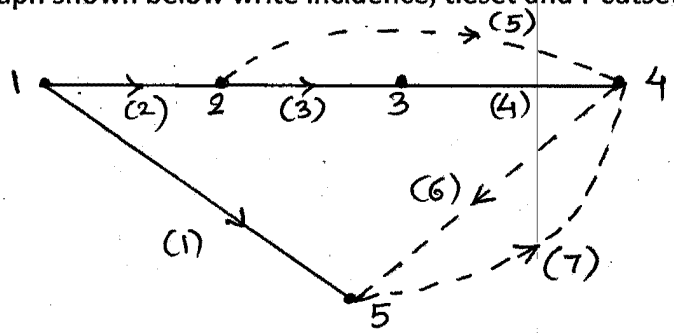
Q5 a) Realize the Foster and Cauer forms of the following impedance function 10

$$Z(s) = \frac{4(s^2+1)(s^2+9)}{s(s^2+4)}$$

b) Test whether the following functions are positive real functions or not 10

$$F(s) = \frac{2s^3+2s^2+3s+2}{s^2+1}$$

Q6 a) For the graph shown below write incidence, tieset and f-cutset matrix 10



b) In the network shown assuming all initial conditions zero , find $i_1(0^+)$, $i_2(0^+)$ 10

$\frac{di_{1(0+)}}{dt}$, $\frac{di_{2(0+)}}{dt}$, $\frac{d^2i_{1(0+)}}{dt^2}$, $\frac{di_{2\,(0+)}}{dt}$