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) Find the angle between the surfaces
\[ x \log z + 1 - y^2 = 0, \quad x^2 y + z = 2 \text{ at } (1, 1, 1). \]

b) Show that the functions \( f_1(x) = 1, f_2(x) = x \) are orthogonal on
\((-1, 1).\) Determine the constants \( a \) and \( b \) such that the function
\( f_3(x) = -1 + ax + bx^2 \) is orthogonal to both \( f_1 \) and \( f_2 \) on that interval.

c) Find the Laplace transform of \( \int_0^t u^{-1} e^{-u} \sin u \, du. \)

d) Prove that \( f(z) = (x^3 - 3x y^2 + 2x y) + i(-3x^2 y - x^2 + y^2 - y^3) \) is analytic and find \( f'(z) \) and \( f(z) \) in terms of \( z. \)

Q.2 a) Obtain half-range sine series of \( f(x) = x(\pi - x) \) in \((0, \pi)\) and hence,
find the value of \( \sum \frac{(-1)^n}{(2n-1)^3} \)

b) Prove that
\[ \vec{F} = (y^2 \cos x + z^3) \hat{i} + (2y \sin x - 4) \hat{j} + (3xz^2 + 2) \hat{k} \]
is a conservative field. Find the scalar potential for \( \vec{F}. \)

c) Find the inverse Laplace transform of
\[
\begin{align*}
(i) & \quad \frac{s + 2}{s^2 - 4s + 13} \\
(ii) & \quad \frac{1}{(s - a)(s - b)}
\end{align*}
\]

Q.3 a) Prove that
\[ J_{5/2}(x) = \sqrt{\frac{2}{\pi x}} \left( \frac{3 - x^2}{x^2} \sin x - \frac{3}{x} \cos x \right). \]

b) Find the analytic function \( f(z) = u + iv \) if
\[ 3u + 2v = y^2 - x^2 + 16xy. \]
c) Expand  \( f(x) = \begin{cases} \pi x, & 0 < x < 1 \\ 0, & 1 < x < 2 \end{cases} \) period 2 into a Fourier Series. 08

Q. 4 a) Prove that
\[
\int x^3 \cdot J_0(x) \, dx = x^3 \cdot J_1(x) - 2x^2 \cdot J_2(x).
\]
06
b) Use Stoke’s Theorem to evaluate \( \int_C \vec{F} \cdot d\vec{r} \) where \( \vec{F} = yz \, i + zx \, j + xy \, k \) and \( C \) is the boundary of the circle \( x^2 + y^2 + z^2 = 1, \, z = 0 \). 06
c) Solve using Laplace transform \( (D^2 - 3D + 2) \, y = 4e^{2t} \) with \( y(0) = -3 \) and \( y'(0) = 5 \). 08

Q. 5 a) Prove that \( 2J_0''(x) = J_2(x) - J_0(x) \). 06
b) Use Laplace transform to evaluate 
\[
\int_0^\infty e^{-t} \left( \int_0^t u^2 \sin hu \cos hu \, du \right) \, dt.
\]
06
c) Obtain complex form of Fourier Series for \( f(x) = e^{\alpha x} \) in \((-\pi, \pi)\) where \( \alpha \) is not an integer. Hence deduce that when \( \alpha \) is a constant other than an integer
\[
\cos \alpha x = \frac{\sin \pi \alpha}{\pi} \sum \frac{(-1)^n \alpha}{(\alpha^2 - n^2)} e^{inx}
\]
08

Q. 6 a) Express the function
\[
f(x) = \begin{cases} e^{kx}, & \text{for } x < 0 \\ e^{-kx}, & \text{for } x > 0 \end{cases}
\]
as Fourier Integral and hence, prove that
\[
\int_0^\infty \frac{\omega \sin \omega x}{\omega^2 + k^2} \, d\omega = \frac{\pi}{2k} e^{-kx} \quad \text{if } x > 0, \, k > 0.
\]
06
b) Using Green’s theorem evaluate
\[
\oint_C (e^{x^2} - xy) \, dx - (y^2 - ax) \, dy
\]
where \( C \) is the circle \( x^2 + y^2 = a^2 \). 06
c) Under the transformation \( w = \frac{z - 1}{z + 1} \), show that the map of the straight line \( y = x \) is a circle and find its center and radius. 08
N.B

1. Question No.1 is compulsory.
2. Attempt any three questions from remaining five questions.
3. Assume suitable data if required.
4. Use Smith chart for the transmission line problem if asked.

Q.1(a) Find the Norton’s equivalent circuit across the terminal a-b for the circuit shown in Figure No.1.

![Figure No.1](image)

(b) Obtain the instantaneous value of currents through R and L and obtain the total current in terms of RMS value for the circuit shown in Figure No.2. This circuit is energized by a sinusoidal a.c. voltage of \( v = 100\sin (1000t+36) \) volt.

![Figure No.2](image)
(c) Determine the Z-parameters for the circuit shown in Figure No.3. (5-M)

![Figure No.3](image)

(d) Differentiate between lossy transmission line and lossless transmission line with respect to (i) Equivalent circuit (ii) Propagation constant (iii) Attenuation constant (iv) Characteristics impedance (v) Input impedance. (5-M)

Q.2) (a) Find the transmission parameters for the circuit shown in Figure No.4 (10-M)

![Figure No.4](image)

(b) For network shown in Figure No.5, the switch is opened at $t = 0$, find $v(t)$ for $t > 0$. (10-M)

![Figure No.5](image)
Q.3) (a) Find the Thevenin's equivalent circuit for the network shown in Figure No.6 at the right of the terminal a-b.

(b) A series RC combination, having an impedance of \( Z_L = (450-j600) \, \Omega \) at 100 MHz, is connected to a 300 \, \Omega \) transmission line. Calculate in meters the position and length of short circuited shunt stub designed to match this load to the line. Give any one solution and solve using Smith chart only.

Q.4) (a) A driving point impedance is given by \( Z_{LC} (s) = \frac{s^2(s^2+4)(s^2+6)}{(s^2+1)(s^2+5)} \). Obtain the first form of Cauer network.

(b) Find the voltage drop across the capacitor and the resistor for the circuit shown in Figure No.7.
Q.5) (a) Find the Z parameters for the network shown in Figure No.8

(b) (I) State properties of the positive real function (PRF).

(II) Check positive realness of the function \( Y(s) = \frac{s^2+2s+20}{s+10} \) with proper reason.

Q.6) (a) Find \( V_c(t) \) and \( I_L(t) \) in the circuit shown in Figure No.9 assuming zero initial conditions.

(b) A load impedance of \( Z_L = (40+j70) \, \Omega \) terminates 100 \, \Omega \) transmission line of length 0.3\( \lambda \) long. Use formulas and determine following parameters.

(i) Find load admittance at the load end of transmission line.
(ii) Find input impedance at the input port of transmission line.
(iii) Find reflection coefficient at the load end of transmission line.
(iv) Find voltage wave standing ratio (VSWR) along the transmission line.
N.B. 1. Question No. 1 is Compulsory
2. Out of remaining questions, attempt any three
3. Assume suitable data if required
4. Figures to the right indicate full marks

1. (a) Compare SRAM and DRAM [5]
   (b) Compare Mealy and Moore machine [5]
   (c) Compare TTL and CMOS Logic [5]
   (d) Compare PLA with PAL [5]

2. (a) Prove that NAND and NOR Gates are universal Gates [10]
   (b) Design a full subtractor and implement using logic Gates [10]

3. (a) Design a 4 bit Binary to Grey code converter [10]
   (b) Implement the given function using 8:1 Multiplexer
       \[ F(A, B, C, D) = \sum m(0, 1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 13) \] [10]

4. (a) Explain 4-bit asynchronous up counter with proper timing diagram [10]
   (b) Write a VHDL program to design a 4:1 Mux [10]

5. (a) Minimize the following expression using Quine McClusky Technique [10]
   \[ F(A, B, C, D) = \sum m(0, 1, 2, 3, 5, 7, 9, 11, 15) \] [10]
   (b) Convert JK FF to T FF and SR FF to D FF [10]

6. (a) Design synchronous mod 5 counter using T FF [10]
   (b) Write a note on CPLDs [10]
Instructions – i) Questions 1 is Compulsory
         ii) Out of remaining questions attempt any three questions
         iii) Figures in the bracket to the right hand side indicate full marks.

Q.1 a) Explain alternate and chopped mode in dual trace CRO. (05)
      b) Define precision, accuracy and sensitivity with suitable example. (05)
      c) Explain selection criteria for transducers. (05)
      d) Write a note on piezoelectric transducer. (05)

Q.2 a) Explain working of strain gauge and derive expression for gauge factor. (10)
      b) Explain Kelvin's double bridge and its application in low resistance measurement. (10)

Q.3 a) Write a note on applications of Q meter. (10)
      b) Define power and energy and explain working of a single phase energy meter. (10)

Q.4 a) Explain heterodyne type wave analyser and its application. (10)
      b) Draw and explain Schering bridge and drive expression for measurement of capacitance. (10)

Q.5 a) Draw and explain R_2R ladder network DAC for 3 bit input taking suitable example. (10)
      b) Discuss DSO with the help of block diagram along with various modes of operation also explain its applications. (10)

Q.6 a) Draw and explain capacitive transducer for level measurement (10)
      b) Explain SAR type ADC with neat block diagram and comment on its speed. (10)
SE, sem-III, Electronics & Telecommunication, SH201
Analog Electronics

Q. 1
Duration: 3 hours
Maximum Marks: 80

N.B.: (1) Question No. 1 is compulsory.
(2) Solve any three questions from the remaining five.
(3) Figures to the right indicate full marks.
(4) Assume suitable data if necessary and mention the same in answer sheet.

Q. 1 Attempt any 5 questions

a) Write down current equation of diode and explain significance of each parameter.
b) Calculate $I_B$, $I_C$ and $V_{CE}$ for the common emitter circuit shown in Fig. 1b

\[ V_{BB} = 4V \]
\[ R_1 = 2k \]
\[ 220k \]
\[ \beta = 200 \]

\[ V_{CE} \]

Fig. 1b

c) Explain effect of temperature on JFET and derive equation for zero temperature drift.
d) Compare CE, CB and CC configuration.
e) Draw small signal hybrid pi model of BJT including early effect.
f) Why LC oscillators are preferred for high frequency applications?

Q. 2

a) Draw the output waveform for the clipper and clamper circuit shown in Fig. 2a and 2b.

\[ V_i \]
\[ 20V \]
\[ -20V \]
\[ 5V \]

Fig. 2a

b) Derive the expression for frequency of oscillation for a transistorized (BJT) RC phase shift oscillator.
Q.3  

a) Find $I_{Q}$ and $V_{CEQ}$ for the circuit shown in Fig 3a if $\beta = 100$. 

\[ R_1 = 35 \text{k}, \quad R_c = 0.8 \text{k}, \quad R_2 = 20 \text{k}, \quad R_e = 0.5 \text{k}, \quad -5 \text{V}, \quad -10 \text{V} \]

Fig. 3a

b) Explain the construction and characteristics of N-channel Enhancement MOSFET. Draw transfer and drain characteristics.

Q.4  

a) For the circuit shown in Fig. 4a, determine $V_{GSQ}$ and $V_{DSQ}$. Also calculate voltage gain, input impedance and output impedance.

$V_{TN} = 1 \text{V}, \quad K_n = 0.5 \text{ mA/V}^2, \quad \lambda = 0.01 \text{V}^{-1}.$

Fig. 4a

b) Find $I_{DQ}$, $V_{GSQ}$, $V_{DSQ}$, $V_D$ and $V_S$ for the circuit shown in Fig 4b.

Fig. 4b
Q.5  

a) For the circuit shown below in Fig.5b, the transistor parameters are \( \beta = 100 \) and \( V_A = \infty \). Determine \( Z_i, Z_o \) and \( A_v \)

\[ V_{BE(on)} = 0.7 \text{ V} \]  \[ \text{[10]} \]

b) Draw and explain energy band diagram of MOS capacitor in accumulation, depletion and inversion region.

Q.6  

Short notes on: (Attempt any four) \[ \text{[20]} \]

- Construction and operation of varactor diode
- Crystal oscillator
- Transistor as a switch
- Emitter follower.
- Regions of operation of FET