

RP

INDIAN INSTITUTE OF TECHNOLOGY

Date: ___ April 2012, FN/AN, Time: 3 Hrs., Full Marks: 100, No. of Students : 660 (Non-ECE branches); End Spring Semester, Sub. No.: EC21101, Sub. Name: Basic Electronics

Instructions

- All waveform sketches / diagrams must be neatly drawn and clearly labeled. Answers must be brief and to the point.
- The final answers (numerical values with unit) should be underlined or enclosed within box with unit.
- For every Question No., start your answer from a new page.
- Avoid writing answers of the various parts of a single question at different locations in your answer-script.
- For any value related to any device parameter or circuit parameter, which you may find not given with a problem, assume suitable value for such parameter.

1A. Multiple choice questions:

(3x1=3 marks)

I. For an ideal OPAMP CMRR^d is

- (a) Infinite
- (b) Zero
- (c) One
- (d) none of these

II. Input impedance for a voltage follower is

- (a) Zero
- (b) Infinite
- (c) Kilo Ohm
- (d) none of these

III. Ideal OPAMP characteristic

- (a) Differential gain zero, O/P resistance infinite, I/P impedance zero
- (b) Differential gain infinite, O/P resistance infinite, I/P impedance zero
- (c) Differential gain infinite, O/P resistance zero, I/P impedance infinite

1B. For the circuit shown in Fig. 1 find the input resistance.

(7 marks)

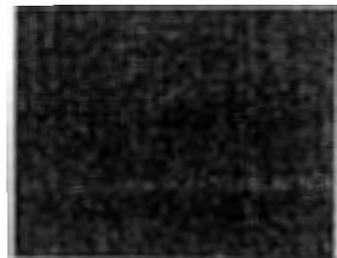
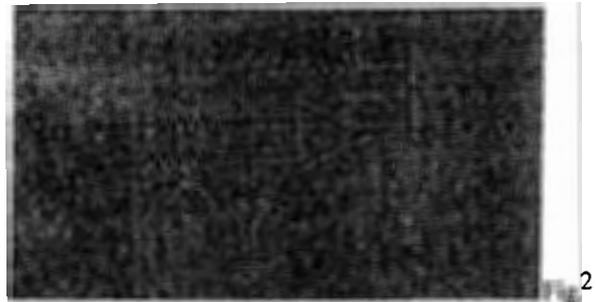


Fig. 1

1C. Calculate the differential-mode rejection ration of a differential amplifier shown in Fig. 2. $R_1=R_3=15 \Omega$, $R_2=25 \Omega$ and $R_4=30 \Omega$. Determine v_0 when: (a) $v_{i1}= + 2V$, $v_{i2}= - 2V$ (b) $v_{i1}= v_{i2}= + 2V$ (c) Determine common mode gain, (d) Determine the CMRR (dB).

(10 marks)



2

2A. In a sample of silicon bar at $T = 300 \text{ K}$, the electron concentration varies linearly with distance as shown in Fig. 3. The diffusion current density is found to be $J_n = 0.19 \text{ A/cm}^2$. Electron diffusion coefficient $25 \text{ cm}^2/\text{s}$ and consider 6 V is applied across this 2 cm long bar. Find out (a) The electron concentration (b) conductivity and (c) drift velocity.

(10 marks)

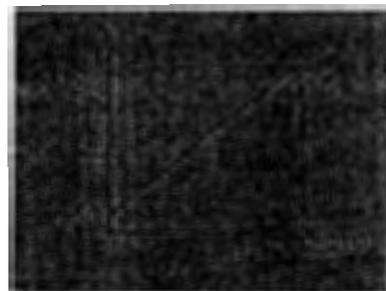
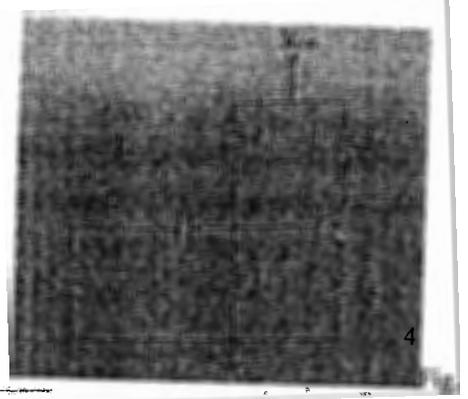


Fig. 3

2B. In a uniformly doped GaAs junction at $T = 300\text{ K}$, at zero bias, only 20% of total space charge region is to be in the p -region. The built in potential barrier is 1.20 V . Intrinsic carrier concentration in GaAs is $1.8 \times 10^6\text{ cm}^{-3}$. What is the majority carrier concentration in n -region? (10 marks)

3. For the circuit shown in Fig. 4, the transistor parameters are $\beta = 100$, $V_{BE(on)} = 0.7\text{ V}$ and the Early Voltage $V_A = \infty$. Also, $V_{CC} = 10\text{ V}$, $R_S = 0.5\text{ k}\Omega$, $R_I = 56\text{ k}\Omega$, $R_2 = 12.2\text{ k}\Omega$, $R_C = 2\text{ k}\Omega$ and $R_E = 0.4\text{ k}\Omega$. Determine the input resistance R_i and the small signal voltage gain v_o/v_s . (20 marks)



4A. Describe a simple common source MOSFET circuit with an n -channel enhancement mode device and discuss the relation between the drain to source voltage and gate-to-source voltage. (6 Marks)

4B. For the NMOS common source amplifier as shown in Fig. 5, the transistor parameters are $V_{TN} = 2\text{ V}$, $K_n = 1\text{ mA/V}^2$, and $\lambda = 0$. Assume $R_{si} = 2\text{ k}\Omega$ and a load resistance $R_L = 3\text{ k}\Omega$ is capacitively coupled to the output. (a) Determine the quiescent values of drain current and drain-to-source voltage, (b) find the small-signal voltage gain. (14 Marks)

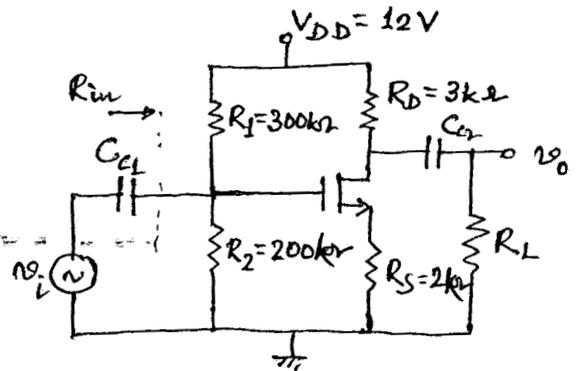


Fig. 5

5A. The diode in the circuit of Fig. 6 has a piecewise linear parameters $V_\gamma = 0.7\text{ V}$ and $r_f = 10\Omega$, if the triangular wave is applied at the input (v_i) plot V_{out} vs time. (10 marks)

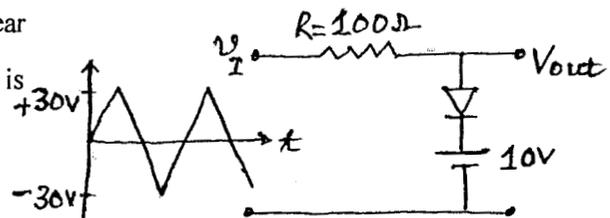


Fig. 6

5B. In the voltage regulator circuit in Fig. 7, let $V_i = 6.3\text{ V}$, $R_i = 12\Omega$ and $V_Z = 4.8\text{ V}$. The zener diode current is to be limited to the range $5 \leq I_Z \leq 100\text{ mA}$. (a) Determine the range of possible load resistances (b) Determine the power rating required for the zener diode and the load resistor. (10 marks)

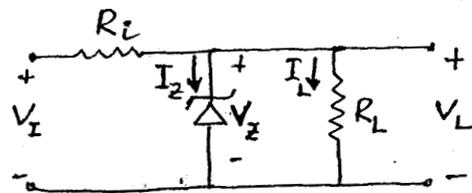


Fig. 7

Dept. of E & E C E, IIT Kharagpur
Semester Examination, Spring 2011-12
Subject: Digital Communications [EC31002]
Date: 23.04.2012(A/N), Time: 03 Hrs; No. of Students: 111; Full Marks: 50

Instructions: Answer ANY FIVE questions. Answer of a question should be at one place. Make and state suitable assumptions wherever necessary. Use the following approximation if necessary: $\text{erfc}(u) = [1/(u\sqrt{\pi})].\exp(-u^2)$

1. (a) Let $Z = X + 0.5.Y$ where X and Y are independent Gaussian random variables with zero mean and unity variance. Determine variance of Z and sketch its pdf. 3
1. (b) Draw the block diagram of a correlation receiver structure for 16-QAM and explain its operation. Derive an expression for the likelihood function of the outputs of the correlator bank in the 16-QAM demodulator in presence of AWGN. 7
2. (a) Consider a discrete source of 8 symbols where each symbol is a 3-bit PCM coded representation of a discrete voltage between ± 1.0 volt. If the probability of occurrence of a symbol is inversely related to the magnitude of the corresponding signal voltage, determine the entropy of the discrete ensemble. Now, design a binary Huffman code for representing the 8 discrete voltage levels and determine the average codeword length per symbol. 4
2. (b) Draw a typical block diagram of a narrowband digital communication transceiver. Mention important functions of the blocks with reference to the nature and type of input and output signals of the block. 4
2. (c) Mathematically justify that equivalent baseband description and analysis of narrow bandpass signals are sufficient for a linear time invariant channel. 2
3. (a) Let the input to an AWGN channel be a discrete random variable X which can take 08 different values (± 1 volt, ± 2 volts, ± 3 volts and ± 4 volts) with equal probability. The output of the channel, Z is $Z = X+Y$, where Y is the noise component. Assuming that X and Y are independent and that Y is Gaussian with a mean of zero and variance of 1.0 Volt^2 , determine the mean and variance of Z and also plot the pdf of Z when X assumes ± 1 volt. 4
3. (b) Consider digitization and transmission of a good quality signal (Bandwidth: from 150 Hz to 15 HKz). List the quantization and coding schemes that may be considered to ensure a desired SQNR of 50 dB. If the signal is limited to ± 2.5 Volts and the normalized ACF for $\tau = 1 T_s$ is 0.87, determine the overall bit rates for the coding schemes. Draw a block diagram of a DPCM coder-decoder and explain its operation. 4

3. (c) Write a note on A-law companding. 2
4. (a) State and justify the Gram Schmidt Orthogonalization procedure. 6
4. (b) Consider 04 energy signals $s_1(t) = -2.0; 0 \leq t \leq 2.0$ sec, $s_2(t) = +2.0; 0 \leq t \leq 1.0$ sec, $s_3(t) = +3.0; 0 \leq t \leq 4.0$ sec and $s_4(t) = -3.0; 0 \leq t \leq 3.0$ sec. Find the orthonormal basis functions to represent these signals. Suggest whether the concept of Nyquist filtering should be applied to transmit these signals through a narrowband channel. 4
5. (a) Establish that the concept of matched filtering is equivalent to correlation receiver in terms of error performance in AWGN channel. 4
5. (b) Let $\varphi(t) = -1.0$ for $0 \leq t \leq T/2$ and $\varphi(t) = +1.0$ for $T/2 < t \leq T$. Determine and plot the impulse response of a filter matched to $\varphi(t)$. Sketch the output of the filter when $\varphi(t)$ is given as input and identify the desired time instant for sampling its output. 4
5. (c) Suggest the basis functions and an information bit rate that can be supported in an AWGN channel following the principle of coherent demodulation for quaternary FSK (QFSK) if a transmission band from 400 MHz to 404 MHz is available. 2
6. (a) A QPSK signal is applied to a correlation receiver where the locally generated basis function is offset in phase from the basis function of the transmitter by θ radian. Determine an expression for the average probability of error for the receiver in AWGN and sketch it vs. θ for an E_b/N_0 of 10 dB. 4
6. (b) Consider a BFSK system transmitting data @ 2.0 Mbps through an AWGN channel with noise psd $(N_0) = 10^{-15}$ Watt/Hz. Determine the average BER if the peak amplitude of the received sinusoid waveforms for '0' and '1' is 100 micro volt in absence of noise. 3
6. (c) Write an expression for complex baseband $\tilde{u}(t)$ for QPSK signal and write a small C / MATLAB program with sufficient comments to generate a QPSK modulated signal. 3
7. (a) Let the received signal in presence of AWGN for 16-PSK be $r(t) = s(t) + n(t) = [s_I(t) + n_c(t)] \cdot \cos\omega_c t - [s_Q(t) + n_s(t)] \cdot \sin\omega_c t$. If $n_c(t)$ and $n_s(t)$ are i.i.d. zero-mean Gaussian processes with variance σ^2 , write an expression for the envelope of $r(t)$ and describe its statistical features. 4
7. (b) Write short notes on (**any THREE**): (i) Huffman coding, (ii) Various 'channels' in the context of digital wireless communications, (iii) Nonlinearity in transmit power amplifier and (iv) Inter-symbol interference and its removal. 2 x 3 = 6

INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date ... 20 / 04 / 2012..... FN / AN Time : 2 / 3 Hrs. Full Marks60..... No. of Students 102

Autumn / Spring Semester Dept. E & ECE Sub. No. EC 31004

... 3rd Yr. B. Tech. (H) / B-Arch (H) / M.Sc. Sub. Name VLSI Engineering

- The final answers (numerical values with unit) should be underlined or enclosed in box.
- For any value related to any device parameter or circuit parameter, which you may find not given with a problem, **assume a suitable value** for such parameter.
- For each problem, write the answers of all its parts together and avoid writing answers of its various parts at different locations in your answer-script.

For all problems assume the following parameter values, unless explicitly specified for a particular problem.

$V_{DD} = 2.5$ V, the design rule $\lambda = 125$ nm. $(W/L)_{NMOS} = 8\lambda / 4\lambda$. $(W/L)_{PMOS} = 16\lambda / 4\lambda$.

Process trans-conductance parameter, $k_n' = 100$ $\mu\text{A} / \text{V}^2$, $k_p' = 50$ $\mu\text{A} / \text{V}^2$; Threshold voltage: $V_{Tn} = |V_{Tp}| = 0.2$ V_{DD} ,

Use channel length modulation parameter, $\lambda_n = \lambda_p = 0.1$ V^{-1} for small-signal analysis.

Ignore body-bias effect (i.e. $\gamma_n = \gamma_p = 0$ $\text{V}^{0.5}$). Assume all the o/p node capacitances are lumped into the single capacitance, C_L where $C_L = 100$ fF.

1. Problem on MOS amplifier and switch: 0.5x24 = 12 points

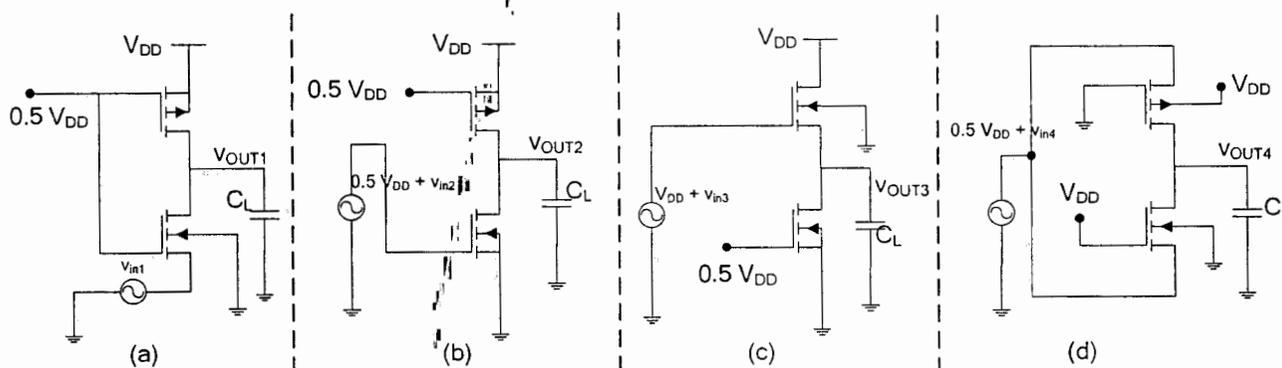


Figure 1. MOS Amplifier and Switch circuit

For the circuit in Figure 1(a):

- (1.a.1) Find the DC values of I_D [μA] and V_{OUT} [V].
- (1.a.2) Find the value of low-frequency small-signal voltage-gain, $A_v = v_{out} / v_{in}$ [V/V].
- (1.a.3) Find the value of low-frequency small-signal output impedance, R_{out} [Ω].
- (1.a.4) Find the value of low-frequency small-signal input impedance, R_{in} [Ω].
- (1.a.5) Find the value of 3-dB band-width, ω_{3dB} [rad/s].
- (1.a.6) Find the value of equivalent input noise spectral density, $\overline{v_{in,n}^2}$ [V^2/Hz].

For the circuit in Figure 1(b):

- (1.b.1) Repeat (1.a.1).
- (1.b.2) Repeat (1.a.2).
- (1.b.3) Repeat (1.a.3).
- (1.b.4) Repeat (1.a.4).
- (1.b.5) Repeat (1.a.5).
- (1.b.6) Repeat (1.a.6).

For the circuit in Figure 1(c):

- (1.c.1) Repeat (1.a.1).
- (1.c.2) Repeat (1.a.2).
- (1.c.3) Repeat (1.a.3).
- (1.c.4) Repeat (1.a.4).
- (1.c.5) Repeat (1.a.5).
- (1.c.6) Repeat (1.a.6).

For the circuit in Figure 1(d):

- (1.d.1) Repeat (1.a.1).
- (1.d.2) Repeat (1.a.2).
- (1.d.3) Repeat (1.a.3).
- (1.d.4) Repeat (1.a.4).
- (1.d.5) Repeat (1.a.5).
- (1.d.6) Repeat (1.a.6).

2. Problem on MOS device-geometry scaling: 1 x 24 = 24 points

Refer to the circuits in **Figure 1(a)** through **Figure 1(d)** in Problem 1. Now, we scale-down the device-sizes for all the transistors in all of the above circuits. Scaling factor = 2. (E.g. $W' = \frac{W}{2}$, $L' = \frac{L}{2}$ etc.) Calculate the corresponding scaling factor of all the circuit-performance parameters. Ignore short-channel effects.

Figure 1(b): Device sizes are scaled down under constant-voltage scaling paradigm. Calculate:

- (2.a.1) Scaling factor for I_D and for V_{OUT}
- (2.a.2) Scaling factor for A_v
- (2.a.3) Scaling factor for R_{out}
- (2.a.4) Scaling factor for R_{in}
- (2.a.5) Scaling factor for ω_{3dB} . Assume $C'_L = \frac{C_L}{2}$
- (2.a.6) Scaling factor for $\overline{V_{in,n}}^2$

Figure 1(b): Device sizes are scaled down under constant-field scaling paradigm. Calculate:

- (2.b.1) Scaling factor for I_D and for V_{OUT}
- (2.b.2) Scaling factor for A_v
- (2.b.3) Scaling factor for R_{out}
- (2.b.4) Scaling factor for R_{in}
- (2.b.5) Scaling factor for ω_{3dB} . Assume $C'_L = \frac{C_L}{2}$
- (2.b.6) Scaling factor for $\overline{V_{in,n}}^2$

Figure 1(c): Device sizes are scaled down for the same fabrication technology itself. Calculate:

- (2.c.1) Scaling factor for I_D and for V_{OUT}
- (2.c.2) Scaling factor for A_v
- (2.c.3) Scaling factor for R_{out}
- (2.c.4) Scaling factor for R_{in}
- (2.c.5) Scaling factor for ω_{3dB} . Assume $C'_L = \frac{C_L}{2}$
- (2.c.6) Scaling factor for $\overline{V_{in,n}}^2$

Figure 1(d): Device sizes are scaled down under constant-field scaling paradigm. Calculate:

- (2.d.1) Scaling factor for I_D and for V_{OUT}
- (2.d.2) Scaling factor for A_v
- (2.d.3) Scaling factor for R_{out}
- (2.d.4) Scaling factor for R_{in}
- (2.d.5) Scaling factor for ω_{3dB} . Assume $C'_L = \frac{C_L}{2}$
- (2.d.6) Scaling factor for $\overline{V_{in,n}}^2$

3. Problem on pass-FET and Transmission Gate: (2 + 2 + 2 + 2) x 3 = 24 points

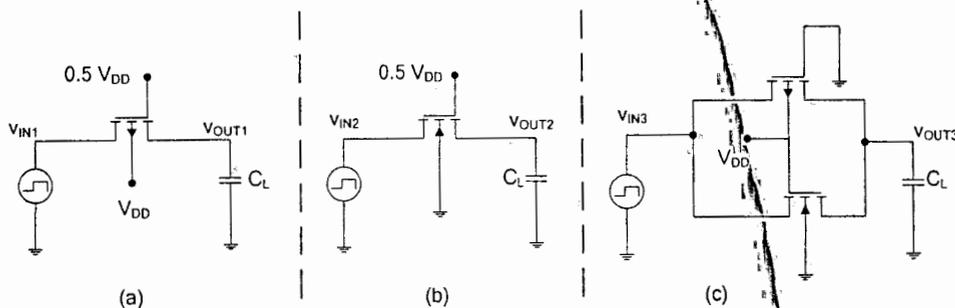


Figure 2. Pass Transistor and MOSFET switch circuit

In this problem, the notations used are:

V_{OH} : Output-high voltage; V_{OL} : Output-low voltage

$t_{LH}(x_1\%, y_1\%)$: the time taken for charging from $x_1\%$ of output-voltage-swing to $y_1\%$ of output-voltage-swing.

$t_{HL}(x_2\%, y_2\%)$: the time taken for discharging from $x_2\%$ of output-voltage-swing to $y_2\%$ of output-voltage-swing.

P_{dyn} : Dynamic power dissipation. Assume system-clock frequency, $f_{CLK} = 10$ MHz and switching activity factor, $\alpha = 1$.

V_{IN} : Square-wave with peak-to-peak voltage-swing of $0V - V_{DD}$.

Refer to Figure 2(a) circuit.

- (3.a.1) $V_{OH} = ?$ $V_{OL} = ?$ [in V]
- (3.a.2) $t_{LH}(0\%, 90\%) = ?$ [in ps]
- (3.a.3) $t_{HL}(100\%, 10\%) = ?$ [in ps]
- (3.a.4) $P_{dyn} = ?$ [in uW]

Refer to Figure 2(b) circuit.

- (3.b.1) $V_{OH} = ?$ $V_{OL} = ?$ [in V]
- (3.b.2) $t_{LH}(0\%, 90\%) = ?$ [in ps]
- (3.b.3) $t_{HL}(100\%, 10\%) = ?$ [in ps]
- (3.b.4) $P_{dyn} = ?$ [in uW]

Refer to Figure 2(c) circuit.

- (3.c.1) $V_{OH} = ?$ $V_{OL} = ?$ [in V]
- (3.c.2) $t_{LH}(0\%, 90\%) = ?$ [in ps]
- (3.c.3) $t_{HL}(100\%, 10\%) = ?$ [in ps]
- (3.c.4) $P_{dyn} = ?$ [in uW]

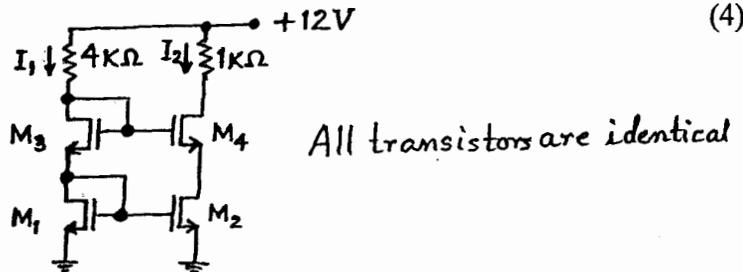
INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date: 20.4.2012 AN Time: 3 Hrs. Full Marks: 50 No. of students: 251
 Spring Semester 2011-2012 Dept. of E&ECE Sub. No. : EC 21008 / EC 21010
 2nd Yr. B.Tech.(H) Sub. Name: *ANALOG ELECTRONIC CIRCUITS*

Instruction: ANSWER ALL THE SIX QUESTIONS
 ANSWER TO ALL THE PARTS OF A QUESTION SHOULD BE TOGETHER.

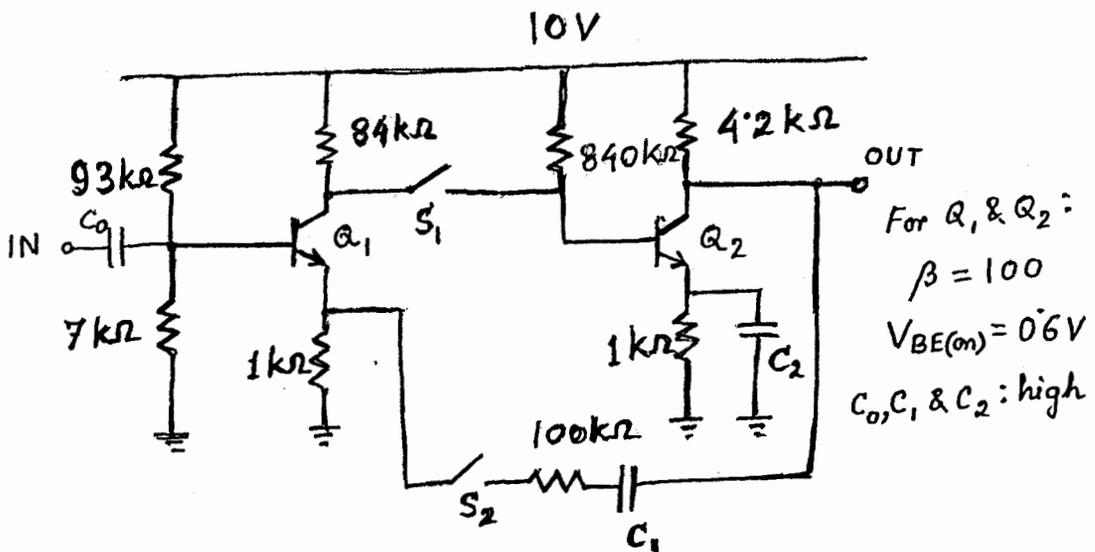
1. (a) Draw a simple current mirror circuit containing β -helper transistor for 1:2 mirroring ratio. Given that β of all the transistors are equal to 100 and Early voltage of all the transistors are very high. If the current in the mirroring branch is 2 mA, then what is the precise value of the current in the mirrored branch? Derive the necessary expression of the mirrored current. (6)

(b) Refer to the circuit shown in the figure below. Given that transconductance factor $K = 1 \text{ mA/V}^2$, $V_{th} = 1 \text{ Volt}$, $\lambda = 0.02 \text{ V}^{-1}$. Find the values of I_1 and I_2 . What is the value of small signal resistance looking into the drain of transistor M_4 . (4)



2. Draw a differential amplifier using n -MOS transistors for differential pair with resistive load and 1 k Ω resistor as its tail bias. Find the values of the load resistors such that for 4 Volt input common mode level, the output common mode voltage is 6 Volt. Calculate its common mode and differential mode gains in mid frequency range. For one input equal to 4 Volt and the other input equal to $(4 + 0.1 \sin(\omega t))$ Volt, find the expressions of the signals at the two outputs of the amplifier. Given that transconductance factor $K = 1 \text{ mA/V}^2$, $V_{th} = 1 \text{ Volt}$, supply voltage = 10 Volt, $\lambda \approx 0$. (8)
3. Draw a voltage-shunt feedback system cascaded with a current-series feedback system. Voltage gain, input resistance and output resistance of the forward amplifier in the first feedback system are 100, 2 k Ω and 4 k Ω respectively and those of the forward amplifier in the second feedback system are 40, 2 k Ω and 4 k Ω respectively. Feedback networks are ideal and the value of the feedback factor of the feedback networks in the first- and the second systems are 100 $\mu\text{A/V}$ and 1 V/mA respectively. Calculate the input resistance, the output resistance and the overall voltage gain of the complete cascade system. (8)

4. Transfer function of a differential to single-ended amplifier has low frequency gain of 400 and two left hand side poles are at 1 kHz and at 200 kHz. The amplifier is used in a feedback configuration with a feedback factor of 0.25. Neatly sketch the magnitude and phase of the loop gain of the feedback system. Calculate its phase margin. Calculate the position of the poles of the feedback system. What should be the value of the feedback factor for which the system is stable with a phase margin of 60° ? (8)
5. Draw the circuit diagram of an L-C oscillator and derive the necessary conditions for its oscillation. Draw the circuit diagram of a phase shift oscillator and derive the necessary conditions for its oscillation. (8)
6. Refer to the two-stage amplifier circuit shown in the figure below. Calculate the small signal voltage gains of the first stage and the second stage individually (switches S_1 and S_2 are open). Calculate the overall voltage gain of the two-stage amplifier in mid-frequency range when S_1 is closed and S_2 is open. Calculate the overall voltage gain of the two-stage amplifier when both S_1 and S_2 are closed. (8)



----- END -----

Q1. Suppose $s[n] = h[n] * g[n] * p[n]$, where $h[n]$ is minimum phase, $g[n]$ is maximum phase & $p[n] = \sum_{k=0}^4 \alpha_k \delta[n-k]$, $[\alpha_k, \alpha_0 \text{ are unknown}]$.
develop a method to separate $h[n]$ from $g[n]$.
[Note: - * denotes convolution & $\delta[n] =$ unit delta fn.
HINT: - You might like to use Homomorphic filtering].

Q2. Show that a signal $x[n]$ and its complex cepstrum $\hat{x}[n]$ satisfies a non-linear difference equation
$$x[n] = \sum_{k=-\infty}^{\infty} \left(\frac{k}{n}\right) \hat{x}[k] x[n-k], \quad n \neq 0.$$

Q3. while using Kaiser window, $w[n] = \frac{I_0 \left[\beta \left(1 - \left(\frac{n-x}{\alpha} \right)^2 \right)^{\beta/2} \right]}{I_0[\beta]}$, $0 \leq n \leq M$, $\alpha = M/2$.
during your assignment, what was I_0 ? How sketch $I_0[n]$ with respect to n ?
How was $I_0[n]$ implemented? For a linear phase filter, what is the group delay?
what is the effect of β on main-lobe & side-lobes of the window.

Q4. If $h[n]$ is real & is an impulse response of a 2nd order all-pass system. Calculate its group delay.

Q4. Derive the discrete-time Fourier TX of unit step sequence $u[n]$. Then derive the z-Transform of $u[n]$. Can you comment on the results & convergence of z-TX.

Q5. If in complex z-plane, $X(p e^{j\omega}) = u(p, \omega) + j v(p, \omega)$. $X(z = p e^{j\omega})$.
 $X(z)$ is an analytic fn., then derive the relationship between, $u(p, \omega)$ & $v(p, \omega)$.

Q6. (a) Describe the steps of Parks-McClellan-type Algorithm in a flow-chart scheme for design of maximum phase FIR Filters.
(b) What is bilinear transformation. How can it be used to design IIR Filters.

Q.7. Let $H\{\cdot\}$ denote the ideal operation of Hilbert Tx. given by $H(e^{j\omega}) = \begin{cases} -j & 0 \leq \omega < \pi \\ +j & -\pi \leq \omega < 0 \end{cases}$ [3+3+2+2] pts.

$$\& H\{x[n]\} = \sum_{k=-\infty}^{\infty} x[k] h[n-k].$$

a) find $h[n]$

b) Prove, $H\{H\{x[n]\}\} = -x[n]$

c) Prove, $\sum_{n=-\infty}^{\infty} x[n] H\{x[n]\} = 0$

d) Prove, $H\{x[n] * y[n]\} = H\{x[n]\} * y[n] = x[n] * H\{y[n]\}$.

Q.8. What is radix-4 FFT? derive its matrix formulation & flow graph? (butterfly diagram) How many complex multiplications & additions you need to perform. [10] pts.

Q.9. a) Write down the LPF ($h_0[n]$) & HPF ($h_1[n]$) filter coefficients for Haar Transform. [2+2+2+2+2] pts.

b) How are the Haar scaling ($\phi(t)$) & wavelet ($\psi(t)$) functions related to the filter coefficients.

c) Sketch & label $\phi(t)$ & $\psi(t)$ upto 3-scales.

d) How do you represent a f². f(t) in terms of scaling & wavelet fns? How are the coefficients obtained? What is the order of computation?

e) Using filterbank representation how do you obtain the coefficients? What is the order of computation.

Q.10. a) $x[n] \rightarrow \downarrow 2 \rightarrow H(z) \rightarrow y_a[n]$, Find $X_a(z)$ & $Y_a(z)$ [4+4+2] pts.
 b) $x[n] \rightarrow G(z) \rightarrow \downarrow 2 \rightarrow y_b[n]$, Find $X_b(z)$ & $Y_b(z)$
 ↑ $x_b[n]$

Date: April , 2012
Spring Semester 2011-2012
2nd Year B.Tech..

Time: 3Hrs. Full Marks: 100
Dept. Electronics & ECE
Sub. Name: Signals and Systems

No. of students: 120
Sub. No. EC21004

← PLS. READ INSTRUCTIONS CAREFULLY →

Answer all five questions. Answers should be brief, to the point and legible. Sketches wherever appear should be neat and properly labeled. Justification, steps, assumptions must be unambiguously mentioned. All parts of a question must be answered at one place.

Q1. (a) If input to a system, defined by $h[n] = [1, 2, 4]$ is $x[n] = [1, 1, 0, -2]$ then find output of the system. Is this system stable?

(b) Solve the difference equation

$$y[n+2] - \frac{3}{2}y[n+1] + \frac{1}{2}y[n] = (1/4)^n, \text{ for } n \geq 0 \text{ where } y[0]=10 \text{ and } y[1]=4$$

(c) Given, a system represented by unit sample response $h_1(n)$ is a Low Pass Filter. Show if another system with unit sample response $h_2(n) = (-1)^n h_1(n)$ represents a Low Pass Filter/ High Pass Filter/Band Pass Filter/Band Stop Filter.

(d) What is the origin of aliasing in time domain? How can this be prevented?

(e) For a linear system with impulse response $h(t)$, consider the input $x(t)$ as wide sense stationary process with mean μ_X and autocorrelation $R_X(\tau)$. Find mean and autocorrelation of the output $y(t)$.

5+5+3+3+4

Q2. (a) Realize $y[n] - 0.5 y[n-2] = x[n] + 0.25 x[n-1] - 0.5 x[n-2]$ in hardware using only two delay elements.

(b) What is transposition theorem? Using transposition theorem give an alternate representation of 2(a). Comment on the difference between realization 2(a) and 2(b).

(c) For both realizations of 2(a) and 2(b) give $x[n] = [1, -2, 3]$ as input and show how output is generated in each case by giving values at different nodes at different time instances.

(d) A 90 degree phase shifter is a system with frequency response

$$H(e^{j\omega}) = -j \text{ for } 0 < \omega < \pi \text{ and } H(e^{j\omega}) = j \text{ for } -\pi < \omega < 0$$

Find unit sample response of the system.

5+5+4+6

Q3. (a) Define z-transform and state the significance of Region of Convergence. State and prove the accumulation property of z-transform.

(b) Consider a single pole stable system. Take three different values of the pole and show how the system responds to unit step sequence input in each of these three cases and plot them.

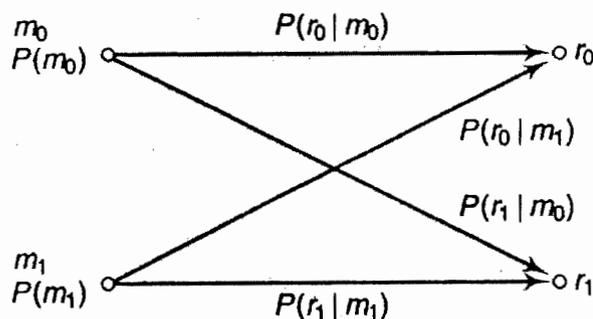
- (c) For three cases in 3(b) find frequency response of the system and comment on findings of 3(b) and 3(c), if they are related in anyway.
- (d) The output $y[n]$ of a discrete-time LSI system is found to be $2(1/3)^n u[n]$ when the input $x[n] = u[n]$.
- Find (i) the impulse response $h[n]$ of the system and
(ii) the output $y[n]$ when input $x[n]$ is $(1/2)^n u[n]$.

5+4+5+6

- Q4. (a) What is circular convolution? How linear convolution can be obtained from circular convolution?
- (b) Compute DFT coefficients $X[k]$ for $x[n] = [1, 1, 0, -1]$. Hence, compute inverse DFT of $X[k]$.
- (c) Consider, $x[n]$ of 4(b) and $y[n] = [1, 0, -1, 1]$. Find $z[n]$ which is circular convolution of $x[n]$ $y[n]$. Using DFT, show how $X[k]$, $Y[k]$ and $Z[k]$ are related.
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3+5+6+6

- Q5. (a) What is noise? What is the significance of Signal to Noise Ratio (SNR) in the context of Signals & Systems?
- (b) Give mathematical definition of 'orthogonality'. Show how addition of noise affect the distinguishability of signal. From this, comment how design of a system is affected due to addition of noise or what are the associated trade-offs.
- (c) For the communication channel shown in following figure, it is given that $P(r_0|m_0) = 0.9$, $P(r_1|m_0) = 0.1$, $P(r_0|m_1) = 0.4$, and $P(r_1|m_1) = 0.6$. Find the probability of error for an optimal receiver designed for above system. State the rule adopted for the decision at the receiver end.



- (d) If noise affecting the channel for the system defined in 5(c) is gaussian in nature, show using histogram plot how conditional probability is calculated for above and decision threshold is obtained for optimum receiver.
- (e) Define Aurocorrelation and Power Spectral Density. How are they related?

3+5+5+4+3

→ END OF Q. PAPER ←

Dept. of E & ECE

End-Semester Examination

Time: 3 hrs Full Marks: 50

24/8

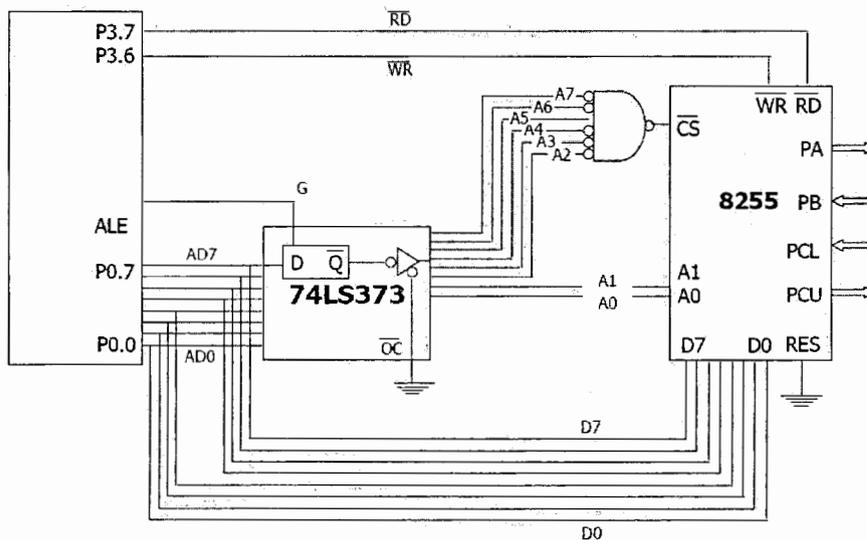
EC 31006 MICROCONTROLLER & EMBEDDED SYSTEMS

Figures in the right hand margin indicate marks.

- Q1. (a) Write a program in assembly language of 8051 that checks the content of port P0. If the number read is equal to 20H, it sends FFH to port P0. If it is equal to 30H, 40H, or 50H, it sends FFH to port P1, P2, or P3 respectively. (3+3)

(b) Write a program in 8051 assembly language to find the LCM of two numbers stored at external memory locations 6000H and 6001H, with the smaller one in 6000H. Use the stack to hold the LCM.

- Q2. The following figure shows the interconnection of an 8255 PPI to the 8051 microcontroller. (1+1+3)



- (a) Find the I/O port addresses assigned to ports A, B, C, and the control register.
 (b) Find the control byte for PA = output, PB = input, PC0 – PC3 = input, and PC4 – PC7 = output
 (c) Write a program to get data from PB and send it to PA and send data from PCL to PCU.

- Q3. Answer the following questions regarding the interrupt structure and processing of 8051. (5)

- (i) What are the advantages of using interrupts to serve an external device?
- (ii) Why are the interrupts in 8051 known as vectored interrupts?
- (iii) How many interrupts are available in 8051 and what for each of these is used?
- (iv) Although only 8 bytes are reserved for each of the interrupts in the interrupt vector table, 8051 can execute ISRs that consume more than 8 bytes. Explain how this is possible.

(v) The following figure shows the various fields in the interrupt enable register in 8051. Explain the significance of each field.

EA	--	ET2	ES	ET1	EX1	ET0	EX0
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(PTO)

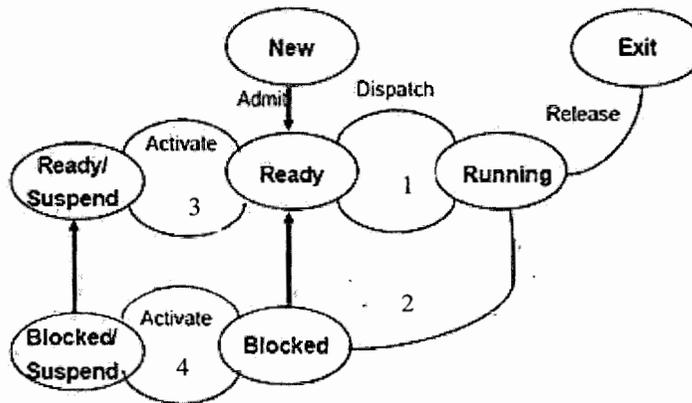
- Q4. Explain the function of the each of the following registers in 8051: (3+2+3)
 (i) Timer 0/1 register (ii) TMOD register (iii) TCON register.

Explain the operation of the timers in mode 2, that is, in auto-reload mode. Write an 8051 C program to toggle only pin P1.5 continuously every 250 ms. Use Timer 0, mode 2 to create the delay. Assume a crystal frequency of 11.0592 MHz.

- Q5. What are the data types available in ARM? (1+1+3+3)

How does the Little Endian type of storage differ from the Big Endian type of storage? Suppose that the number 0x12345678 is stored at memory location 1000 in Big Endian format. If the processor now assumes the data to be in Little Endian format, what will it get if it reads (i) a byte, (ii) a half-word, (iii) a word; from the location 1000? Now if the data bus lines are connected to memory in reverse order, that is, bit-0 of data bus is connected to data line 31 of memory, 1 to 30, and so on, what values will be read in the three cases. (2+4)

- Q6. The following figure gives the state transition diagram of a process.



Explain when a process enters each of the states. Give the condition for each of the transitions: 1, 2, 3, and 4.

- Q7. Real-time systems can be classified as: Hard real-time systems, Firm real time systems, and Soft real time systems. Give the characteristics of each of these and give at least two example systems belonging to each class. (6)

- Q8. Assume that you have to schedule a set of tasks $T = \{T_1, T_2, \dots, T_n\}$ having periods $p = \{p_1, p_2, \dots, p_n\}$ using Table-driven scheduling. In this context, what do you mean by 'major cycle' of the task set? Prove that the major cycle is equal to $LCM(\{p_1, p_2, \dots, p_n\})$ even when the tasks have arbitrary phases. (1+5)

RA INDIAN INSTITUTE OF TECHNOLOGY

Date: April , 2012
Spring Semester 2011-2012
2nd Year B.Tech..

Time: 3Hrs. Full Marks: 100
Dept. Electronics & ECE
Sub. Name: Signals and Systems

No. of students: 120
Sub. No. EC21004

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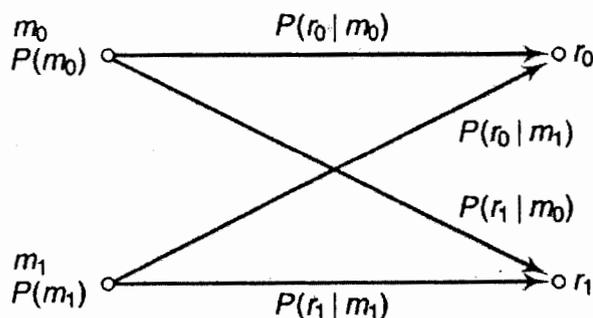
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Date :
No. of Students – 120
Sub. No. EC21006

Time : 3 Hrs.

Full Marks 100

Dept. of E & ECE
Spring Semester : 2011-12
Sub.: Electromagnetic Engineering

- Instructions :*
- 1) ATTEMPT ALL THE QUESTIONS
 - 2) MAKE NECESSARY ASSUMPTIONS WITH JUSTIFICATIONS, IF NECESSARY
 - 3) ATTEMPT ALL THE PARTS OF A QUESTION AT ONE PLACE

1. The boundary surface between two regions I and II in a magnetic field is on the $z = 0$ plane. The magnetic field intensity at the interface in Medium I ($z < 0$) is $\vec{H}_1 = 25 \hat{a}_x + 30 \hat{a}_y$ A/m. The relative permeability of medium I is 12.0 and that of medium II is 15.0. Find

- a) the magnetic field intensity at the interface in medium II if the interface has no surface current
- and b) the same quantity if the interface has a current sheet defined by $\vec{K} = 6.00 \hat{a}_y$ A/width

2.

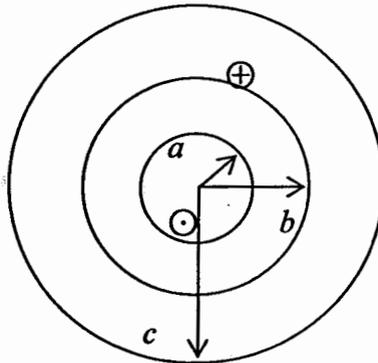


Figure – 1

The cross sectional view of a coaxial transmission line is shown in Figure 1. The current density is flowing through both inner and outer conductors and their directions are as shown. The inner conductor is a solid one and the region between the two conductors is filled by a dielectric. Find

- a) internal inductance of the inner conductor
- b) inductance due to linkage of flux in the dielectric region
- c) inductance due to linkage of flux within the outer conductor.

3. At frequency $f = 150$ MHz, the propagation constant and intrinsic impedance of a medium are $0.01 + j12$ m^{-1} and $110 + j1.2$ Ω respectively. The amplitude of the magnetic field intensity of an uniform plane electromagnetic wave travelling along positive z direction in the medium at $z = t = 0$ is $0.9 < 0$ A/m.

- a) Write expressions for the instantaneous electric field intensity and instantaneous magnetic field intensity
- b) Calculate the average power flow per unit area along the direction of propagation of the wave at $z = 0$ and also at $z = 10$ m.

4. A y -polarised uniform plane wave travelling in free space is incident obliquely on a perfect plane conductor. The surface of the conductor is at $z = 0$ and the $x - z$ plane is the plane of incidence. The angle of incidence is 30° , the amplitude of electric field intensity of the incident wave is 15 V/m and frequency of the wave is 125 MHz . 20
- Express the electric field and magnetic field intensity vectors of the incident and reflected waves in phasor form.
 - Find the complex Poynting vectors of the incident wave, reflected wave and the sum of the complex Poynting vectors of the incident and reflected waves.
 - What conclusion you can draw from the value of the sum of the complex Poynting vectors of the incident and reflected wave?

5. The radii of the inner and outer conductors of a coaxial transmission line are 2 mm and 4 mm respectively. The conductivity of the conductors is $5.8 \times 10^7 \text{ S/m}$. The relative permittivity, relative permeability and conductivity of the insulation between the conductors are 3.5 , 1.0 and $6.0 \times 10^{-8} \text{ S/m}$ respectively. 20
- Find per unit length resistance, inductance, capacitance and conductance of the line at a frequency of 150 KHz .
 - If a 7 m length line is terminated by a load impedance of 150Ω and is driven by a source having $\tilde{V}_s = 10 \angle 0^\circ \text{ V}$ and $\tilde{Z}_s = (75 + j0)\Omega$, determine the time-average power delivered to the line and also to the load.
 - Repeat these calculations if the line is terminated by its characteristic impedance.

6. A pulse generator having a source impedance of 50Ω is attached to a 50Ω coaxial cable having some unknown length and load resistance. The dielectric of the cable is Teflon ($\epsilon_r = 2.1$). The open circuit voltage waveform of the pulse generator is a pulse of duration $10\mu\text{s}$. If the recorded voltage at the input to the line is as shown in Figure 2, determine 10
- the length of the line
- and
 - the unknown load resistance.

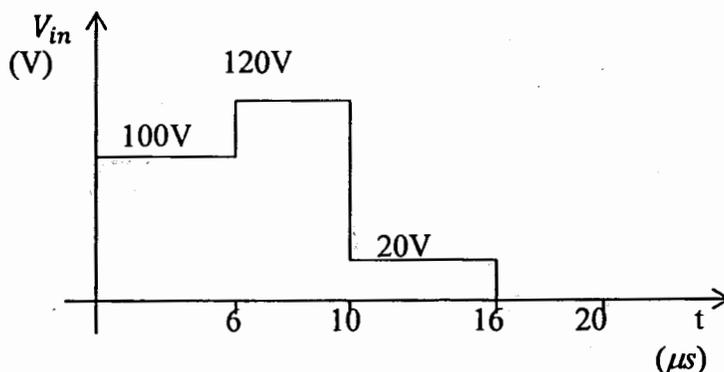


Figure - 2

7. A z -directed current element $I_z dl$ and another x -directed current element $I_x dl$ have the same angular frequency ω . 10
- Find the expressions for the far-fields of the z -directed antenna. Also, write the expression for the far-fields of the x -directed current element.
 - If I_z leads I_x by 90° , show that on the y -axis in the far-field, the field is right-handed circularly polarised.