I.E.S-(Conv.)-2002

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed: Three Hours *Maximum Marks : 200*

Candidates should attempt any FIVE questions. All questions carry equal marks. Values of the following constants may be used wherever necessary.

Electronic charge = -1.60×10^{-19} Coulomb.

Free space permeability = $4\pi \times 10^{-7}$ Henry/m.

Free space permittivity = $(1/36\pi) \times 10^{-9}$ Farad/m.

Velocity of light in free space = 3×10^{8} m/sec.

Boltzmann constant = 1.38×10^{-23} Joule/K.

Planck's constant = 6.626×10^{-34} Joule .sec.

1. (a) Why are the temperature coefficients of resistance of conductors and semiconductors different? Explain with reference to the parameters involved.

10s

(b) What are the important properties of the following materials which make them important in electronics?

GaAs, Al_2O_3, Ruby, $BaTiO_3$ & Yttrium Iron Garnet (YIG).

Indicate their specific applications.

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(c) What are the 2 types of capacitors used in Silicon Integrated Circuits (ICs) ? Compare these with respect to their

(i) capacitance/area (ii) breakdown voltage V_{BD} (iii) voltage dependence

Draw and explain their equivalent circuits.

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2. (a) Explain and draw the capacitance vs gate voltage ($C-V_g$) characteristic of a Si NMOS device at (i) low and (ii) high frequencies. What parameters can be determined from these characteristics?

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(b) What parameters determine the threshold voltage V_T of a MOS device? How can V_T be controlled? What phenomena become important in short channel devices and how are the device characteristics affected?

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(c) A Silicon NMOS device has gate width W = 100 μm (10^{-4} m), gate length L = 2 μm (2×10^{-6} m), oxide thickness d_{ox} = 0.2 μm (2×10^{-7} m), relative dielectric constant of oxide $\varepsilon_{ox} = 3.9$ and electron mobility $\mu_n = 0.08$ m^2/V.s.

Find the trans-conductance g_m of the device in the linear region of operation for drain voltage V_D = 1 V.

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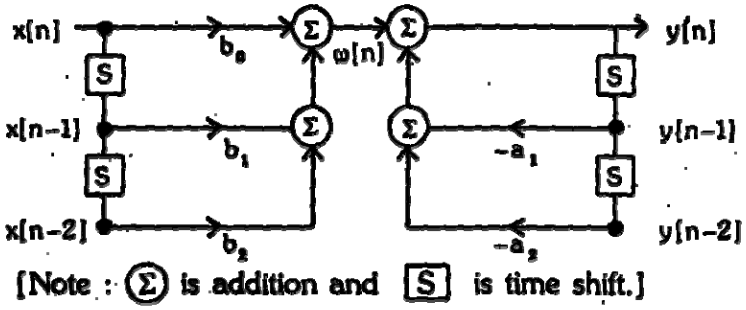
3. (a) With mathematical expressions, define the properties "stability" and "casuality" of a system.

10

(b) Obtain the difference equation to represent the discrete time system of the figure given below:



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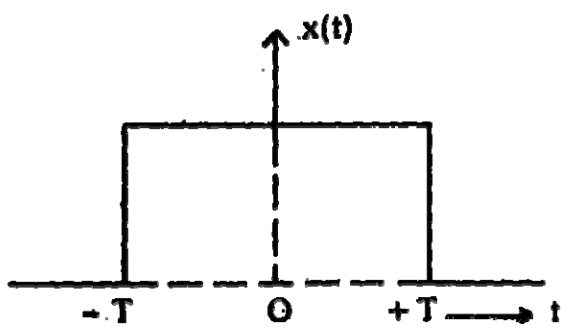
(c) For the above "direct form I" implementation of a Linear Time Invariant [LTI] system, derive the "direct form II" implementation. Show the block diagram and point out the improvement.

15

4. (a) With sketches of waveforms, explain the four classes of Signals Mention the Fourier representations applicable to thee 4 classes of Signals.

12

(b)



For the rectangular pulse shown in the above figure, determine the Fourier Transform of x(t) and sketch the magnitude spectrum with respect to frequency.

20

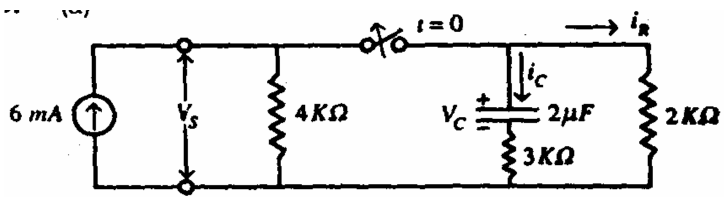
(c) Determine the Z-transform of the signal

$$x[n] = \begin{cases} 1, & n = -1 \\ 2 & n = 0 \\ -1 & n = 1 \\ 1, & n = 2 \\ 0, & \text{ohterwise} \end{cases}$$

Also obtain the Discrete Time Fourier Transform (DTFT) for this signal.

8

5. (a)



In the circuit shown above, the switch is opened at t 0. Find i_R, i_C, V_c and Vs.

15

(b) Obtain the transform impedances and admittances of

(i) a resistor with initial current

(ii) an inductor with initial current

(iii) a capacitor with initial voltage.

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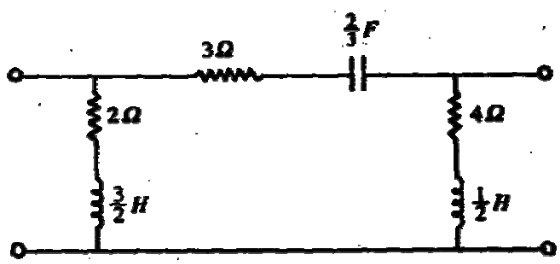

Find the Y-parameters of the circuit shown above.

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6. (a) What is a "microstrip line" ? Give the expression for the characteristic impedance in terms of its dimensions. Where does it find applications?

10

(b) When a transmission line of finite length is terminated with a load equal to its characteristic impedance, it appears as an "infinite line" to the sending end source. Justify this by applying voltage and current equations.

20

(c) A line from the transmitter output is 100 metres long and the frequency of the signal being transmitted is 1.2 MHz. The characteristic impedance Z_0 of the line is 500 ohms. Calculate the input impedance if the remote end is (i) open (ii) shorted. Neglect losses.

10

7. (a) Explain briefly the following terms as applied to characterisation of measurement systems

(i) accuracy (ii) precision

(iii) resolution (iv) sensitivity and

(v) linearity

10

(b) Draw a neat block schematic to illustrate digital measurement of frequency. Explain the operation of the system.

15

(c) An analog voltage signal whose highest frequency is 1 KHz is to be digitally coded with a resolution of 0.01 per cent coveting the voltage 0-10 V. Determine

(i) the minimum sampling rate

(ii) the minimum number of bits in the digital code

(iii) the analog value of the least significant bit

(iv) the r.m.s. value of the quantization error

(v) the aperture time required for the A/D converter.

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ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed: Three Hours *Maximum Marks : 200*

Candidates should attempt Question No. 1 which is compulsory and FOUR more questions taking TWO each from Section A and Section B.

Some useful constants are given below:

$e = 1.6 \times 10^{-19}$ coulomb

$m = 9.1 \times 10^{-31}$ kg

$h = 6.625 \times 10^{-34}$ J-s

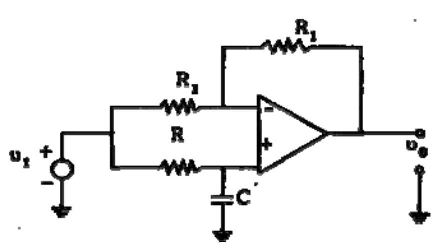
$c = 3 \times 10^{8}$ m/s

G = universal constant of gravitation, 6.628×10^{-11} $m^3/kg\text{-}s^2$

M = mass of the earth, 5.997×10^{24} kg

r = radius of the earth, 6378 km

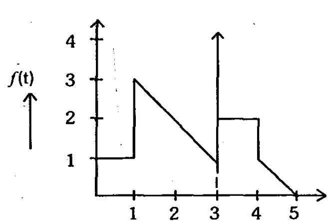
1. (a) Derive the transfer function of the circuit shown below and identify the function of the circuit: 8



(b) Discuss the classification of amplifiers based on function, frequency, conduction angle, type of coupling and load. 8

(c) (i) What are the various categories of semiconductor memories? Explain their comparison based upon speed (access time), power requirements, cost per bit noise immunity and packing density. 5

(ii) What determines the fan-out limitations of MOS logic circuits? 3



Resolve f(t) in terms of step, impulse and ramp functions. Also find the Laplace transform of f(t).

8

(e) A matched filter has a frequency response given by

$$H(f) = \frac{1 - e^{-j2\pi fT}}{j^{2\pi f}}$$

Determine the impulse response h(t) of the filter.

8

(f) (i) In a 4-input NAND gate, two inputs are to be used. What are the options available for the unused inputs and which one is the best and why?

4

(ii) How will you obtain 8 to 1 MUX from 4 to 1 MUX's?

4

(g) Prove that a (n, k) linear block code of minimum distance d_{min} can correct up to t errors if and only if

$$t \le 1/2\left(d_{\min} - 1\right)$$

8

(h) An X-band rectangular waveguide filled with a dielectric ($\varepsilon_r = 2.56$) is operating at 9.5 GHz. Calculate group and phase velocities. Also calculate the TE and TM wave impedances.

8

(i) Define loaded and unloaded Q of a parallel R-L-C circuit and show that external $Q(Q_e)$, loaded $Q(Q_l)$ and unloaded $Q(Q_u)$ are related through

$$\frac{1}{Q_t} = \frac{1}{Q_e} + \frac{1}{Q_u}$$

8

(j) Distinguish between:

2×4 = 8

(i) Local and Global variables

(ii) Call by value and Call by reference

(iii) Clock cycle, Machine cycle and instruction cycle

(iv) Instruction and Microinstruction.

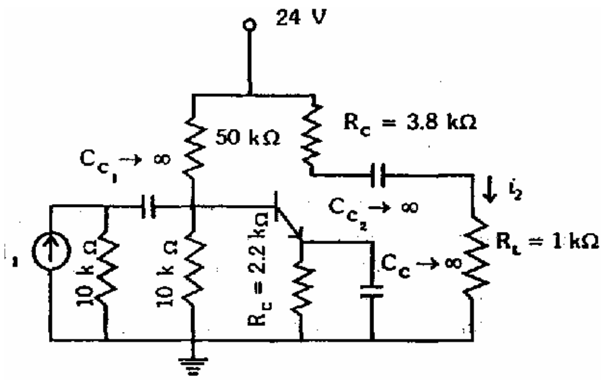
SECTION A

2. (a) Draw the circuit of an astable multivibrator using p-n-p transistors, whose output is a square wave with steep edges. Also draw the labelled waveforms at the collectors and bases of the two transistors. Determine the frequency of the output waveform. Discuss its application as a voltage to frequency converter.

20

(b) In an R-C coupled amplifier, shown below, the BJT has $j_{fe} = 50$. All bypass and coupling capacitors are assumed to have zero reactance at the signal frequency. Find the quiescent conditions and draw the small-signal equivalent circuit, neglecting h_{oe} and h_{re}.

10



3. (a) Draw a BJT RAM cell and explain how data can be stored and retrieved from it.

24

(b) On what factors the switching speed of a BJT and a MOSFET depends?

6

4. Draw the circuit of a 2-input TFL totempole output NAND gate with the help of four transistors (a multimeter, phase splitter, and totempole amplifier transistors).

(a) Explain the function of multimeter transistor. What is the disadvantage of using back to back diodes in place of multimeter transistors?

(b) Explain the function of protecting diodes connected to multimeter transistor.

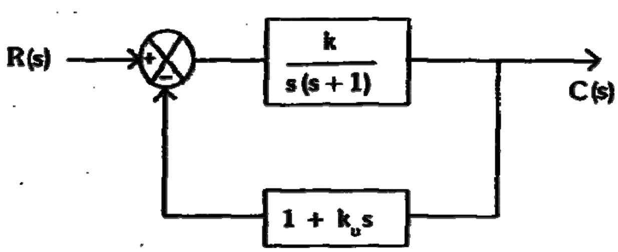
(c) Why the output of these gates cannot be wire-ANDed?

(d) Why this logic circuit is faster than open collector logic circuit ?

(e) What determines the fan-out limitations of this circuit?

30

5. (a)



Determine the value of k and velocity feedback constant k_v so that the maximum overshoot in the unit step response is 0.2 and the peak time is 1 sec. With these values of k and k_v, obtain the rise time and settling time.

15

(b) Consider a closed loop system whose loop transfer function is

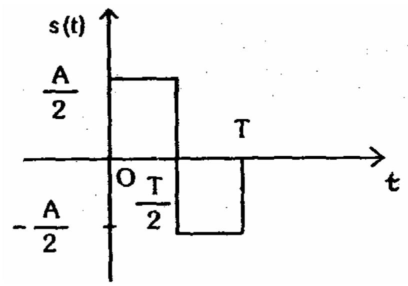
$$G(s)H(s) = \frac{Ke^{-Ts}}{s(s+1)}$$

Determine the maximum value of the gain k for stability as a function of dead time T.

15

SECTION B

6. (a) Consider the signal s(t) shown below:



(i) Determine the impulse response of a filter matched to signal s(t).

(ii) Plot the matched filter output as a function of time.

(iii) What is the peak value of the output?

20

(b) Show that the input-to-output SNR gain of a matched filter depends on the product of the input signal duration and the noise bandwidth.

10

7. (a) What ate the different types of errors in Delta modulator? How can these be removed?

10

(b) Explain the principle of operation of DPSK transmitter and receiver.

10

(c) Determine the signal-to-quantization ratio of a Delta modulator for a sinusoidal signal with a bit rate of 64 kWs and input signal bandwidth of 4 kHz.

10

8. (a) The inside dimensions of an X-band WR 90 waveguide are a = 2.286 cm and b = 1.016 cm. Assume that the waveguide is air-filled and operates in dominant TE_{10} mode, and that the air will breakdown when the maximum electric field intensity is 3×10^6 V/m. Find the maximum power that can be transmitted at f = 9 GHz in the waveguide before air breakdown occurs. Derive all the necessary equations.

15

(b) The system noise temperature at the input of the LNA of a satellite receiver station operating in the C-band is 450 k. If the diameter of the receiver antenna (parabolic reflector) is 30 m, compute the earth station figure of merit.

15

9. (a) What is the difference between isolated I/O and memory - mapped I/O ? What are advantages and disadvantages of each?

10

(b) What are the advantages of 8086 over 8085 ? What are the limitations of 8086 ?

7

(c) Explain, with example, the use of RST 6, 8085 instruction.

3

(d) With the help of block diagram, show the interfacing of a digital computer with the analog required for the controlling arid monitoring of a physical variable (assumed to be analog). Explain the function of its important blocks.

10