I.E.S-(Conv.)-2001

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 Joule sec.

1. (a) Consider a solid containing N identical atoms per m^3, the polarizability of which is α farad m^2. Assuming a Lorentz internal field, derive the Clasius-Mosotti relation.

15

(b) With reference to the hysteresis curve, explain the phenomenon of spontaneous polarization in ferroelectric materials.

10

(c) What is Curie temperature? Indicate the nature of variation of the dielectric constant in a ferroelectric material above the Curie temperature.

10

(d) Name two common ferroelectric materials.

5

2. (a) In intrinsic silicon, the Fermi level lies near the middle of the bandgap. How does the Fermi level move when it is doped with (i) phosphorus, and (ii) boron atoms? Can the Fermi level be pushed up into the conduction band ? If yes, explain how. If not, explain, why.

5+5+5

(b) Explain why a doped semiconductor that is extrinsic at normal temperatures, behaves as an intrinsic material above a certain temperature, Upon which parameters will this temperature depend?

10+5

(c) "An n-type semiconductor has more number of electrons than holes, hence it has a net negative charge". Justify or nullify the above statement.

10

3. (a) Sketch the terminal current-voltage characteristics of the following diodes under both forward and reverse biased conditions.

15

(i) p-n junction diode.

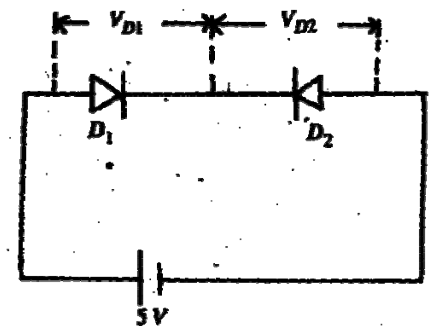
(ii) Zener diode.

(iii) Tunnel diode.

(iv) Shockley diode.

(v) Light-emitting diode.

(b)



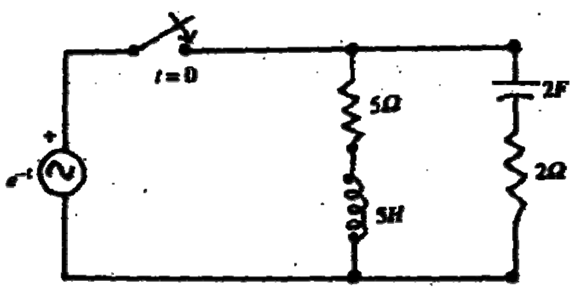
Find the voltage drop across each of the silicon junction diodes shown in the above figure at room temperature. Assume that reverse saturation current flows in the circuit and the magnitude of the reverse breakdown voltage is greater than 5 volts.

10

(c) Elucidate three consequences of the Early effect in bipolar junction transistors.

15

4. (a)



For the circuit shown in the above figure obtain an expression for the current delivered by the source as a function of time, when the switch S is closed at t = 0. Assume the circuit to be initially unenergised.

10

(b) For a linear two-port network, show that $z_{11}\, y_{11} = z_{22}\, y_{22}$, where z and y are respectively the elements of the z- and y-parameters of the network and the subscripts have their usual significance.

15

(c) Find the first partial fraction form of a network whose driving-point impedance function $Z_D(S)$ has zeros at $S = -2$ and $S = -6$ and poles at $S = 0$, $S = -4$ and $S = -8$. Assume that $Z_D(S) = 1\ \Omega$ at $S = -3$.

15

5. (a) Define standing wave ratio (SWR) for a transmission line terminated by a resistive load.

5

(b) A transmission line of characteristic impedance 75 Ω is terminated by a resistive load of 100 Ω. What will be the value of SWR if the line is terminated by a short circuit?

5+5

(c) Explain the operation of a quarter-wave transformer.

15

(d) It is required to match a 100 Ω load to a transmission line of characteristic impedance 75 Ω. What should be the characteristic impedance of the quarter-wave transformer used for this purpose, if it is connected directly to the load ?

10

6. (a) The mean time to failure (MTTF) of an integrated circuit obeys a law of the form

$$\text{MTTF} = C \exp (T_0 / T)$$

where T is the operating temperature and C and T_0 are constants. The following values of MTTF at various temperatures were obtained from accelerated-life tests.

MTTF (hours)	**54**	**105**	**206**	**411**	**941**	**2145**
Temperature (K)	**600**	**580**	**560**	**540**	**520**	**500**

(i) Estimate the values of C and T_0.

(ii) For an MTTF of 10 years, calculate the maximum allowable temperature.

10+5

(b) With appropriate circuit diagram, outline the theory of Maxwell bridge for the measurement of an Unknown inductance.

15

(c) In a Maxwell bridge, the fixed-value bridge components have the following values = 5 Ω, C = 1 mF. Calculate the value of the unknown impedance (L_u, R_u) if R_1 = 159 Ω and R_2 = 10Ω at balance. Also calculate the Q factor for the unknown impedance at a supply frequency of 50 Hz.

10

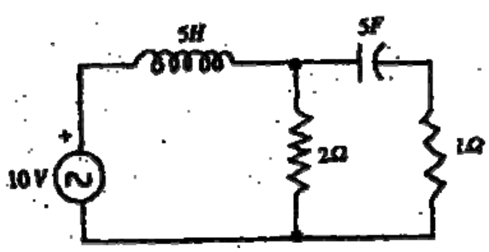
7. (a) Sketch the impedance curve of a quartz crystal as a function of frequency:

10

(b) Compare the merits and demerits of CMOS integrated circuit vis-a-vis those of bipolar integrated circuits.

10

(c)



Obtain the dual of the circuit shown in the above figure.

10

(d) Using Poisson's equation, show that electric field lines originate from a positive charge and terminate on a negative charge.

10

I.E.S-(Conv.)-2001

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed: Three Hours *Maximum Marks : 200*

Candidates should attempt question no I which is compulsory and FOUR more questions taking TWO each from Section A and Section B.

Some useful constants are given below:

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

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

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

$c = 3 \times 108$ m/s

G = universal constant of gravitation, 6.668×10^{-11} $m^3/kg\text{-}s^2$

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

r = radius of the earth, 6,378 km.

1. (a) A transistor is connected in common emitter configuration as an amplifier. The parameters of the transistor specified are:

$I_B = 25$ μA, $I_{CBO} = 100$ nA, beta = 100.

Find its I_C, I_E, I_{CEO} and alpha, where symbols have their usual meaning.

8

(b) Draw a neat circuit diagram of a voltage time base generator using a negative resistance switch. Explain its operation in free running mode. Derive an expression for its frequency of oscillation.

8

(c) A simple full wave bridge rectifier circuit has an input voltage of 240 V a.c. r.m.s. Assume the diodes to be ideal. Find the output d.c. current, d.c. voltage, r.m.s. values of output currents and voltages and the peak inverse voltage that appears across the non-conducting diode. Assume load resistance to be 10kΩ.

8

(d) Mention the hardware interrupts in 8085 microprocessor in the order of their priority and mention the address branched to when this interrupt occurs.

8

(e) Clearly differentiate between the following concepts :-

(i) Combinational and sequential circuits.

4

(ii) Synchronous and asynchronous counters.

4

(f) (i) Explain the meaning of information from the information theory point of view. Explain how it is measured. How can we quantify one unit of information? Explain.

4

(ii) A source emits 4 messages m_1, m_2, m_3, m_4 with probabilities of 1/8, 1/4, 1/2 and 1/8. Calculate the entropy of the information.

4

(g) Differentiate between the following in C programming-

(i) do-while loop and while loop

(ii) iteration and recursion.

8

(h) (i) When raw binary bits generated by the source can be transmitted in a channel, why is source coding done which adds to complicacy of the transmission work?

4

(ii) Obtain Shannon-Fano code for the source information consisting of 5 messages m_1, m_2, m_3, m_4 and m_5 with probabilities of

1/16, 1/4, 1/8, 1/2, 1/16

4

(i) A radiating antenna operating at 25 MHz, has radiation resistance of 50 C. It is fed an r.m.s. value of current of 10 Amp. It has a bandwidth of 500 kHz. Find its Q and the power that will be radiated by this antenna.

8

(j) For the mechanical system shown in Fig 1 write the differential equation representing the system. Draw an integrator based electronic circuit to simulate this mechanical system to study the variations of x for different values of the parameters.

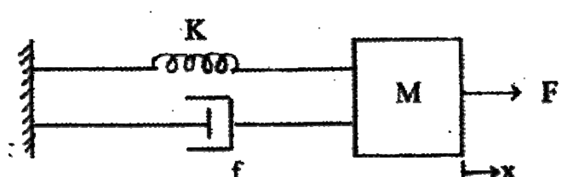


Fig. I

Symbols used have their usual meaning.

8

SECTION A

2. (a) In the circuit of Fig. 2 all the transistors are matched Si transistors. Symbols carry their usual meaning.

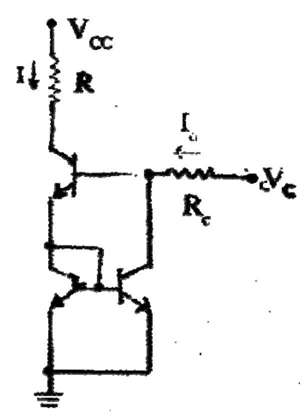


Fig. 2

(i) Find the expression of the current I in terms of I_0.

3

(ii) Calculate the value of I if $V_C = 5$ V, $R_e = 2$ kΩ, $V_{cc} = 6$ V and R = 2.2 kΩ. Take $V_{BE} = 0.7$ V and $\beta = 100$.

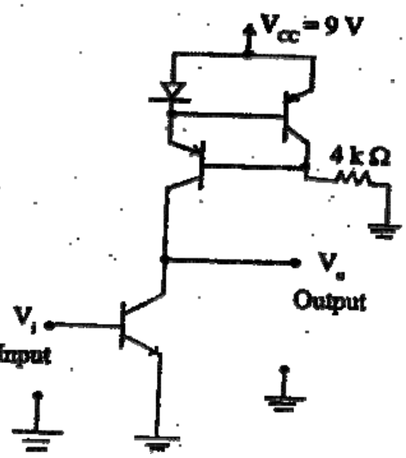
2

(iii) What can be the maximum value of I ? If R_C is varied between 1 kΩ and 4 kΩ give the range of variation of I.

3

(b) For the amplifier circuit shown in Fig. 3, find the mid-band gain using small signal equivalent circuit. Take early voltage of NPN transistor 95 V and that of PNP transistors as 76 V. Forward resistance of the diode is negligible and thermal equivalent voltage, $V_T = 0.025$ V, β is large.

Fig. 3



(c) Explain the advantages of active load over the passive load.

3. (a) (i) Explain why bias stabilization is done in a bipolar junction transistor amplifier circuit.

4

(ii) Draw a fixed bias circuit and a self bias circuit using a. BJT and mention typical component values and supply voltages for your circuit.

6

(iii) Briefly explain the principle of operation of fixed bias and self bias circuits using BJT

5

(iv) Compare the relative merits and demerits of fixed bias and self bias circuits using BJT from the application point of view. Choose, with suitable reasons, the one which you would recommend for cascaded amplifier operation.

3

(b) Assume three identical non-interacting amplifier stages are connected in cascade having an overall upper cut-off frequency of 10 kHz and lower cut-off frequency of 10 Hz.

(i) calculate the tower and upper cut-off frequencies of individual stages.

6

(ii) Derive the equations used in solving part (i) of this question.

6

4. Binary message bits are coming serially. They are to be taken in blocks of four binary digits a_3 a_2 a_1 a_0 and coded into 7-bit binary word as a_3 a_2 a_1 a_0 c_2 c_1 c_0, where c_2, c_1 and c_0 satisfy the following equations-

$a_3 + a_2 + a_1 + c_2 = 0$

$a_3 + a_2 + a_0 + c_1 = 0$

$a_3 + a_1 + a_0 + c_0 = 0$

(a) Draw the complete logic circuit for generating c_2, c_1 and c_0 giving the details of S/P converter and parity generator circuits. Explain the working of the circuit.

15

(b) If an additional parity bit C_P is to be generated making total number of bits in a block (part a) equal to eight so that number of 1's in the block are even, give the logic circuit for generation of C, using minimum number of X-ORs.

7

(c) If the 7 parallel bits generated in part (a) are to be transmitted serially give the details of the P/S converter such that 7-bit word is accommodated over the original 4-bit word duration.

8

5. (a) A control system is represented by the block diagram of Fig. 4. Find its characteristic equation using block diagram reduction technique.

5

(b) Calculate its damping factor and undamped natural frequency for $k_v = 10$.

5

(c) What should be the value of k_v for critical damping?

5

(d) For $k_v = 10$, find the expression of C(t) and obtain the time at which the first overshoot occurs. Also find the peak-overshoot magnitude.

15

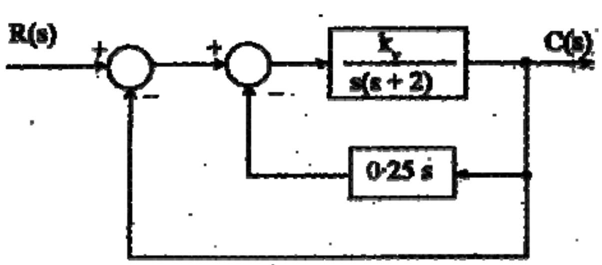


Fig. 4

SECTION B

6. (a) Voice signal band limited to 3.4 kHz is sampled at 8 kHz and pulse code modulated using 64 quantization levels. Ten such signals time division multiplexed (TD Med) using one 5-bit synchronizing word every alternate frame. Calculate the minimum channel bandwidth required for transmission of the TDM signal.

15

(b) A carrier signal at 1 MHz is phase shift keyed by a rectangular polar binary signal at 64 k bits/sec. Draw the amplitude spectrum of

(i) the polar binary signal

5

(ii) the PSK signal and explain how it is related with the spectrum of the polar binary signal.

10

7. (a) In a F.O. Communication link optical fiber with attenuation 0.4 dB/km is used, –3 dBm optical power is launched from the source on to the fiber. The link uses 3 splices with 1 dB power loss in each and there comes a 1 to 10 star coupler with 3 dB coupling loss at 10 km from the transmitter. Each of the ten receivers uses a photo-detector with 10 n W/M, bit/sec sensitivity. What can be the maximum link length if data rate is 100 M bits/sec ?

15

(b) A 10 MHz carrier is frequency modulated using a modulating signal $e_m = E_m \sin 10^3 \pi t$. The resultant FM signal has frequency deviation of 5 kHz.

(i) Calculate the modulation index of the FM wave.

3

(ii) What should be the capture range of a PLL used for demodulation of this signal?

6

(iii) Derive the result of part (b).

6

8. (a) Justify, in brief, the following statements giving suitable for your answer:

(i) 'Transit time effect' sets a limitation to the high frequency behaviour of the conventional vacuum tubes, but it plays a vital role in the operation of klystrons.

(ii) PIN diodes are more suitable for high frequency switching applications as compared to PN junction diodes.

(iii) Low power LASER beams are considered to be very powerful as compared to high power ordinary light beams.

(iv) Always an attenuator is connected in the microwave experimental bench just after the klystron tube.

(v) Prove penetration in the slotted section of a microwave bench is kept very low during measurements, even if it decreases the pick-up signal.

3 × 5

(b) A transmission line of 72 Ω is connected to a 100 Ω load as shown in Fig. 5.

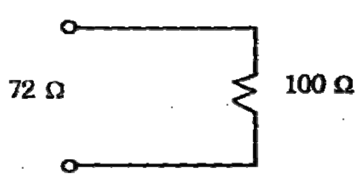


Fig. 5.

Find:

(i) Standing-wave ratio due to this mismatch.

3

(ii) Reflection Coefficient.

3

(iii) Ratio of the reflected and the incident powers at the load.

2

(iv) Percentage of incident power inflected from the load.

1

(v) Percentage of the incident power absorbed in the load.

1

(c) Find the optimum length of a vertical Marconi antenna for transmission of a 50 MHz signal. Assume the velocity factor to be 0.85.

5

9. (a) Explain, in brief, the following terms used in data structure and differentiate between them-

(i) Stack and queue.

6

(ii) Sort and search.

6

(b) Write an interactive program in C language to accept the radius of a circle from the user and to display the perimeter of the circle on the screen. Assume the value of pi = 3.14159. Write comments in the program to explain the statements.

12

(c) Give meaning – operand, number of bytes, machine cycles and T-states for the following opcodes, used in 8085 microprocessor

LDA, JMP, POP.

6

* * * * * * *