I.E.S-(Conv.)-1991

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed: Three Hours *Maximum Marks: 200*

Candidates should attempt Question 1 which is compulsory

and any FOUR of the remaining questions.

Assume suitable data, if necessary.

1. (a) A charge Q is distributed over two concentric hollow spheres of radii r and R (>r) such that their surface densities are equal: Find the potential at the common centre.

8

(b) The periphery of copper disc 50 cm in radius and 10^{-3}mm in thickness is maintained at a potential of 50 V. A thin rod 1 cm in radius is soldered to the disc at its centre (at right angles to the plane of the disc) and maintained at a potential of 49V. If the resistivity of copper is 1.7×10^{-8} Ω-m. calculate the current through the disc.

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(c) In the circuit shown in Fig. 1 (c). a voltmeter reads 30V when it is connected across 400Ω resistor. Calculate what the same voltmeter will read when it is connected across the 300Ω resistor.

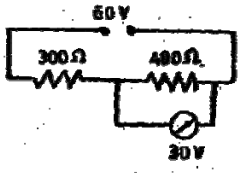

Fig. 1 (c)

(d) The electric field strength produced at a distance x m in a direction from an antenna is 15m V/m and at the same lime its value in the opposite direction is 2m V/m. Calculate the front-to-back ratio of antenna in d B.

8

(e) A coaxial cable whose dielectric loss is negligible has an attenuation of 2d B/m at a frequency of 0.5 MHz. Calculate the frequency at which 6m length of the cable will suffer a loss of 50 dB.

8

(f) A transistor exhibits a change of 0.99 mA in its collector current for a change of 1.0 mA in its emitter current. Calculate its common-base and common-emitter short-circuit current gains.

8

(g) Electrons are excited across the forbidden energy gap E_0 in germanium by photons. Calculate the maximum wavelength for a photon which will produce electron-hole pairs in germanium, if E_0= 0.71 eV.

8

(Electronic charge e=1.6×10^{-19}C; Planck's constant h= 6.625×10^{-34} joule-see; Velocity of light = 3×10^{8} m/sec.)

(h) An inductive coil has a resistance of 300Ω and an inductance of 2 H when measured at very low frequency. The distributed capacitance is 250 μF. Find the percentage change in effective inductance when the coil is operated at a frequency of 2 kHz.

8

2. (a) A 3 μF capacitor is charged to a potential of 300 V and a 2μF capacitor is charged to a potential of 200V. If these two capacitors are connected in parallel, plates of same polarity being connected together, what is the value of their common, potential? If the plates of opposite polarity are joined together after the two capacitors are charged, what amount of charge will flow, and from which capacitor does it come?

17

(b) With the help of a suitable diagram showing the relative orientations of magnetic induction, current densities and electric fields in a semi-conducting specimen derive an expression for the Hall constant, the Hall angle and the Hall mobility. How would you measure these quantities experimentally?

17

3. (a) By drawing a suitable diagram, explain the operation of a full-wave (centre-lapped) rectifier circuit. A centre-tapped transformer used in a full-wave rectifier circuit has a 250 V primary winding and a 9-0-9 V Secondary winding. The load resistance is 150Ω. Calculate the d.c. output voltage, d.c. load current and the peak inverse voltage rating required for tile diodes, if they are assumed ideal.

17

(b) An R-C driving point impedance function is expressed as

$$Z_{RC}(s) = \frac{(S+2)}{(S+1)(S+3)}$$

Realize its first and second Cauer forms.

4. (a) In the circuit shown in Fig: 4(a), the switch S is open for a certain time and is then closed at t=0.. The voltages across C_1 and C_2 are 0V and 10V respectively at the time of switching. Find the current i_2 in resister R_2 and the voltage v_2 across the capacitor C_2 for t≥0.

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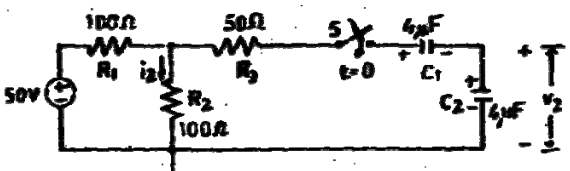

Fig. 4 (a)

(b) Consider the mid-band equivalent circuit of a common-emitter transistor amplifier as shown in Fig. 4 (b). Transistor h-parameters are : h_{ie} =1500Ω, $h_{re}=10^{-3}$, h_{fe}=100, $h_{oe}=50\times10^{-6}$ mho. Find the mid-band current gain where i_{s2} is the signal current in the 5kΩ resistor.

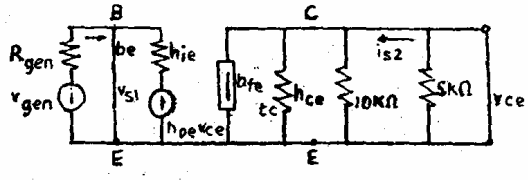

Fig. 4 (b)

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5. (a) A long cylindrical conductor of radius a, bearing the charge λ per unit length, is immersed in a dielectric medium of constant permittivity ε. Find the electric field at distance r > a from the axis of the cylinder.

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(b) Explain the terms 'radiation-resistance' and 'antenna-efficiency'. A low frequency transmitting antenna has a radiation resistance of 0.2Ω and a loss resistance of 1Ω. If the current fed into the antenna is 50A. Calculate the radiated power, the power input and the antenna efficiency.

17

6. (a) Define 'attenuation coefficient' and 'phase coefficient' in the context of a transmission line. A correctly terminated transmission line has Z_0=600Ω, <=1 dB/m, and β= 15°/m. The tine is 6 m long. A 600Ω source of e.m.f. 2.4 V is applied to the input terminals of the line. And the magnitude of the received current at the output terminals and its phase relative to the input voltage.

17

(b) In an inductive transducer as shown in Fig. 6(b).the coil has an inductance of 1500μH when the target made of ferromagnetic material is 1 mm away from the core. Calculate the value of inductance when a displacement of 0.1 mm is applied to target in a direction moving it towards the core. Show that die change in inductance is linearly proportional to the displacement. Neglect the reluctance of the iron parts.

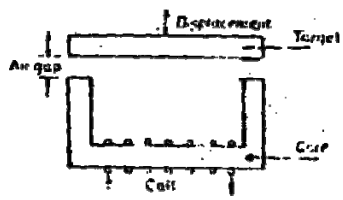

Fig.6(b)

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7. (a) The coil of a 250 V moving iron voltmeter has a resistance of 600Ω and an inductance of 0.9H. The instrument reads correctly at 50 Hz a.c. supply and takes a current of 150 mA at us full scale deflection. What is the percentage error in the instrument reading when it is connected to 200V d.c. supply?

17

(b) Explain the working of a p-n junction diode. In an abrupt p-n junction silicon diode, the conductivities of p-type and n–type silicon α_p = 100(Ω-cm)$^{-1}$ and α_n = 1 (Ω-cm)$^{-1}$. The intrinsic carrier concentration for silicon is 1.5×10^{10} cm^{-3} . Calculate the value of potential barrier for the unbiased diode a 300° K. For silicon, μ_p=500 cm^2 /V-sec and μ_0 = 1300 cm^2/V-sec.

(Electronic charge e = 1.6×10^{-19} C; Boltzmann's constant k = 1.38×10^{-23} JK^{-1})

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ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed: Three Hours ***Maximum Marks: 200***

Candidates should attempt any FIVE Questions choosing no more than THREE questions from each Section.

Assume any data. if required.

SECTION A

1. (a) For the circuit (Fig. 1) given below, I_{CBO} = 10μA, h_{FE}=100. Estimate I_C and V_O. Also derive a relation for us stability factor $S = \delta_{IC} / \delta I_{CBO}$.

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(b) Using reasonable approximations for the circuit given (see Fig. 2) at the specified operating conditions, determine

(i) R_2 for correct bias

(ii) C_1 for corner frequency ω=10 rad/se

(iii) output transformer inductance L_1 for a corner frequency ω_L=200 radians/sec.

Assume that the d.c. resistance of the transformer secondary is 10% of the load resistance.. Assume an appropriate turns ratio.

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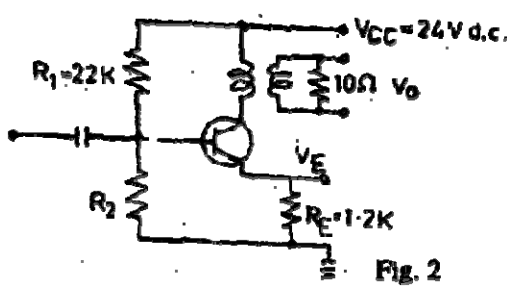

Fig. 2

At Ic = 10 mA

β = 380, r_e=11 Ω

r_b = 700 Ω, r_d = 5250 Ω

(c) For the circuit given (see Fig. 3) of UJT, it is given that lowest range of effective voltage V_{EE} across C_1 is V_1

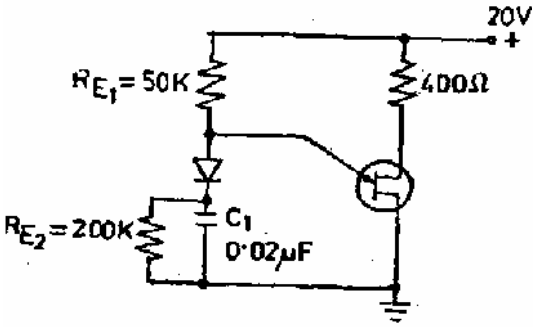

Fig. 3

Where

V_1=2.5 V I_v = 1 m

V_v=2V I_{Peak} = 4μA

η=0.6

(i) Determine whether the circuit will function as relaxation oscillator or not. What are the limits of R? (ii) Find V_p and V_{EE} (iii) Find the UJT, OFF and ON periods (FV) find its duty cycle. Also give waveforms across capacitors and its output.

10

(d) Design an inverting, Schmitt circuit using a 741 operational amplifier. It has upper triggering point UTP of 3V. Take load resistance R_L as 10kΩ and a supply voltage of ± 15 V. For 741, input bias current is 500 nA=$I_{B(max)}$. Assume current in output circuit as 100 times of $I_{B(max)}$. Also calculate the actual UTP and LTP when resistors with standard values are used.

10

2. (a) Design a junction FET amplifier (see Fag 4) to operate from 12V supply with a gain of a least 5 Bias at V_{DQ}=8 V, I_{DQ} = 0.25 mA, Y_{GSQ}= –0.6V. Estimate R_D, R_S, g_m and voltage gain A Choose R_G= 1 M, C_1=C_2=0.1 μF. Estimate C_S work satisfactorily for 1=1000 Hz.

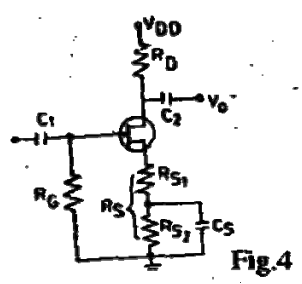

Fig.4

2N 3438

$V_{GS(OFF)}$ = V_p = –2 V

I_{DSS} = 0.5 mA

BV_{GSS} = 50 V

$I_{G(OFF)max}$ = 0.5 mA

Also prove

$$g_m = -\frac{2I_{DSS}}{V_P}\left(1-\frac{V_{GS}}{V_P}\right)$$

10

(b) Analyse the operation of 5 V supply given (see Fig. 5) operating at a load current (i) 200 mA (ii) 400 mA. From the specifications of 7805, an input of 7.3 V is allowable to maintain line regulation V, is ripple voltage. Given

$$V_{r(Peak)} = 3.(2.4)I_{de} / C = 3V_{r(runs)}$$

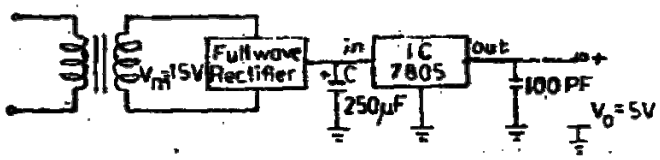

Fig. 5

Also determine the maximum value of load current at which regulation is maintained.

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(c) Design an IC 555 astable multivibrator to give a pulse output with pulse repetition frequency (PRF) of 2 kHz and duty cycle = 66%. Use V_{CC} = 18 V. Assume $I_{C(min)} >$ threshold is equal to 1 mA. Also analyze the circuit to determine PRF and duty cycle.

10

(d) Explain the procedure for deciding bias conditions of n-channel depletion MOSFET amplifier: Give the complete Circuit of amplifier.

10

3. (a) For a 12-bit A/D converter if the normalized range is 1 and the clock repetition frequency is 500 kHz. (i) find the normalized resolution and dB range (ii) it a counter type A/D converter is used then calculate maximum conversion time, average conversion time and maximum conversion rate.

10

(b) Design a combinational circuit that converts a decimal digit from the 8, 4, 2,1 code to BCD.

10

(c) Implement the tour Boolean functions listed using three half-adder circuits.

$$D = A \oplus B \oplus C$$

$$E = ABC + ABC$$

$$F = AB\overline{C} + \left(\overline{A} + B\right)C$$

$$G = ABC$$

10

(d) Implement a full-adder circuit with multiplexers.

10

Or

(e) A combinational circuit is defined by the functions:

$F_1(A, B, C) = \sum(3, 5, 6, 7)$

$F_2(A, B, C) = \sum(0, 2, 4, 7)$

Implement the circuit with a PLA having three inputs, four product terms and two outputs.

10

4. (a) Design a three-stage synchronous counter to repeat the number sequence: 0,1,3,2,6,7,5,4 in binary using J and K flip-flops and Karnaugh maps. Start by drawing out a state table and key map for the counter.

15

(b) Design a three-bit binary counter using three T hip-flops. giving its excitation table. Also realize the circuit.

15

(c) Design a serial adder using shift registers, which will add two 4 bit numbers, storing the result in one of the original data registers.

10

5. (a) Design a clocked sequential circuit whose state diagram is given below, using J-K flip-flops. Use excitation table and give its logic diagram.

15

(b) Design a Mod-5 counter using J-K flip-flops. Give Karnaugh maps and the counter circuit Also give Mod–5 counter waveforms.

15

(c) Draw the logic diagram (showing all gates) of a master slave D flip–flop. Also obtain a logic diagram of a master slave J-K flip-flop with AND and NOR gates. Include a provision for seizing and clearing the flip-flop asynchronously (without clock).

10

SECTION B

6. (a) Find the S-parameters for a waveguide component if the measured VSWR=1.3 when the component is terminated with a matched load. It is also found that the power to the matched load is 60 mW for an input power of 100 mW. The same results are obtained when the component is reversed.

5

(b) The scattering matrix for a two-port is

$$[s]=\begin{bmatrix} 0 & 0.8e^{j30^o} \\ 0.8e^{j30^o} & 0 \end{bmatrix}$$

What shift in port positions is required to make S_{12} and S_{21} real?

(c) The input power to the E-plane arm of a magic T is 250mW. Find the output powers from the other anus. Consider the magic T to be ideal and matched at all ports.

10

(d) Find the scattering coefficients for an ideal directional coupler having a coupling coefficients C=3 dB.

10

(e) The specifications of a three-port circulator are given as insertion loss = 1 dB, isolation 25 dB and VSWR = 1.4. Characterize the isolator by its S-parameters.

10

7. (a) The terminating impedance Z_1=(100+j100) ohms and the characteristic impedance Zo of. the line and stub is 50 ohms. The first stub is placed at 0.40λ away from the load. The spacing

between the two stubs is 3/8λ. Determine the length of short-circuited stubs when the match is achieved. What terminations are forbidden for matching the line by the double stub device? (Use Smith Chart.) Why is double stub matching preferred over single stub matching?

15

(b) A two-capvity Klystron Amplifier has the following parameters, V_0 = 1000 volts, I_o = 25 mA, f = 3 GHz

Gap spacing in the either cavity = d = 1 mm.

Spacing between the two cavities L = 4 cm.

Effective shunt impedance R_{sh} = 30 kΩ.

(i) Find the input gap voltage to give maximum voltage Vg.

(ii) Find the voltage gain.

(iii) Find the efficiency of the amplifier.

Also derive the formula of efficiency used.

15

(c) An IMPAT diode has the following parameters:

Carrier drift velocity	$V_a = 2 \times 10^7$ cm/sec
Drift region length	L=6 μm
Maximum operating voltage	$V_{0\,max}$ = 100V
Maximum operating current	L_o max = 200 mA
Efficiency	η = 15%
Breakdown voltage	V_{bd} = 90 Volts

Compute- -

(i) the maximum CW output power in watts;

(ii) the resonant frequency in GHz.

10

8. (a) Compare the PPM and PDM digital systems considering signal to noise ratios. Obtain the derivations of justify your comments.

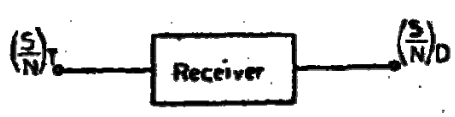
10

(b) (i) For a continuous transmitting source having an ideal receiver with no information loss in it and the information rates at the input and output to be identical, show that

$$\left(\frac{S}{N}\right)_D = \left(\frac{Z}{B_T / W}\right)^{B_T/W}$$

where $Z = \dfrac{P_T}{\eta W}$

and Noise power N = ηB_T



Chanel bandwidth = B_T Message bandwidth = W

Fig. 7

(ii) An ideal system has $B_T/W=4$ and $(S/N)_D$ = 40 dB. What is the new value of (S/N)D,. if B_T tripled while other parameters are fixed?

10

(c) A source is transmitting SIX messages with probabilities 0.30, 0.25,0.15,0,12,0,10 and 0.8 respectively.

(i) Find the binary Huffman code..

(ii) Determine its average word length, efficiency and redundancy.

10

(d) A signal band limited within 3.6 kHz is to be transmitted via binary PCM on a channel whose maximum pulse rate is 40,000 pulses. sec. Design the PCM system and draw a block diagram showing all parameters.

10

9. (a) The open loop transfer junction of a unity feedback control system is given by G(S)=K/S(1+0.1S)(1+S)

(i) Determine the value of K so that the resonance peak M_I of the system is equal to 1.4.

(ii) Determine the value of K so that the Gain margin of the system is 20 dB.

(iii) Determine the value of K so that the phase margin of the system is 60 degrees.

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(b) A unity feedback system is characterized by the transfer function

$$G(S)=\frac{K}{S(S+3)(S+9)}$$

Design a suitable compensator to meet the following specifications:

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(i) Settling time for ±2% tolerance, band = 4 sec

(ii) Steady state error for ramp input ≤ 10%

(c) Explain processing of video output of camera tube in TV receivers (Black and White).

10

(d) Explain PAL system colour television. Draw and explain block diagrams of PAL encoder and decoder.

10

10. Write short notes on any four of the following:

40

(a) Frequency shift keying system,

(b) Delta modulation.

(c) Colour Television.

(d) MTI Radar.

(e) Digital Microwave Communication. Systems,

(f) Rad Navigational Aids,

(g) Digital Control System with at least one application.