ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

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

Candidates should attempt question No. 1 which is compulsory

and any FOUR of the remaining questions.

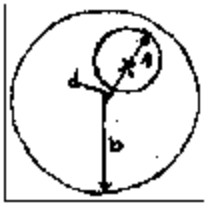
The number of marks carried by each question is indicated at the end of the question.

Answers must be written in English.

Assume suitable data, if necessary. but indicate them clearly.

1. (a) An eccentric hole of radius a is bored parallel to the axis of a right circular cylinder of radius b(b>a) as shown in the figure below. The two axes arc at a distance d apart. A current of *I* amperes flows in the cylinder. What is the magnetic field at the Centre of the hole?

8



(b) Calculate the steady state current in the 2Ω-resistor shown in the figure below. The internal resistance of the battery is negligible and the value of capacitor C is 0.2 μF.

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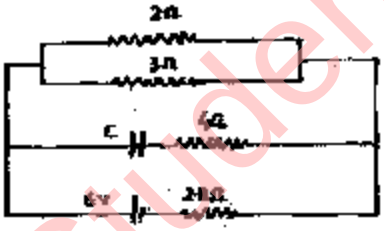

(c) A small sphere of polarizability α and radius a is placed at a distance (r>>a) from a conducting sphere of radius b, which is maintained at a potential V. Find an expression for the force on the dielectric sphere.

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(d) An infinite number of charges each equal to q are placed along the x-axis at x=1, x=2, x=4, x=8, .. and so on. Find the potential and electric field at the point x=0 due to this set of charges.

8

(e) An a-c supply of 230 V is applied to a half-wave rectifier circuit through a transformer having primary to secondary turns ration 10:1. Find

(i) the d-c output voltage and

(ii) the peak inverse voltage. Assume the diode to be ideal.

(f) The, radial component of the radiated power density of an infinitesimal linear dipole of length $l(<<\lambda)$ is given by

$$W_r = A_0 \sin^2 \theta_0 / r^2 \text{ watts/m}^2$$

where A_0 is the peak value of the power density: r and θ are the usual spherical coordinates. Determine the directivity of the antenna

8

(g) An electron moves in a magnetic field. Apply the quantum condition to the circular path and find the radii and energy levels.

8

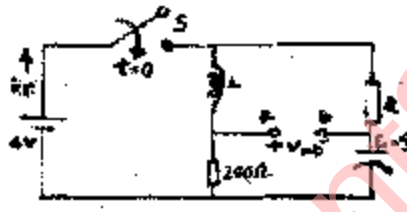
(h) A lossless transmission line with air dielectric is 12m long. What is the linr length in wavelengths and what is the value of β(phase constant) at 15MHz?

8

2. (a) State the relative merits of bipolar and field effect transistors. A field effect transistor is used as a simple common source amplifier. The gain of the amplifier is found to be 60 and 45 with load resistances of 20kΩ and 60kΩ respectively. Determine the drain resistance and trans-conductance of the transistor.

17

(b) In the Circuit shown in the figure below, the capacitor and inductor do not have initial stored energy. On closing the switch at t = 0, it is found that $i(0') = 15$ mA and that $V_{ab}(t) = 0$ for all $t \geq 0$. Evaluate R and L.



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5. (a) A line of characteristic impedance 600 / O Ω is terminated in a load Z_L. The VSWR measured on the line is 1.5 and the first maximum occurs at a distance of 20 cms from the load. The line is open wire and is supplied from a generator at 300 MHz. Find the value of the load impedance .

17

(b) A small loop antenna is operated as a 'mobile' antenna by a horn at a frequency f= 7.2 MHz. The loop is 45 cm in diameter and is constructed from copper tubing of 0.5 cm radius. Determine the theoretical efficiency of the antenna. For copper, conductivity per unit length σ Cu $5.8\times10^7 \Omega^{-1}m^{-1}$ and skin depth $\delta cu = 0.066/\sqrt{f}$.

17

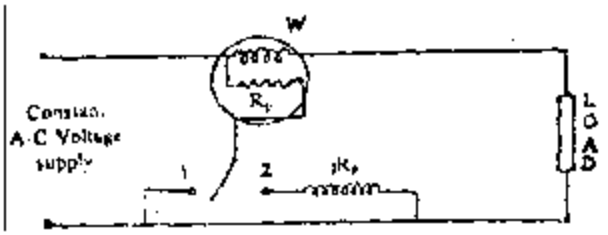
6. (a) A dielectric cube of side $\vec{L}$ has a radial polarization given by $\vec{P} = A\vec{r}$, where A is a constant and $\vec{r} = \hat{i}x + \hat{j}y + \hat{k}z$ The origin of coordinates is at the centre of the cube. Find all the bound charge densities, and show explicitly that the total bound charge vanishes.

17

(b) The resistance of the pressure coil branch of the wattmeter II in the circuit of the figure below is R_p. In position 2 of the switch, an inductive reactance of R_p ohms is connected in series with the pressure coil branch. If the readings of the wattmeter in switch positions 1 and 2 arc

W_1 and W_2 respectively, determine the reactive power taken by the load in terms of W_1 and W_2. Neglect current coil impedance and pressure coil reactance.

17



7. (a) A television transmitting antenna mounted at a height of 120m, radiates 15 kW of power equally in all directions in azimuth at a frequency of 30 MHz. Calculate

(i) Maximum line-of-sight range

(ii) the field strength at a receiving antenna mounted at a height of 16m at a distance of 12km, and

(ii) the distance at which the field strength reduces to 1m V/m.

17

(b) A 1μF-capacitor contains TiO_2 as a dielectric of relative permittivity $\varepsilon_1 = 100$. For an applied d-c voltage of 100 V. Find

(i) energy stored in the capacitor and

(ii) the energy dissipated in polarizing TiO_2.

17

Some useful constants:

Velocity of light, $c = 3 \times 10^8$ m/s

Electronic charge $c = 1.6 \times 10^{19}$ coulombs

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.

The number of marks carried by each question is indicated at the end of the question.

Answers must be written in English. Assume any data if required.

(Question No. 1 is compulsory)

1. (a) Give the circuit of a two level clipper with clipping levels at –3V and 5V. Draw the output waveform when the input is sinusoidal of 5V rms value. Assume the devices to be ideal.

6

(b) The leakage currents of a transistor, with usual notations, are $I_{CEO} = 410\ \mu A$ and $I_{CBO} = 5\mu A$, the base current I_B being 30 μA. Calculate the collector current.

6

(c) A varactor diode has a depletion capacitance C given by $C=10\ (1-0.7V)^{-½}$ pF when V is the bias voltage on the diode (in volts). The diode is placed in parallel with a 0.75 μH inductor which forms a part of the frequency modulator. Find die required bias voltage so that the inductor-diode combination resonates at 100 MHz.

6

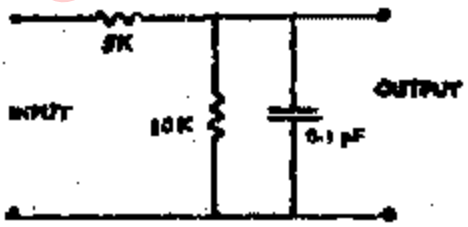
(d) Using two-input NAND gates only, realise the binary logic function $\overline{A} + \overline{B}C$.

6

(e) Draw a fully labelled block diagram of a super-heterodyne receiver for broadcast frequencies. How is the band changed?

6

(f) Draw the asymptotic Bode plod (amplitude ratio only) for the system shown below. Use only plain paper and mark the important values on the plot.



(g) A modulating signal x(t) with its Fourier transform x(f) modulates a sinusoidal carrier of frequency f_C. Write (do NOT derive) the expressions for full AM. DSB-SC and SSB signals and their spectra

6

(h) A 30m diameter earth station antenna of circular aperture is used to receive satellite signals in the 4 GHz band. The system noise figure is 1 dB. Calculate the G/T of the earth station. Express the answer in dBK^{-1}.

6

(i) Describe a multihole directional coupler of waveguide type. Explain the principle. Give the advantages of a multihole directional coupler over a two-hole directional coupler.

6

(j) Treating the signal $10 \sin 2\pi\ 100\ t \cos^2 2\pi\ 300\ t$ volt (with t in sec) to be a. low pass signal, Calculate the Nyquist sampling rate for this signal.

6

SECTION A

(Attempt any two questions)

2. (a) Analyse the effect of the emitter by pass capacitor on the low frequency response of an R-C coupled amplifier State the assumptions you make. Use hybrid parameters. Also give an asymptotic Bode plot of the magnitude of response giving important values when the emitter resistor is 1K. emitter by pass capacitor is 200 μF collector load resistor is 2K and the transistor parameters are $h_{ie} = 1.1K$ and $h_{fe} = 50$. Neglect the effect of other parameters.

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(b) Give an expression for A-law compression as used in commercial PCM telephone systems. What is the typical value of the parameter A? Draw compression characteristic and typical curves for signal-to-quantisation noise ratio vs the input signal power for systems with and without companding. Discuss the advantages of companding.

15

3. (a) Draw the circuit of a Wien Bridge oscillator using a single operational amplifier. Derive the conditions for oscillations. State how:

(i) a Continuous variation of frequency is achieved?

(ii) a change in frequency range is achieved?

and (iii) the amplitude of oscillations is stabilised?

20

(b) Design a binary half adder using only basic gates. Make a full adder using two half adders and any other basic gates. Write down Boolean functions for the half adder and express the Boolean function for mc full adder in terms of those of the half adder and any other basic logic operations.

15

4. (a) Starting with a carrier signal $A \cos\omega_c t$ and a modulating signal $A \sin \omega_m t$ derive an expression for the frequency modulated signal showing all steps death. Derive an expression for the spectrum of tic signal. Plot both the amplitude and the phase spectra of the FM signal.

20

(b) (i) What is a geostationary satellite ? Give an idea about its orbit. What are the considerations in the choice of frequencies for such satellites?

7

(ii) What is QPSK ? How is QPSK modified for use with satellites? What are the advantages of QPSK ?

8

5. (a) Describe the structure and operation of an Impatt diode. Derive expressions for the operating frequency and output efficiency.

20

(b) Describe a colour television transmission system indicating clearly how colours are transmitted. How arc these signals derived front the camera outputs?

15

SECTION B

(Attempt any two questions)

6. (a) Consider a three-port lossless 3 dB power divider with ports numbered as 1, 2 and 3. The input port (numbered 1) is matched. The ports 2 and 3 are output ports. Write down the S-parameter matrix for the divider and evaluate the voltage reflection coefficients at all the ports.

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(b) Design an operational amplifier (single stage) to give a 21 dB voltage gain without phase reversal.

15

7. (a) A certain eight bit uniform quantisation PCM system can accommodate a signal ranging from –1V to +1V. The rms value of the signal is 0.5 V. Evaluate the signal-to-quantisation noise ratio and express it in decibels.

20

(b) A message source generates eight message symbols m_1, m_2, ... m_8 with probabilities 0.25, 0.03, 0.19, 0.16, 0.11, 0.14, 0.08 and 0.04 respectively. Give the Huffman codes for these Symbols. Calculate the entropy of the source and the average number of bits per symbol.

15

8. (a) In the measurement of received field strength and power density a 23 dB gain antenna is connected to a 50 ohm input impedance voltmeter through a 50 ohm. 1 dB loss coaxial cable. The frequency is $3GH_2$ and the metre reading is 200μV. Calculate the field and power density at antenna.

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(b) (i) Synthesize an SR clocked flip flop using basic gates. Give its truth table.

(ii) Convert the above into a JK flip flop, give its truth table and discuss race around condition.

(iii) Convert a JK flip flop into a JK master slave flip flop.

(iv) Convert a JK flip flop into a D flip flop and write its truth table.

15

9. (a) Derive an expression for the blind speeds of an MTI radar. How is the blind speed problem solved ?

10

(b) List the advantages and disadvantages of hydraulic controllers.

10

(c) Draw the root locus diagram for die following control system and calculate the breaking and breakaway points.

15