ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time allowed: 3 Hours *Maximum Marks : 200*

Candidates should attempt question ONE 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, and indicate the same clearly. Some useful constants are given below.

Parts of the same question must be answered together and must not be interposed between answers to other questions.

Some useful data:

Electron change: 1.6×10^{-19} Coulomb

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

Free space permittivity: 8.85 pF/m

Velocity of light in free space: 3×10^{8} m/s

Boltzmann constant: 1.38×10^{-23} J/K

1. (a) A voltage source with waveform as shown in Fig. 1 (a) is connected across a 30 μF capacitor at time t = 0. Find the values of the current in the capacitor at t = 0.5 ms and t = 2.5 ms. Also calculate the total energy delivered by the source till t = 7.0 ms. The capacitor has no charge prior to t = 0.

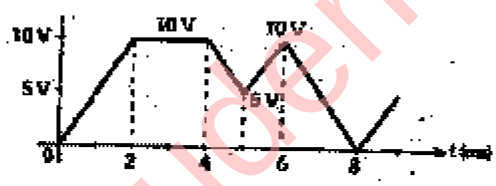


Fig. 1(a)

(b) Find the electric field vector E for an anisotropic dielectric material when the displacement Vector $D = D_x i_x + D_y i_y + D_z j_z$ $5.0\,(i_x + i_y - 2i_z)$ ρC/m^2 and E is related to D as

$$\begin{bmatrix} D_x \\ D_y \\ D_z \end{bmatrix} = \varepsilon_0 \begin{bmatrix} 4 & 2 & 2 \\ 2 & 4 & 2 \\ 2 & 2 & 4 \end{bmatrix} \begin{bmatrix} E_x \\ E_y \\ E_z \end{bmatrix}$$

following usual notations.

(c) Calculate the frequency at which the circuit of Fig. 1 (c) will be in resonance. Will this frequency change if the positions of the inductor and capacitor are interchanged?

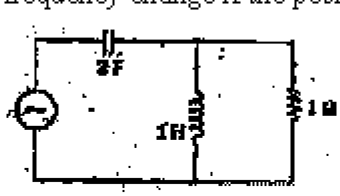


Fig. 1(c)

(d) Find the current I in the circuit of Fig. 1 (d) using superposition theorem.

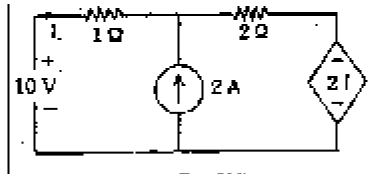


Fig. 1(d)

(e) Given an electric field 30 sin (10^{10} t + 15°) V/m, find the conduction and displacement current densities in a material with $\sigma = 4.0$ S/m, $\varepsilon = \varepsilon_0$ and $\mu = \mu_0$. Also determine the frequency (in Hz) at which the two densities will become equal in magnitude.

(f) Determine the group velocity of a 12 GHz signal propagating in the TM_{11} mode in a rectangular waveguide of 4.0 cm × 2.0 cm cross section.

(g) A galvanometer recorder with a 100 Ω coil resistance is connected to a transducer. The transducer acts as a voltage source in series with a 250 Ω resistance. The recorder response to a step input to the transducer is that of a second order system with a damping factor of 0.3. Find the resistance that should be put in parallel with the transducer so that the damping factor increases to 0.7.

(h) The excitation to a two-terminal network is 4 + 5 sin ωt + 3 cos 2 ωt volt while the response current equals 0.3 cos ωt + 0.1 cos (2 ωt − 45^0)A. Find the average power supplied by the excitation source.

2. (a) Sketch the output waveform for the circuit of Fig. 2 (a). Also draw the variation of energy stored in the capacitor as a function of time. Mark appropriate values. Take the diode to be ideal.

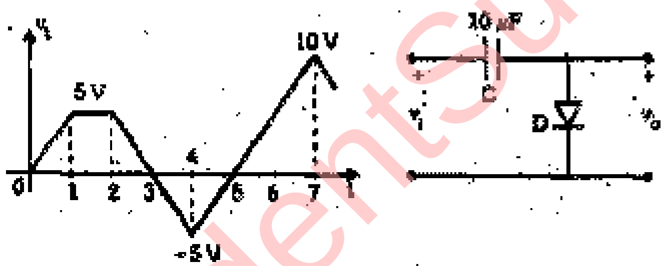


Fig. 2(a)

(b) A series type ohmmeter uses a 100 Ω basic movement with full-scale deflection for 100 μA. The battery voltage in the ohmmeter circuit is 9V. The desired scale marking for half scale deflection is 50 kΩ. Find the values of the required resistor R_1 in shunt with the meter and the resistor R_2 in series with the battery. Also find the maximum value of R_1 that will compensate for a 10% drop in the battery voltage and the percentage error al half scale mark when R_1 is so adjusted for the 10% drop in battery voltage.

3. (a) Determine the complex power S in the circuit of Fig 3 (a). Also find the resonance frequency of the circuit.

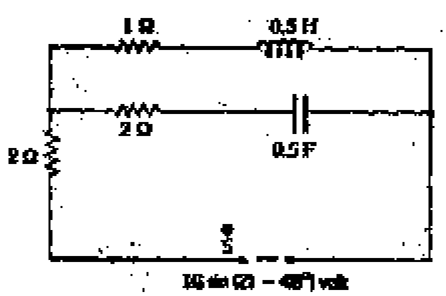


Fig. 3(a)

(b) Determine the Thevenin's equivalent circuit in the s-domain for the circuit of Fig. 3 (b) to the left of the points A and B and then determine the current in R_3 in time domain. What are the values of this current for t = 0 and t = ∞ ? The switch is closed at t = 0.

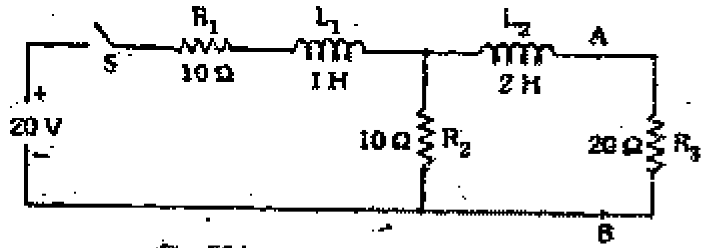


Fig. 3(b)

4. (a) Consider an interface in the y–z plan perpendicular to x-axis). The region x<0 is medium 1 with relative permeability $\mu_{r1} = 4.5$ and the magnetic field H_1 equals

$$H_1 = 4.0i_x + 3.0iy - 6.0\ iz\ A/m.$$

The region x > 0 is medium 2 with relative permeability μ_{r2} = 6.0. Find the magnetic field intensity H_2 in medium 2 and the angle made with the normal.

(b) Find the cutoff frequency m the dominant mode of a rectangular waveguide of 2.29 cm × 1.12 cm cross section. Also find the phase velocity guide wavelength and the impedance at 7.0 GHz. What as the average power flow when the rms electric field is 800 V/m?

5. (a) A 150m long 600Ω transmission line is terminated into a 424.3 < 45° Ω load. It operates at 400 kHz and its attenuation and phase shift constants are 2.4 × 10 Np/m and 0.0212 rad/m. The received voltage is 50 < 0° volt. Find the reflection coefficient, position and value of voltage maximum on the line. Also find the input impedance.

(b) Synthesize an R-C ladder network with the transfer impedance $Z_{12} = \frac{1}{s^2 + 4s + 3}$

6. (a) A strain gauge of 1000 nominal resistance gauge factor 2.5 and a temperature coefficient 2 × 10^{-5}/°C as connected an one arm of the bridge shown an Fig 6(a). The resistance of the detector is 100 Ω and the sensitivity is 15 mm/μA. Find the deflection when the gauge as strained 0.24%. Also find the effective strain indicated when the temperature increases by 8°C considering the gauge resistance to be the only factor responsible Suggest a solution to overcome this effect.

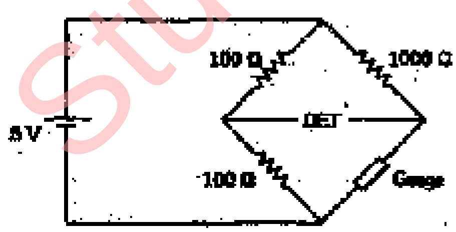


Fig. 6(a)

(b) Determine the radiation pattern of two identical monopole antennas separated by 5λ/8 and fed with equal currents but differing in phase by 45°. Sketch the pattern Mark important directions and pattern values. Indicate the angles for nulls.

7. (a) Determine the Thevenin's equivalent for the circuit of Fig. 7 (a) to the left of AB and specify Z_L for maximum power into Z_L for maximum power into Z_L.

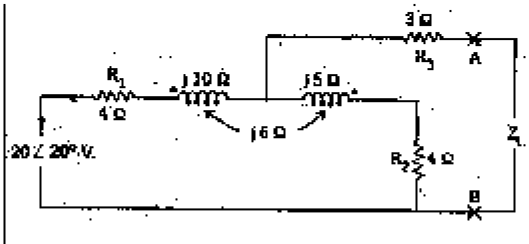


Fig. 7(a)

(b) A potential function 3x + 5y volt exists in free space. Find the stored energy in a 2 m^3 volume (spherical) centred at the origin.

I.E.S.-(Conv.)-1996

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed : Three Hours *Maximum Marks : 200*

Candidates should attempt question ONE which is compulsory and any 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.

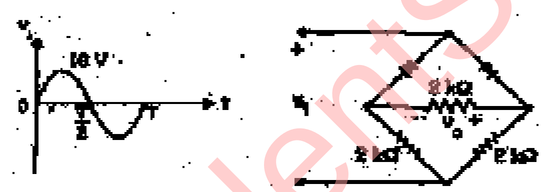
Answers must be written in English.

Assume any data if required.

Parts of the same question must be answered together and must not be interposed between answers to other questions

1. (a) Determine v_0 for the following network for the indicated input.

(b) Determine the output waveform for the network shown and calculate the output dc level and the required NV of each diode.



(c) How can JK-flip flop be used as (i) D-flip flop, and (ii) T-flip flop? Justify your answer with the help of truth tables.

(d) Convert the following Octal numbers into equivalent Hexadecimal numbers.

(i) 134

(ii) 67

(iii) 1527

(iv) 4753

(e) Determine the value of k so that all the roots of the following polynomial are to the left of the line $\sigma = -0.5$.

$$F(s) = s^3 + 6s^2 + 11s + k$$

(f) Sketch the constant-M loci in the G-plane for a unity feedback system and derive the equations for the loci.

(g) A 30 m 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}.

(h) According to CCIR-standards for TV channels, what are the values of picture. IF and sound IF? Specify the frequency range for channel 4 and channel 10. For each of these channels, indicate the picture carrier frequency and the sound carrier frequency.

(i) A rectangular waveguide is 1 cm × 2 cm in dimensions. Calculate cut-off wavelength for TE_{10} and TM_{11} modes.

(j) An X-bank radar unit has a CW radiation power of 4 kW: Determine:

(i) The power density in milliwatts per square centimeter at a distance of 2 m.

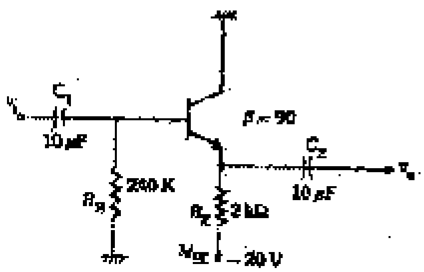
(ii) The electric field intensity in volts per meter at the same distance.

(iii) The magnetic field intensity in amperes per meter at the same distance.

SECTION A

(Attempt any two questions)

2. (a) Determine V_{CE} and I_E for the following network.



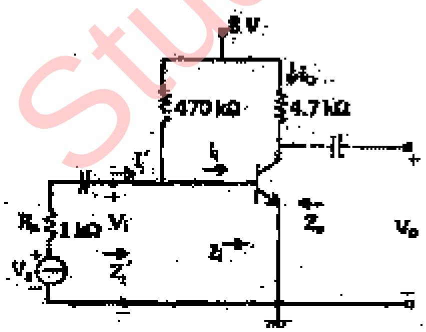
(b) For the network shown, determine the following parameters using the complete hybrid equivalent model and compare with the results obtained using the approximate model in which the effects of h_{re} and h_{oe} axe neglected.

(i) Z_i and Z'_1

(ii) A_v

(iii) A_i to I_o / I_i and $A'_i = I_o / I'_i$

(iv) Z_0



The h-parameters of the transistor are:

hfe = 110, h_{ie} = 1.6 kΩ

$h_{re} = 2 \times 10^{-4}$, hoe = 2 μΩ

3. (a) Draw OPAMP circuits for

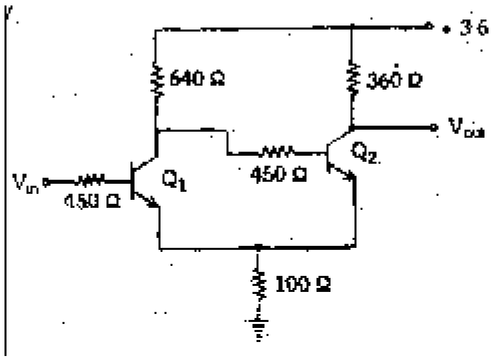
(i) Display Driver (ii) Instrumentation Amplifier

Briefly describe the operation of these circuits.

(b) Draw the block diagrams of the 555 timer Show how 555 can be used as an astable multivibrator. Describe the circuit operation with the help of waveforms and derive an expression for the frequency of oscillations.

4. (a) Design a circuit using NAND gates only that has one control line and three data lines. When the control line is high, the circuits is to detect who one of the data lines has a 1 on it then the control line is low, the circuit will output a 0, regardless of what is on the data lines.

(b) For the transistor circuits shown below determine the voltage transfer characteristic, assuming V_{CE} sat, = 0.2 V and BE, on = 0.7V



5. (a) Design a logic Circuit Using half adders, full adders and basic gates which can add two 4-bit CD numbers and gives BCD output.

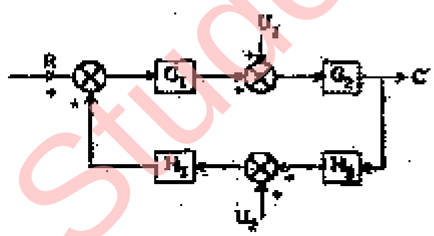
(b) Draw the truth table for testing whether a BCD number than or equal to 5 and mechanize it by using

(i) An 8-input multiplexer (ii) A 4-input multiplexer and residual gates (iii) A 2-input multiplexer and residual gates

SECTION B

(Attempt any Two questions)

6. (a) Find the output in the following block diagram having three input : R, U_1 and U_2.



(b) Enumerate the advantages of state space modelling. Derive relations to find the poles and zeros of a system from the state space model. Determine the poles and zeros of the following system:

$$X = \begin{bmatrix} 0 & 1 \\ -20 & -9 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$C = \begin{bmatrix} -17 & -5 \end{bmatrix} X + [1] r$$

7. (a) What are the advantages that the super-heterodyne receiver has over the TRF receiver? Are there any disadvantages? How is the constant IF achieved in a super-heterodyne receiver? How does the use of r.f. amplifier improve the S/N ratio of a super-heterodyne receiver?

(b) Draw the block diagram of a basic PLL system and explain its ability to track the frequency changes in the input signal. What are meant by "lock range" and "capture range" ? How can- a PLL be used as an FM demodulator?

8. (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. Calculate the signal to quantisation noise ratio and express it in decibels. Derive the relation used.

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

9. (a) What is a directional coupler? Define directivity and coupling factor. Briefly discuss the two-hole directional coupler and derive its S-matrix.

(b) A 6 GHz e.m. wave propagates in a parallel plane waveguide, the separation between the planes being 3 cms. Determine the cut-off wavelength of the dominant mode, the guide wavelength of the dominant mode, the corresponding group as well as phase velocities, and the characteristic wave impedance.

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