ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed: Three Hours *Maximum Marks :200*

Candidates should attempt any FIVE questions.

Some useful constants are given below:

Electron charge : 1.6×10^{-19} Coulomb

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

Free space permittivity : $1/36 \pi \times 10$ F/m

Velocity of light in free space : 3×10 m/s

Boltzmann constant : 1.38×10^{-23} J/K

Planck's constant : 6.626×10^{-34} J-s

1. (a) Draw the electrical equivalent circuit of a Quartz Crystal explaining the significance of the various components of the circuit.

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(b) Draw neat sketches of Impedance Vs Frequency, Reactance Versus Frequency of the Quartz resonator indicating the critical frequencies and their values.

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(c) A quartz crystal has the following electrical characteristics:

Series resonance – 200 KHz

Impedance at series resonance – 200 ohms

Parallel resonance at 200.25 KH

Impedance at parallel resonance – 40 MΩ

Determine the component values of the equivalent circuit.

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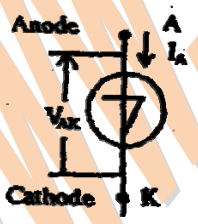
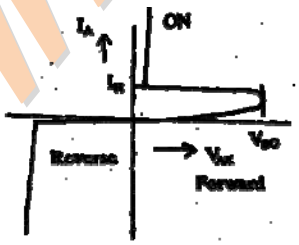
2. (a)



(b)



The electrical symbol representation of a four layer pnpn diode is shown in the above figure (a) and its VI characteristic is shown in the above figure (b).

(a) Explain why the VI characteristic of the pnpn diode be haves as represented in figure (b).

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(b) Can the above device be used as an electronic switch? If so why?

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(c) Use the device to design a simple circuit to generate a continuous sawtooth wave of amplitude 100 volts, and repetitive frequency of 500 Hz. The following data is available regarding the four layer diode:

V_{BO} = 100 V I_A = 20 A I_H = 20 mA

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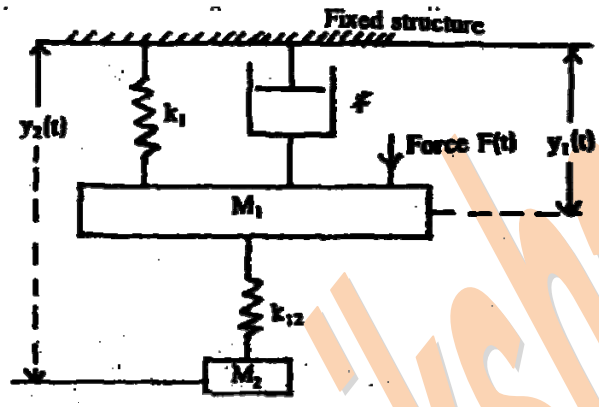
3.



A dynamic vibration absorber is shown in the above figure. The system is seen in many situations involving machines containing several unbalanced components. The parameters M_2 and k_{12} may be chosen such that the main Mass M_1 does not vibrate when F(t) = a sin ω_0 t.

(a) Obtain the differential equation describing the system.

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(b) Draw the analagous electric circuit based on Force current analogy.

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(c) What is the condition for Mass M_1 not vibrating at frequency ω_0.

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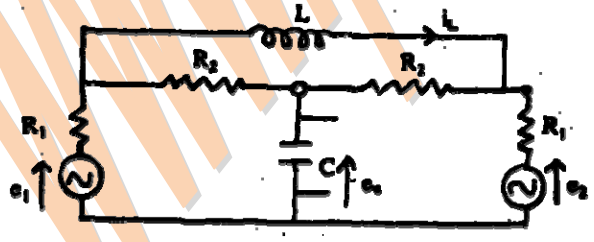
4.



A balanced bridge network is shown in the above figure.

(a) Choose a set of state variables and write the state equations representing the network in the form X = AX + BU.

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(b) Draw the state model flow graph of the above system.

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(c) State the advantages of state space analysis over the conventional differential equation methods of solving system behaviour.

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5. State clearly the Thevenin's and superposition theorems and explain their usefulness in linear network analysis.

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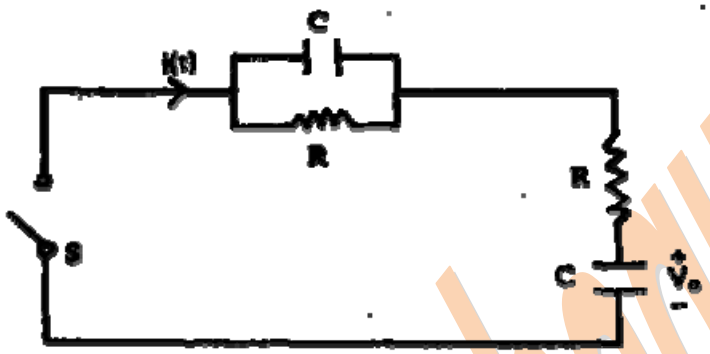
The circuit of the figure below is a well-known network used in control applications.



In the above figure C = 1 μfd R = 1 MΩ and the initial voltage V_0 across the right hand capacitor is 20 volts for t < 0 when the switch was open. At t = 0 the switch is closed. Determine i(t) after switch is closed.

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Plot i(t) versus time on a graph paper indicating salient values.

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6. (a) Why do we prefer hollow wave guides to open wire two conductors,. or coaxial transmission lines for transmission of power?

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(b) What factors does the power carrying capacity of a wave guide depend upon?

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(c) A wave guide has an internal breadth 'a' of 3 cms and carries a dominant mode of a signal of unknown frequency. If the characteristic impedance of the mode is 500 ohms what is frequency of the signal?

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7. (a) The speed of a rotating shaft is to be measured by using a photo electric device and an electronic counter. Sketch a suitable arrangement for making this measurement and comment on the accuracy of this method.

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(b) Explain the working of a Digital Voltmeter using the dual slope technique.

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(c) The DVM using the dual slope technique has a reference voltage of 1000 V and the fixed time is 1000 counts. What is the voltage indicated if the counter reads 762 on the downward slope?

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ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

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

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

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

M = mass of the earth, 5.997 × 1024 kg,

r = radius of the earth, 6,378 km

1. (a) Specify the characteristic features of INSAT-2E.

(b) Draw beam current waveforms of a klystron for at least four values of bunching parameter. Write an expression for the bunching parameter and specify each quantity in the expression.

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(c) Compare O- and M-type tubes. Write your answer in a tabular form.

(d) The frequency response of a transfer function T(jω) is given below. Determine

(i) the transfer function

(ii) the step response assuming no initial energy storage.

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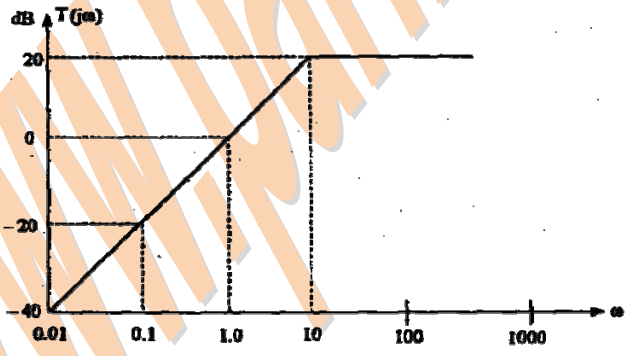

(e) (i) In FM radio broadcasting, the modulation index is 40%. What is the value of frequency deviation?

2

(ii) In an FM modulation system, the modulation index is doubled. By what percentage does the total transmitted power in crease?

2

(iii) For the following microwave coaxial connectors write the full form and the frequency upto which these can be used satisfactorily.

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(a) APC 3.5 (b) BNC

(c) TNC (d) SMC

(f) A parabolic antenna of gain 10,000 is needed at an operating frequency of 6 GHz. Find the beam width in the vertical and horizontal planes of the antenna. Assume 75% antenna efficiency and a circular aperture with m = 1 tapered distribution. Also calculate the power received if the incoming signal has a power density of 1 μ W/m^2. . . .

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(g) Define Gamma. Why is gamma correction done in the camera ? What is the value of gamma for picture tube ? Show that the video bandwidth is approximately 5 MHz.

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(h) For the circuit shown below, calculate the Q point for both transistors. Assume silicon transistors, V_{BE} = 0.7 V.

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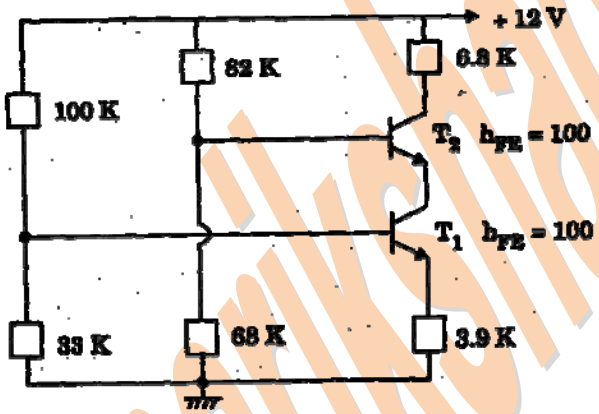

(i) A power supply using half-wave rectifier is to have an output dc voltage of 30 V, with a load resistance of 500 Ω. The ripple factor should not exceed 0.01. Find a suitable value for C. Determine the peak diode current. Assume 50 Hz supply frequency.

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(j) A multimode graded index fibre has an acceptance angle in air of 9^0. Calculate the relative refractive index difference between the core axis and the cladding when the refractive index at the core axis is 1.45.

8

SECTION A

2. (a) A class B transformer coupled amplifier is to supply 4 W to a 10Ω load. The available supply voltage V_{CC} = 30 V. The transformer efficiency is 75%. Specify the output transformer and the output transistors.

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(b) Determine the frequency of oscillation for the following circuit and the value of R_1 needed to maintain oscillations. Name the circuit.

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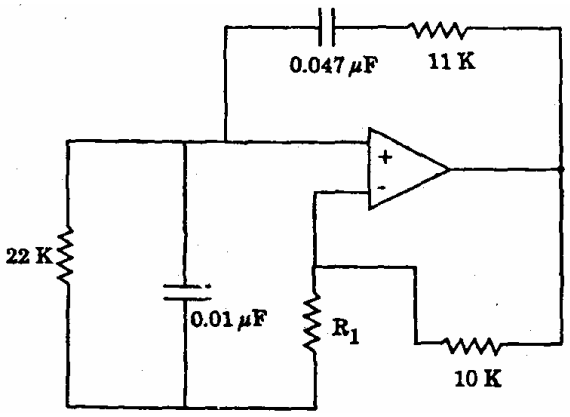

3. (a) Define equalization. Explain with relevant mathematical equations, the principles of operation of a zero forcing transversal equalizer.

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(b) A signal x (t) = cos (3πt) + 0.125 cos (10 πt) is periodically sampled every T_S seconds. Given a sampling signal, S(t) = 4 $\sum_{n=-\infty}^{\infty} I_n \delta(t-0.1n)$ and a sampled signal $x_S(t)$ = x(t) S(t) is obtained, which is $\sum_{n=-\infty}^{\infty} \delta(t-0.1n)$. Determine

(i) the maximum value of the sampling time

(ii) I_0, I_1, I_2, I_{n+4} where I_n is the strength f each impulse.

(iii) the minimum bandwidth for a low pass filter so that the recovered signal will be distortionless.

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4. (a) An information source produces 8 different symbols with probabilities respectively $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{64}, \frac{1}{128}, \frac{1}{256}$. These symbols are encoded as 000, 001, 010, 011, 100, 101, 110 and 111 respectively

(i) What is the amount of information per symbol?

(ii) What are the probabilities of occurring for a 0 and a 1?

(iii) What is the efficiency of the code so obtained?

(iv) Give an efficient code with the help of the method of Shannon.

(v) What is the efficiency of the code so obtained in (iv) above?

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(b) A satellite TV link is designed to provide a video signal-to- noise ratio of 60 dB. The peak deviation is 9 MHz and the highest videobase band frequency is 5 MHz. Calculate the CNR required at the input to the FM detector. Given that the combined noise weighting, emphasis improvement & implementation margin is 12 dB.

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5. (a) (i) Draw the circuit diagram of a two input TTL NAND gate and label component values and write the function table.

3+3

(ii) Draw a typical input-output transfer characteristic of a TTL inverting gate.

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(iii) Define fan out. Which factor is responsible for the limit of fan out in TTL circuits?

4

(iv) "Loading an output with more than its rated fan out has several effects." – Write at least five effects.

6

(b) What is a ROM ? Write the truth table of a 2-to-4 decoder with output polarity control and built with discrete gates and with an 8×4 ROM.

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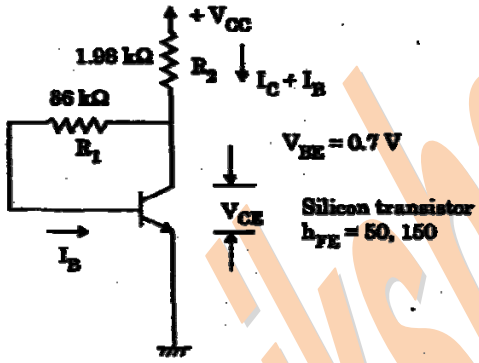
SECTION B

6. (a) Write PASCAL program for the dc analysis of Collector-to-Base bias circuit shown below. The equation for Stability factor S of the circuit is to be included. Run your programme for two values of h_{FE}, 50, 150.



Determine the values theoretically and enter in your results.

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(b) Write an 8085 ALP to add a 16-bit number in locations 5000 H (high byte) and 5001 H (low byte) with another 16-bit number stored in 5002 H (high byte) and 5003 H (low byte). Store the result in BC.

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7. (a) Explain gain margin and phase margin from Nyquist diagram.

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(b) A closed loop transfer function of a unity feedback control system is

$$\frac{C(s)}{R(s)} = \frac{20s^2}{(s+1)(s+3)(s+5)}$$

Determine the response of the system when the excitation applied to the input terminal is $\left[1 + 2t + \frac{3t^2}{2}\right]$.

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(c) For the system shown below, determine the characteristic equation. Hence, find the following when the excitation is a unit step:

(i) Undamped natural frequency

(ii) Damped frequency of oscillation

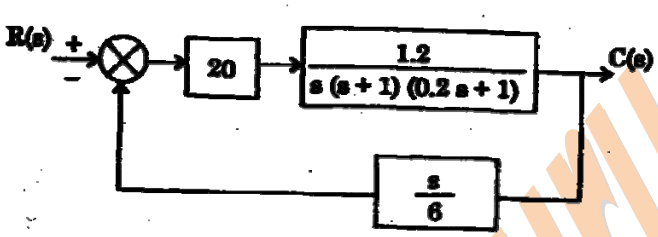
(iii) Damping ratio and damping factor

(iv) Maximum overshoot

(v) Settling time

(vi) Number of cycles completed before the output is settled within 2%, 5% of its final value

(vii) Time interval after which maximum and minimum will occur.



8. (a) (i) Name the frequency bands and the corresponding frequency and channel numbers and corresponding bandwidth allocated to TV, as per CCIRB standards.

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(ii) In the composite video signal, state the duration of the following in microseconds:

Line period, Front porch, line sync pulse, Build up time of line sync pulse, Vertical field period, Field blanking period, line blanking period. Duration of pre-equalising pulse sequence.

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(iii) What is the purpose of CIN diplexer and what does It consist of?

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(b) List out the satellite subsystems, their functions and their main characteristics. Write your answer in a tabular form.

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9. (a) The parameters of a two cavity klystron are as follows:

Beam voltage = 1000 V, Beam current = 30 ma, Frequency = 9 GHz, gap spacing in either cavity = 1 mm, Spacing between centres of the cavities = 4 cm, Effective shunt impedance = 40 kΩ.

Determine

(i) electron velocity

(ii) dc electron transit time

(iii) the input voltage for maximum output voltage

(iv) voltage gain in dB

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(b) A CW radar is designed to cover target velocities of ±600 m/s. The radar operates at a wavelength of 0.1 m. A bank of narrow band filters are used after the detector, each having a bandwidth of 50 Hz. Calculate the number of filters needed.

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(c) What is the part played by Box car generator and AGC portion of a tracking radar receiver?

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