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.

Assume suitable data, if necessary and indicate the same clearly.

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: $1/36\pi \times 10^{9}$ F/m

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

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

Planck's constant: 6.626×10^{-34} J-s

1. (a) Show that a semiconductor has minimum conductivity at a given temperature when

$$n = n_i\sqrt{\mu_h / \mu_e} \quad \& \quad p = n_i\sqrt{\mu_e / \mu_h}$$

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(b) When the current through a Zener diode increases from 20 mA to 30 mA the voltage across it changes from 5.6 V to 5.65 V. What is the voltage across the Zener when the cur rent is 35 mA ?

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(c) A train of rectangular pulses, making excursions from zero to one volt, have a duration of 2 μs and are separated by intervals of 10 μs. Assume that the centre of one pulse is located at t= 0 and obtain the trigonometric, Fourier series for this pulse train.

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(d) A white noise is applied to an RC low pass filter. What is power spectral density of the output noise and what is its average power?

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(e) Find i_1, i_2, and v in the circuit of Fig. 1(e).

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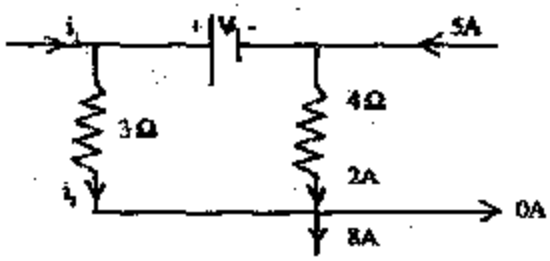

(f) Synthesize the two Foster networks for

$$Z(s) = \frac{s^4 + 10s^2 + 9}{s^3 + 4s}\Omega$$

(g) If the magnetic flux density of a point in a region is 250 sin 120 $\pi t a_z$ mWb/m^2, what is the curl of the electric field intensity?

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(h) With the input of 4 cos 800 πt + cos 2000 πt millivolts to an amplifier, the measured output amplitude is 1 volt at 1 kHz and 1 mV at 600 Hz. If the amplifier input-output characteristics is given by $v_0 = a_1 v_i + a_2 v_i^2$, determine the out- put amplitudes at the other frequencies.

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2. (a) A certain homogenous slab of lossless dielectric material is characterised by an electric susceptibility of 0.12 and carries a uniform flux density within it of 1.6 nC/m^2. Find the electric field intensity, the polarization, the average dipole moment if there are 2×10^{19} & dipoles per cubic meter and the voltage between two equipotential 2.54 cm apart.

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(b) Calculate the inductance of a toroid formed by surfaces $\rho = 3$cm, $\rho = 5$cm, $z = 0$, $z = 1.5$ cm, wrapped with 5000 turns of wire. The core has a magnetic material with $\mu_r = 6$ (Do not use approximation in evaluating the flux).

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3. (a) For the circuit shown in Fig. 3 (a), $\alpha_1 = 0.98$, $\alpha_2 = 0.96$, $V_{CC} = 24$, R_C, $= 120\ \Omega$ and $I_E = -100$ mA. Calculate the current I_{C1}, I_{B1}, I_{E1}, I_{B2}, I_{C2}, and I_C, the voltage V_{CE} and the ratios I_C/I_B and I_C/I_E. Neglect reverse saturation currents.

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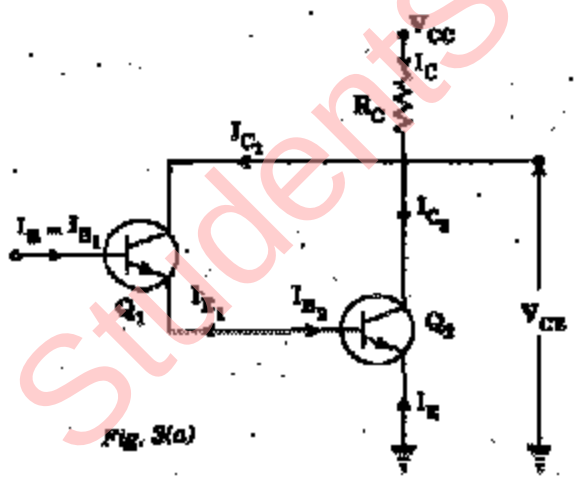

Fig. 3(a)

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(b) A photocathode is illuminated with radiation of wavelength 500 mm. The cathode has a work-function of 1.2 eV. Calculate the anode voltage required to produced zero anode current. When the anode voltage is +90V, find the velocity of the electrons at the anode if the cathode is illuminated with radiation of wavelength 250 nm.

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4. (a) If $F(s) = \frac{(3s+4)(s+5)}{(s+1)^2(s+6)}$, find f(0), f'(0), f''(0).

(Note: F (s) is the Laplace transform of f(t)).

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(b) Find the system transfer function and unit impulse response of the second order difference equation given below assuming zero initial conditions:

$$y(nT) = x(nT) - 0.25y(nT-2T)$$

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5. (a) The switch closes in the circuit of Fig. 5 (a) at t = 0. Assuming a relaxed circuit at the time of switching, determine the current i for t > 0. Also find the voltage V_L across the inductances for t > 0.

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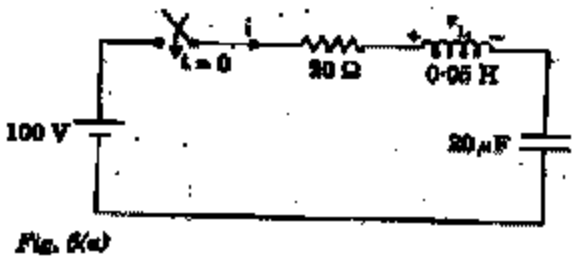

Fig. 5(a)

(b) Find the Z-parameters of the two port in Fig. 5 (b).

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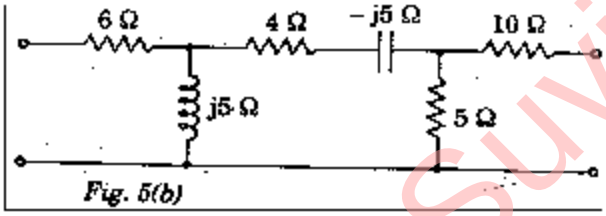

Fig. 5(b)

6. (a) Given that V = XY is a solution of Laplace's equation, where X is a function of x alone and Y is a function of y alone, determine which of the following functions are also solutions:

(i) $2XY + y^2 - x^2$ (ii) X^2Y^2 (iii) $X + 3Y$

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(b) An air-filled rectangular wave guide of cross-section 5 cm × 2 cm is operating in the TE_{10} mode at a frequency of 4 GHz. Determine:

(i) the group velocity (ii) the guide wavelength (iii) the attenuation to be expected at a frequency which is 0.95 time the cut-off frequency (assuming the guide walls to be made of perfect conductors).

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7. (a) A voltmeter with an internal resistance of 4750 Ω is used to measure the voltage across a resistance of 600Ω connected in series with a DC series of internal resistance 400Ω. What is the error in measurement?

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(b) The periodic voltage of the form shown in the Fig. 7 (b) is applied to (i) a true r.m.s. meter (ii) an "average-measuring" – "r.m.s. indicating" meter (iii) a "peak-measuring" – "r.m.s. indicating" meter. Determine the reading of each instrument.

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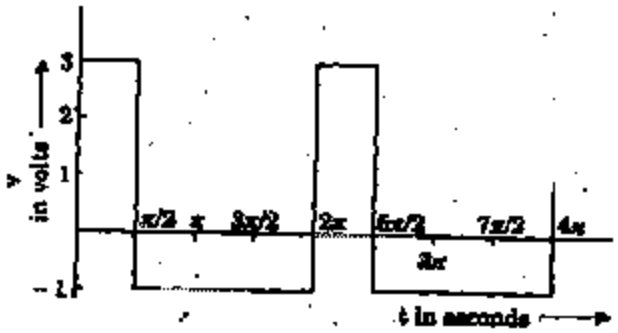

Fig. 7(b)

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Candidates should attempt Question 1 which is compulsory and four more questions taking Two each from Section A and Section B.

1. (a) A silicon transistor with $V_{BE\,(sat)} = 0.8$ V, $B = h_{FE} = 100$, $V_{CE\,(sat)} = 0.2$ V is used in the circuit shown. Find the minimum value of R_C for which the transistor remains in saturation.

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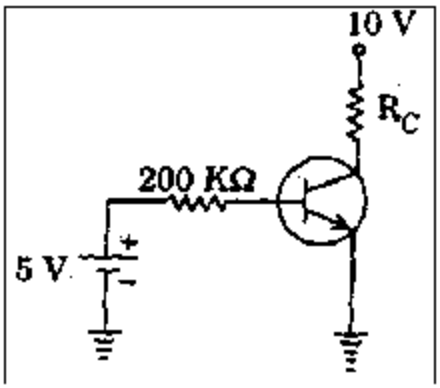

(b) A silicon single phase full wave bridge rectifier circuit is shown. Explain what happens if the transformer and the load positions are interchanged.

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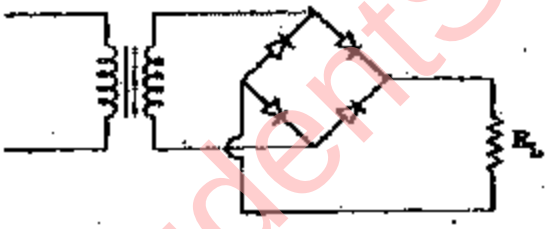

(c) What is the advantage of Hamming code? Using 7-bit even parity Hamming code, detect errors if any and correct them in the following bytes:

(i) 0101110 (ii) 1010011

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(d) The truth-table for A-B flip-flop is shown. Draw schematic diagram using J-K flip-flop and any additional logic to implement it.

Show the design steps.

A_n	B_n	Q_{n+1}
0	0	Q_n
1	0	Q_n
0	1	1
1	1	0

(e) For open loop transfer function $A(s)=\frac{A}{s(s+2)^2}$ a negative feedback is applied with a feedback factor β. Find the value of A, (i) corresponding to the breakaway point, (ii) for which the system becomes unstable.

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(f) According to CCIR system B standard for TV given the values of the following parameters:

(i) Channel B.W (ii) Number of lines per picture (iii) Aspect ratio (iv) Line period (v) Field period

(g) Calculate the efficiency of a system which selects one message out of 13 equi-probable messages in (i) binary systems and (ii) decimal systems.

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(h) The terminating load of an HF transmission line with Z_0 = 50 ohms working at 300 MHz is (50 +j50) ohms. Calculate the VSWR and the position of voltage minima nearest to the load.

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(i) An optical fibre has a core refractive index of 1.5 and a cladding refractive index of 1.47. Find

(i) Critical angle at core-cladding interface

(ii) Numerical aperture NA of the fibre

(iii) The acceptance angle in air for the fibre

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(j) Define the following terms used in microprocessors:

(i) Instruction Cycle (ii) Machine Cycle (iii) T-State

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SECTION A

Attempt any two questions

2. (a) Calculate R_i, $A_v=\frac{V_0}{V_s}$, $A_I=\frac{-I_0}{I_i}$ for the circuit shown.

Use h_{ie} = 1000 ohms; h_{fe} = 99; $h_{re} \cong h_{oe} \cong 0$.

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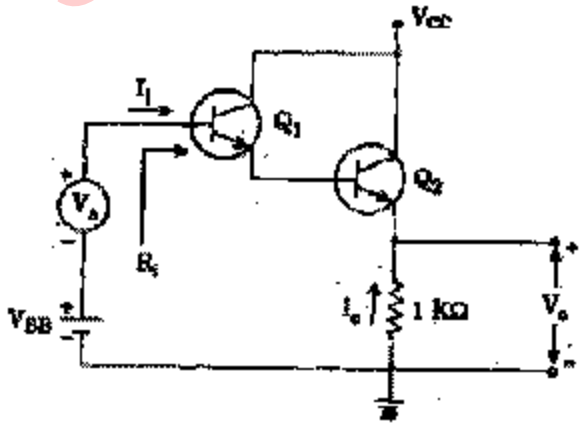

(b) An amplifier with open loop voltage gain $A_{vf} = 1000 + 100$ is available. It is required to have an amplifier whose gain varies by no more than ± 0.2 %. Find (i) reverse transmission factor β of the feedback network (ii) gain with feedback. Derive the formula you used.

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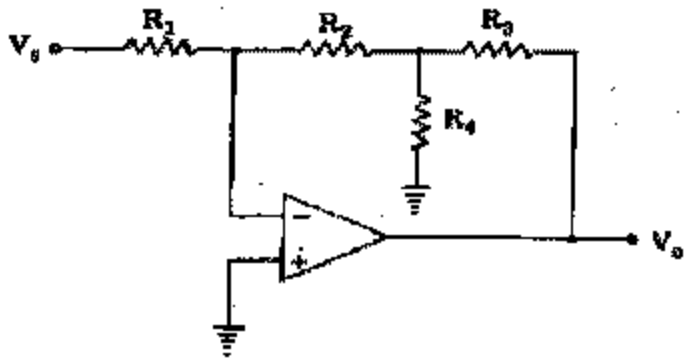
3. (a) Develop the voltage transfer function $\frac{V_0}{V_s}$ for the amplifier shown.



(b) Explain the current foldback characteristics of voltage regulators. Draw a circuit to realise the current foldback characteristic in a low voltage regulator using 723 IC chip. Explain the working of the circuit.

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4. (a) Minimise the following logic expression using Karnaugh map and realize it using NAND gates.

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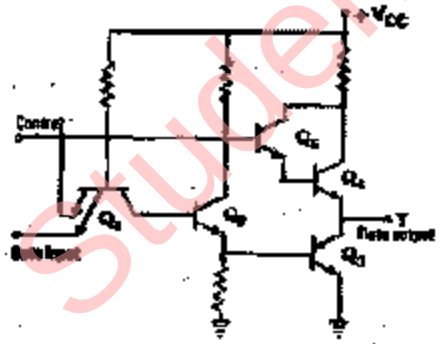
f(A, B, C, D,E, F) = Σm(6, 9, 13, 18, 19, 25, 27, 29, 41, 45, 57, 61)

(b) A Tri-state logic gate circuit is shown. Explain the working of the circuit when (i) control is LOW and when (ii) control is HIGH. What are the applications of the circuit?



(c) What is wired logic ? What are the applications of open collector TTL gates?

For the circuit shown find expression for Y. What logical function is performed by the circuit?

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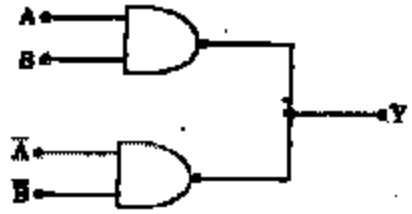

5. (a) The open loop transfer function of a unity feedback control system is

$$G(s) = \frac{K(s+5)(s+40)}{s^3(s+200)(s+1000)}$$

Construct the root-locus diagram of the system and comment on the stability of the system.

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(b) For a proportional plus derivative (PD) controller plot the controller output and error vs time. Specify the equation for the controller.

Calculate the controller output for the above controller at (i) t = 0 and (ii) t = 2 sec, if the error begins to change from zero at the rate of 1.2 % /s. The controller has a set point of 50%; K_p = 4% /% and K_D = 0.4 % s /%.

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SECTION B

Attempt any two questions:

6. (a) A signal is band limited to 3.6 KHz and three other signals are band limited to 1.2 KHz each. These signals are to be transmitted by means of Time-Division-Multiplexing.

(i) If each signal is sampled at its Nyquist rate set up a scheme to achieve this multiplexing.

(ii) Specify the speed of commutator in samples per second.

(iii) If the commutator output is quantized in 1024 levels with the result binary coded what is the output bit rate?

(iv) Determine the minimum transmission bandwidth of the channel.

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(b) Draw refractive index profile for

(i) step-index and

(ii) graded-index fibres.

Determine the cutoff wavelength for a step index fibre to exhibit single mode operation when the core refractive index and radius are 1.46 and 45 μm respectively with the relative index difference being 0.25%.

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7. (a) A two stage amplifier has the following parameters:

	First stage	*Second stage*
Voltage gain	12	20
Input resistance	500 ohms	80 K ohms
Equivalent Noise Resistance	1500 ohms	10 K ohms
Output Resistance	25 K ohms	1 M ohms

Calculate:

(i) the equivalent noise resistance of the two stage amplifier;

(ii) the-noise figure of the amplifier if it is driven by a generator with, output impedance 50 ohms.

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(b) Explain Neutralization and show how it can be realized.

The circuit shown has an internal and stray wiring capacitance of 20 pF. If L_1 = 80 mH and L_2 = 120 mH, determine to what value the neutralizing capacitance C_N should be set so as to neutralize $C_{internal}$.

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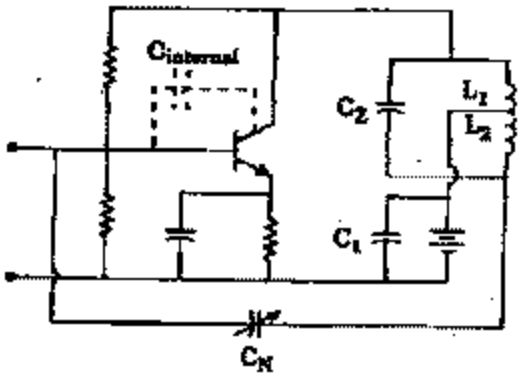

8. (a) For (6,3) systematic linear block code, the three parity-check bits C_4, C_5 and C_6 are formed from the following equation

$C_4 = d_1 \oplus d_3$; $C_5 = d_1 \oplus d_2 \oplus d_3$; $C_6 = d_1 \oplus d_2$

(i) Write the generator matrix G.

(ii) Construct all possible code words.

(iii) If the received work is 010111 find the location of the error and the transmitted data bits.

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(b) Calculate the ratio of circular waveguide cross-sectional area 10 the rectangular waveguide cross-sectional area assuming that both these waveguides have equal cutoff frequency for the dominant mode, if $P_{11} = 1.841$.

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9. (a) Explain with the help of D flip-flops, SR flip-flops and logic gates the working of all Interrupts (except INTR) available in the Microprocessor 8085 CPU.

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(b) Derive the major differences between the HDTV System and the NTSC System.

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