C-31042(T)

Ph. D. Entrance Test, March 2010

ELECTRONICS AND COMMUNICATION

(UIET)

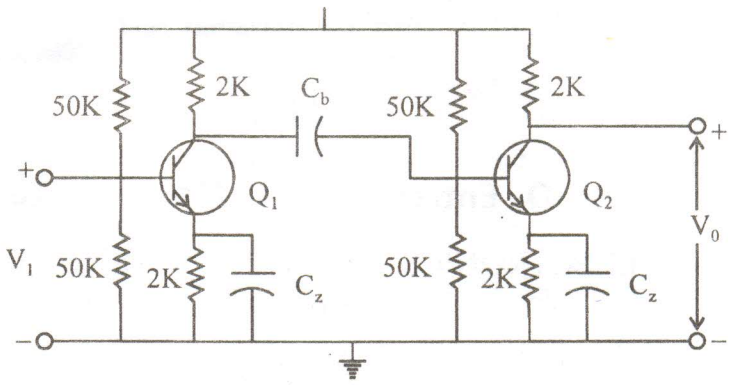
First Paper

(Descriptive Type Questions)

Time : 2 Hours *Maximum Marks :* 100

Note : Each question has three subparts. The candidate has to attempt any *two* subparts out of the three in each questions. All questions carry equal marks.

1. For a two stage RC coupled amplifier, the parameters of the transistors are h_{fe} = 50, h_{ie} = 1·1k, $h_{re} = h_{oe} = 0$. Find (a) midband gain (b) the value of C_b necessary to give a low 3-dB frequency of 20 Hz. (c) find the value of C_b necessary to ensure less than 10% tilt for a 100 Hz square wave input.



2. A ternary communication system transmits one of three signals, $s(t)$, 0, or $-s(t)$, every T seconds. The received signal is either $r_1(t) = s(t) + z(t)$, $r_1(t) = z(t)$, or $r_1(t) = -s(t) + z(t)$, where $z(t)$ is white Gaussian noise with $E(z(t)) = 0$ and $\phi_{zz}(\tau) = \frac{1}{2}E[z(t)z^*(\tau)] = N_0\delta(t - \tau)$. The optimum receiver computes the correlation metric.

$$U = \mathrm{Re}\left[\int_0^1 r(t)s^*(t)dt\right]$$

and compares U with a threshold A and a threshold –A. If U > A, the decision is made that $s(t)$ was sent. If U < –A the decision is made in favour of $-s(t)$. If –A < U < A, the decision is made in favour of 0.

(a) Determine the three conditional probabilities of errors P_e given that $s(t)$ was sent, P_r given that $-s(t)$ was sent, and P_e given that 0 was sent.

(b) Determine the average probability of error P_e as a function of the threshold A, assuming that the three symbols are equally probable a priori.

(c) Determine the value of A that minimizes P_e.

3. The two signal waveforms for binary FSK signal transmission with discontinuous phase are :

$$s_0(t) = \sqrt{\frac{2b_n}{T_b}} \cos\left[2\pi\left(f - \frac{\Delta f}{2}\right)t + \theta_0\right], 0 \le t < T$$

$$s_1(t) = \sqrt{\frac{2b_n}{T_b}} \cos\left[2\pi\left(f + \frac{\Delta f}{2}\right)t + \theta_1\right], 0 \le t \le T$$

where $\Delta f = 1/T << f_c$, and θ_0 and θ_1 are uniformly distributed random variables on the interval $(0, 2\pi)$. The signals $s_0(t)$ and $s_1(t)$ are equally probable.

(a) Determine the power spectral density of the FSK signal

(b) Show that the power spectral density decays as $1/f^2$ for $f >> f_c$.

4. Measurements of a slotted-ALOHA channels show that 20% of the slots are idle :

(a) What is the normalized total traffic on the channel ?

(b) What is the normalized throughput ?

(c) Is the channel underloaded or overloaded ?

5. Find the DTFT of each of the following sequence :

(a) $x_1(n) = \left(\frac{1}{2}\right)^n u(n+3)$

(b) $x_2(n) = \alpha^n \sin(n\omega_0)u(n)$

(c) $x_3(n) = \begin{cases} \left(\frac{1}{2}\right)^n & n = 0,2,4,..... \\ 0 & \text{otherwise} \end{cases}$

6. (a) Justify the statement, "Use of negative feedback will give stable, linear circuit gains that are independent of Op-Amp. the gain is determined solely by feedback resistors, so $A_{OL} >> 1$" ?

(b) For a given Op-Amp, CMRR = 80 dB. Determine the numerical value of the same.

(c) A Schmitt trigger with the upper threshold level Vut = 0V and hysteresis width Vh = 0·4 V converts 500 Hz sine wave amplitude 2 Vpp into square wave. Calculate the direction of negative and positive portion of output waveform.

7. Consider using 8-ary FSK :

(a) Show that if the frequencies are separated by f_s, they are each orthogonal.

(b) Calculate the bandwidth B under the condition of (a)

(c) Determine the ratio of bandwidth of 4-ary FSK and 8-ary FSK when the frequencies are separated by f_s.

8. (a) Sketch the iterface of an ADC 808 to the 8051 microcontroller. Write an 8051 assembly program segment to read an analog signal through the ADC.

(b) What are the alternate functions of Port 3, Port 2 and Port 0 ?

(c) Write an 8051 assembly program to multiple two 8 bit numbers, using shift left and add algorithm ?

9. A sequential circuit has two JK flip-flops A and B and one input x. The circuit is described by the following flip-flop input equations :

$J_A = x$ $\quad\quad$ $K_A = B'$

$J_B = x$ $\quad\quad$ $K_B = A$

(a) Derive the state equations $A(t + 1)$ and $B(t + 1)$ by substituting the input equations for the J and K variables.

(b) Draw the state diagram of the circuit.

(c) Draw the Logic diagram of a 4-bit binary ripple countdown counter, using flip-flops that triggers on the positive edge of the clock.

10. (a) What do you understand by term efficiency of antenna ? Find the relation among power gain, directive gain and efficiency of antenna.

(b) The radiation intensity of an antenna is given by $U = B_0 \cos\theta$ where B_0 is the maximum radiation intensity. The radiation intensity exists in upper hemisphere ($0 \leq \theta \leq \pi/2$, $0 \leq \Phi \leq 2\pi$). Find the maximum directivity of antenna.

(c) Find the radiated field from a short dipole. Also calculate the radiation resistance of short electric dipole.