Major Examination

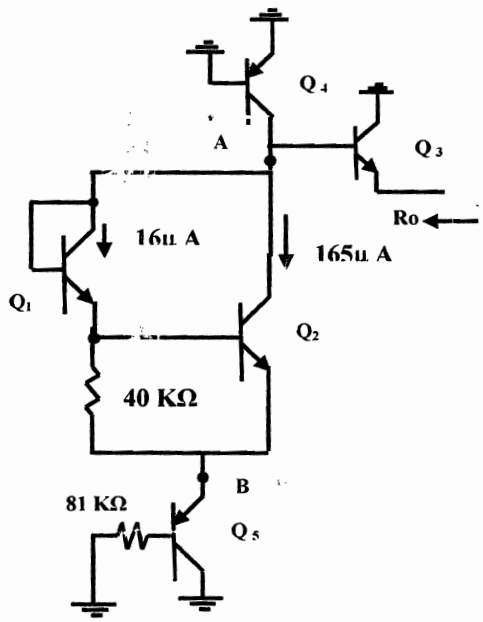
Time: 2 Hour

Fundamental of RF Electronics CRL-713

Maxm. Marks 30

1. **The small signal equivalent circuit of the output stage of an OPAMP is shown below. The biasing collector current of transistor Q_2 is 165 μA, and biasing collector current of transistor Q_1 is 16μA. Use a simple (gm, rπ) model of each transistor to find the output impedance R_O of this circuit. The transistor Q_3 is sourcing the current of 5 mA. The pnp transistors are characterized with an early voltage of 50 V, β of 50, and the npn transistors have β of 200 and early voltage of 125 Volts.**
(Hint: first find the small signal resistance between A, and B)

10 Marks



Q2. Find the autocorrelation function of the signal g (t) = e^{-at} u (t) and validate the Parseval's Theorem by computing the signal energy in the time and frequency domain.

3Marks

Q3. Let g(t) is a base band signal band limited to B Hz. It is double side band, b suppressed carrier modulated using the carrier cos $\omega_o t$. The frequency ω_o is chosen such that $\omega_o >> 2\pi$ B. Show that the energy of the modulated signal is half the modulating signal g(t) . **5 Marks**

Q4. Two base band signals m_1 (t) and m_2(t) are transmitted using the QAM technique. The output of the modulator is $\varphi_{AM}(t) = m_1(t) \cos\omega_c t + m_2(t) \sin\omega_c t$. At the receiver side the locally generated carrier has a frequency error of Δω and phase error of δ. Show that the output of the receiver after passing through the band pass filter is: $m_1(t) \cos[\Delta\omega t + \delta] - m_2(t) \sin[\Delta\omega t + \delta]$ rather than $m_1(t)$. **2 Marks**

Q5. Draw the signal flow graph for solving the simultaneous equations given below: 7 Marks (hint: express eq. 1,2,3 in terms of X_1, X_2, X_3, respectively then draw the signal flow graph)

7 Marks

$$a_{10} X_0 + a_{11} X_1 + a_{12} X_2 + a_{13} X_3 = 0$$
$$a_{20} X_0 + a_{21} X_1 + a_{22} X_2 + a_{23} X_3 = 0$$
$$a_{30} X_0 + a_{31} X_1 + a_{32} X_2 + a_{33} X_3 = 0$$

Q6. A certain two port network is measured to have the scattering parameters as: $S_{11}=0.1\angle 0$, $S_{12} = 0.8\angle 90$, $S_{21}=0.8\angle 90$ and $S_{22}= 0.2\angle 0$. Determine whether the network is reciprocal or lossless. If a short circuit is placed on port 2, what will be resulting return loss at port 1. **3 Marks**