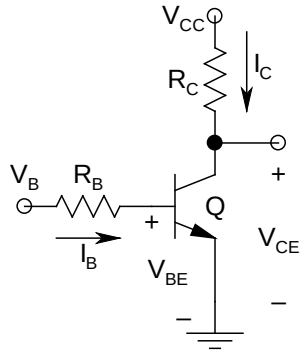
Department of Electrical Engineering
Indian Institute of Technology, Kanpur

EE 210 **Assignment #2** **Assigned: 21.1.25**

1. Consider the BJT circuit shown in the figure. Determine the values of R_C and R_B that would make the transistor Q operate at the bias point of $I_C = 0.5$ mA and $V_{CE} = 3$ V. Assume $V_{CC} = V_B = 5$ V, and $\beta = 100$. Keeping the value of R_B unchanged, determine the new value of R_C that would make the transistor operate at the onset of saturation. Now, assume that this value of R_C is further doubled. What is the new mode of operation of Q, and what is its degree of saturation (DoS) under this condition?



2. The total emitter-base capacitance C_π for an npn transistor under forward active mode of operation is measured to be 6 pF and 8 pF at dc bias current I_C of 1 mA and 2 mA respectively. Determine the zero bias emitter-base junction capacitance C_{je0} (using the thumb rule given in class for forward biased junctions), and the base transit time τ_F, assuming that both of these are constants.

3. An integrated-circuit npn transistor has $\beta_0 = 100$, and $r_0 = 50$ kΩ at $I_C = 1$ mA. With V_{CB} held constant at 10 V, $C_\mu = 0.15$ pF, and $f_T = 600$ MHz and 1 GHz for $I_C = 1$ mA and 10 mA respectively. Assume $V_0 = 0.55$ V for all junctions, and C_{je} is constant in the forward-bias region. Use $r_\mu = 5\,\beta_0 r_0$. Form the complete small-signal equivalent circuits for this transistor at $I_C = 0.1$ mA, 1 mA, and 5 mA, all with V_{CB} held constant at 2 V.

4. An integrated-circuit npn transistor has the following parameters: $\tau_F = 0.25$ nsec, small-signal short-circuit common-emitter current gain is 9 with $I_C = 1$ mA at f = 50 MHz, $V_A = 40$ V, $\beta_0 = 100$, and $C_\mu = 0.6$ pF at the bias voltage used. Determine all elements in the small-signal equivalent circuit at $I_C = 2$ mA, assuming that V_{CB} is held constant (as that for $I_C = 1$ mA), and τ_F remains constant.

5. An npn transistor has the following specifications: $\beta_0 = 100$, $\tau_F = 26$ psec, $C_{je} = 5$ pF, and $C_\mu = 0.5$ pF at a particular bias point with $I_C = 2$ mA. Determine the three important characteristic frequencies f_T (unity-gain cutoff frequency), f_β (beta-cutoff frequency), and f_α (alpha-cutoff frequency) of the transistor at this bias point. Also, estimate f_{max} (absolute maximum operable frequency) of the transistor.