1) First review the problem with its *complete circuit* to determine what solution is required and what information is given.

2) Compute Bias Point
   a) Draw the *Bias Circuit* based on the *complete circuit* by:
      i) Replacing the small signal sources by their zero equivalents (a short circuit for a voltage source, an open circuit for a current source.)
      ii) Replacing capacitors by open circuits
   b) For Diode Circuits:
      i) Examine the problem to determine the nature of source and resistor networks that provide the bias point.
      ii) Consider the circuit and diode current-voltage characteristic to find $I_D$ and/or $V_D$ as required by the problem. (Use an approximate method (constant voltage drop or graphical, or use iterative method.)
      iii) Use this $I_D$ value to find $r_d$
   c) For Transistor Circuits:
      i) Examine the problem to determine the nature of source and resistor networks that provide the bias point.
      ii) Simplify the circuit to place the network connected to each transistor terminal in its simplest form using Thevenin equivalent sources as required. (Of course, form this Thevenin Equivalent *without* the transistor present.)
      iii) By examination, and/or trial-and-error procedures, ensure that the Base-Emitter junction will be forward biased.
      iv) Then, assume that $V_{BE} = 0.7$ (for NPN) and $V_{EB} = 0.7$ (for PNP) and write down the KVL equation that includes the voltage drops across Base and Emitter resistor and source circuits.
      v) Using that $V_{BE} = 0.7$ (for NPN) and $V_{EB} = 0.7$ (for PNP), solve for $I_E$.
      vi) Using the value of $\beta$ or $\alpha$, solve for Base Current and Collector Current
      vii) Special Case: Note (if $\beta$ is estimated to be “infinite”, we neglect the voltage drop across $R_B$ while still using $V_{BE} = 0.7$ (for NPN) and $V_{EB} = 0.7$ (for PNP),
      viii) Solve for Collector Voltage using the value of $R_C$.
      ix) Determine $V_{CB}$ and verify whether the transistor is operating in the active or saturation region.

<table>
<thead>
<tr>
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<th>Active</th>
<th>Saturation</th>
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<tbody>
<tr>
<td>NPN BJT</td>
<td>$V_{BE} \geq 0.7$</td>
<td>$V_{CB} \geq 0$</td>
</tr>
<tr>
<td>PNP BJT</td>
<td>$V_{EB} \geq 0.7$</td>
<td>$V_{BC} \geq 0$</td>
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</table>
x) Compute:
   (1) $r_\pi$
   (2) $r_e$
   (3) $g_m$
   (4) $r_O$ (if an Early voltage is given)

3) Compute Small Signal Response
   a) Draw the small signal circuit.
      i) Draw this based on the complete circuit by including only the time dependent
         sources and replacing the diode or transistor by its small signal circuit model.
         (1) For the diode, this is the small signal resistance, $r_d$
         (2) For the transistor, this is the complete hybrid $\pi$ model.
      ii) Replace capacitors by short circuits
      iii) Replace DC sources by their zero equivalents.
      iv) Compute the desired transfer function values using node voltage analysis
         (1) For Small Signal Circuit Node Voltage analysis the following definitions are
             important.
             
             (a) $\beta = \frac{\alpha}{1 - \alpha}$
             (b) $\alpha = \frac{\beta}{\beta + 1}$
             (c) $g_m = \frac{I_C}{V_T}$
             (d) $r_e = \frac{V_T}{I_E}$
             (e) $r_\pi = \frac{V_T}{I_B}$
             (f) $r_\pi = \frac{\beta}{\alpha} r_e$
             (g) $r_e = \frac{\alpha}{g_m}$
             (h) $\frac{1}{r_e} + g_m = \frac{1}{r_\pi}$