Transistor biasing and thermal stabilization pdf file downloads pdf

The basic function of transistor is amplification. The process of raising the strength of weak signal without any change in its general shape is referred as faithful amplification. For faithful amplification it is essential that:-Emitter-Base junction is forward biased 2.Collector-Base junction is reversed biased 3.Proper zero signal collector current3If the transistor is not biased properly, it would work inefficiently and produce distortion in output signal.A transistor is biased either with the help of battery or associating a circuit with the transistor. The later method is more efficient and is frequently used. The circuit used for transistor biasing is called the biasing circuit. Through proper biasing, a desired quiescent operating point of the transistor amplifier in the active region (linear region) of the characteristics is obtained. It is desired that once selected the operating point should remain stable. The maintenance of operating point stable is called Stabilisation. The selection of a proper quiescent point generally depends on the following factors: (a) The amplitude of the signal to be handled by the amplifier and distortion level in signal (b) The load to which the amplifier is to work for a corresponding supply voltage The operating point of a transistor amplifier shifts mainly with changes in temperature, since the transistor parameters -β, I_{CO} and V_{BE} (where the symbols carry their usual meaning)-are functions of temperature.5For a transistor circuit to amplify it must be properly biased with dc voltages. The dc operating point between saturation and cutoff is called the Q-point. The goal is to set the Q-point such that that it does not go into saturation or cutoff when an a ac signal is applied. Applying KVL through Base Circuit we can write, $I_b R_b + V_{be} = V_{cc}$ Diff w. r. t. I_C , we get $(\partial I_b / \partial I_c) = 0$ S Ico = (1+β) is very large Indicating high un-stability• It is simple to shift the operating point anywhere in the active region by merely changing the base resistor (RB). • A very small number of components are required.• The collector current does not remain constant with variation in temperature or power supply voltage. Therefore the operating point is unstable. • When the transistor is replaced with another one, considerable change in the value of β can be expected. Due to this change the operating point will shift. • For small-signal transistors (e.g., not power transistors) with relatively high values of β (i.e., between 100 and 200), this configuration will be prone to thermal runaway. In particular, the stability factor, which is a measure of the change in collector current with changes in reverse saturation current, is approximately β+1. To ensure absolute stability of the amplifier, a stability factor of less than 25 is preferred, and so small-signal transistors have large stability factors.Usage:• Due to the above inherent drawbacks, fixed bias is rarely used in linear circuits (i.e., those circuits which use the transistor as a current source). Instead, it is often used in circuits where transistor is used as a switch. However, one application of fixed bias is to achieve crude automatic gain control in the transistor by feeding the base resistor from a DC signal derived from the AC output of a later stage.The fixed bias circuit is modified by attaching an external resistor to the emitter. This resistor introduces negative feedback that stabilizes the Q-point.13 Merits:• The circuit has the tendency to stabilize operating point against changes in temperature and β-value.• As β-value is fixed for a given transistor, this relation can be satisfied either by keeping RE very large, or making RB very low. If RE is of large value, high VCC is necessary. This increases cost as well as precautions necessary while handling. If RB is low, a separate low voltage supply should be used in the base circuit. Using two supplies of different voltages is impractical. • In addition to the above, RE causes ac feedback which reduces the voltage gain of the amplifier.The feedback also increases the input impedance of the amplifier when seen from the base, which can be advantageous. Due to the above disadvantages, this type of biasing circuit is used only with careful consideration of the trade-offs involved.14 The Collector to Base Bias CircuitThis configuration employs negative feedback to prevent thermal runaway and stabilize the operating point. In this form of biasing, the base resistor RF is connected to the collector instead of connecting it to the DC source Vcc. So any thermal runaway will induce a voltage drop across the Rc resistor that will throttle the transistor's base current. Applying KVL through base circuit we can write $(I_b + I_C) R_C + I_b R_f + V_{be} = V_{cc}$ Diff. w. r. t. I_C we getWhich is less than (1+β), signifying better thermal stability 16 Merits:• Circuit stabilizes the operating point against variations in temperature and β (i.e. replacement of transistor)• As β -value is fixed (and generally unknown) for a given transistor, this relation can be satisfied either by keeping Rc fairly large or making Rf very low. If Rc is large, a high Vcc is necessary, which increases cost as well as precautions necessary while handling. If Rf is low, the reverse bias of the collector-base region is small, which limits the range of collector voltage swing that leaves the transistor in active mode. •The resistor Rf causes an AC feedback, reducing the voltage gain of the amplifier. This undesirable effect is a trade-off for greater Q-point stability.The feedback also decreases the input impedance of the amplifier as seen from the base, which can be advantageous. Due to the gain reduction from feedback, this biasing form is used only when the trade-off for stability is warranted. This is the most commonly used arrangement for biasing as it provide good bias stability. In this arrangement the emitter resistance 'RE' provides stabilization. The resistance 'RE' cause a voltage drop in a direction so as to reverse bias the emitter junction. Since the emitter-base junction is to be forward biased, the base voltage is obtained from R1-R2 network. The net forward bias across the emitter base junction is equal to VB-dc voltage drop across 'RE'. The base voltage is set by Vcc and R1 and R2. The dc bias circuit is independent of transistor current gain. In case of amplifier, to avoid the loss of ac signal, a capacitor of large capacitance is connected across RE. The capacitor offers a very small reactance to ac signal and so it passes through the condensor.To find the stability of this circuit we have to convert this circuit into its Thevenin's Equivalent circuit • Operating point is almost independent of β variation. • Operating point stabilized against shift in temperature.• As β-value is fixed for a given transistor, this relation can be satisfied either by keeping RE fairly large, or making R1||R2 very low. If RE is of large value, high VCC is necessary. This increases cost as well as precautions necessary while handling. If R1 || R2 is low, either R1 is low, or R2 is low, or both are low. A low R1 raises VB closer to VC, reducing the available swing in collector voltage, and limiting how large RC can be made without driving the transistor out of active mode. A low R2 lowers Vbe, reducing the allowed collector current. Lowering both resistor values draws more current from the power supply and lowers the input resistance of the amplifier as seen from the base. AC as well as DC feedback is caused by RE, which reduces the AC voltage gain of the amplifier. A method to avoid AC feedback while retaining DC feedback is discussed below. Extra Questions, , pdf , , study material, Viva Questions, ppt, past year papers, Semester Notes, Exam, Sample Paper, video lectures, Free, shortcuts and tricks, practice quizzes, Summary, Important questions, , mock tests for examination, Objective type Questions, MCQs, Previous Year Questions with Solutions; Skip to Main Content UNIT- V Transistor Biasing and Thermal Stabilization Need for biasing, operating point, load line analysis, BJT biasing- methods, basic stability, fixed bias, collector to base bias, self bias, Stabilization against variations in VBE, Ic, and β, Stability factors, (S, S', S''), Bias compensation, Thermal runaway, Thermal stability. FET Biasing- methods and stabilization. Questions: 1. What is the need for transistor biasing? 2. Define operating point of BJT. 3. Mention the importance of DC and AC Load lines. 4. Define stability factor. 5. Define the stability factors S' and S''. 6. Explain the factors affecting stability of Q Point. 7. What is thermal runaway? How to overcome the problem of thermal runaway in BJT? Questions: 1. What are the different types of biasing techniques for BJT? 2. Draw a Fixed Bias Circuit of BJT. Derive the three stability factors. 3. What are the advantages and disadvantages of Fixed Bias Circuit? 4. With neat diagram, explain Collector to Base Bias Circuit of BJT. Derive S, S' and S''. 5. Mention the advantages and disadvantages of Collector to Base Bias Circuit. 6. Which biasing method provides more stabilization against the three types of biasing methods? Why? 7. With neat diagram, explain Voltage Divider Bias Circuit of BJT. Derive S, S' and S''. 8. Write the advantages and disadvantages of Voltage Divider Bias. 9. For the circuit shown in Figure, Calculate IB, IC, VCE, VB , VC and VBC. Assume that VBE = 0.7V and β = 50. 10. Calculate the Q point values (IC and VCE) for the circuit shown in the Figure. Questions: 1. What do you understand by bias stabilization and bias compensation? Why it is necessary in transistor amplifiers? 2. What is a condition for thermal stability? 3. Explain bias compensation using sensistors. 4. Write notes on bias compensation using thermistors. 5. Explain the diode compensation technique. 6. Derive the condition for thermal stability. 7. Calculate the value of thermal resistance θ for the transistor in the circuit shown in the Figure. In order to make circuit thermally stable. Assume that ICO = 1 nA at 250C. Questions: 1. Mention the different types of biasing circuits for JFET. 2. With neat diagram, explain Fixed bias of JFET. 3. Discuss Voltage Divider Biasing circuit of JFET. 4. Describe Self Bias Circuit of JFET with neat diagram. 5. Explain the biasing methods of MOSFET.