

II B.Tech II Semester Supplementary Examinations, Aug/Sep 2007
ELECTRONIC DEVICES AND CIRCUITS
(Mechatronics)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Explain about Drift and Diffusion currents in semiconductors. [3+3]
(b) Explain about cut-in voltage of forward characteristic of semiconductor diode [4]
(c) Calculate the magnitude of maximum electric field at 300^0K for P-N junction with $N_A=10^{20} /cm^3$ on P-side and $N_D=10^{15} /cm^3$ on N-side of a Silicon semiconductor diode. Intrinsic carrier concentration $n_i = 2.5 \times 10^{10} /cm^3$ and $V_T=25$ mv at 300^0K [3]
(d) Explain about the significance of built-in voltage [3]
2. (a) Discuss the method of conversion of ac voltage into unidirectional voltage using a semiconductor diode.
(b) Draw the input signal and output signal waveforms of a Full wave rectifier circuit
(c) Derive the expressions for $V_{D.C}$ and $V_{R.M.S}$ for a full wave rectifier circuit.
(d) Derive the expression for ripple factor of a Full wave rectifier circuit. [3+3+4+6]
3. (a) Draw a diagram showing Various currents in a PNP Transistor in CB mode.
(b) Explain the phenomenon of Base width modulation in Transistor operation and discuss its influence on Base current ' I_B ' in a Common Base operated Transistor.
(c) Draw the output characteristics of a Common Base operated Transistor and discuss the role of 'Early Effect' on the CB Transistor output characteristics.
(d) Explain the operation of a PNP Transistor in Common Base configuration. [3+3+4+6]
4. (a) Draw the circuit diagrams showing the three configurations of Transistor amplifiers.
(b) Draw the Transistor biasing circuit using Collector-to-base bias arrangement. Explain the concept of providing proper bias for the Transistor to act as amplifying device
(c) Mention the DC load line equation for CE Transistor Collector to base bias circuit and describe the method of drawing the DC load line on the CE Transistor output characteristics. [6+6+4]

5. (a) Draw the practical circuit of a single stage Common Base Transistor Amplifier with potential divider biasing.
(b) Assuming sinusoidal input signal to the above CB Transistor amplifier, explain the working of the amplifier with necessary waveforms.
(c) Draw the A C equivalent circuit of the CB Transistor amplifier and explain the concept of amplification and mention some practical applications of it. [4+4+8]
6. (a) Draw the potential divider bias circuit for P-Channel JFET and explain the function of each component in the circuit.
(b) Derive the expression for voltage gain of JFET model for self bias configuration. [8+8]
7. (a) Explain the effects on
i. Noise
ii. Nonlinear distortion and
iii. Bandwidth of amplifiers with the introduction of voltage series feedback into the amplifiers
(b) An amplifier with an open-loop voltage gain A_V of -1000 delivers 10 watts of output power at 10% second harmonic distortion, when the input signal is 10mv. If 40 db negative voltage-series feedback is applied and the output power is to remain at 10 watts; calculate
i. the required input signal
ii. percentage second harmonic distortion and
iii. Closed-loop voltage gain. [8+8]
8. (a) What are the limitations of RC phase shift oscillators? How do you overcome them?
(b) Draw a typical practical version of a FET Colpitts oscillator circuit and explain its working.
(c) Mention the expression for the calculation of Colpitts oscillator circuit frequency. If the colpitts oscillator frequency is 2.2 MHZ and the inductance $L = 0.2$ mH; calculate the value of the equivalent capacitor ' C_{eq} ' in the frequency determining network. [4+8+4]

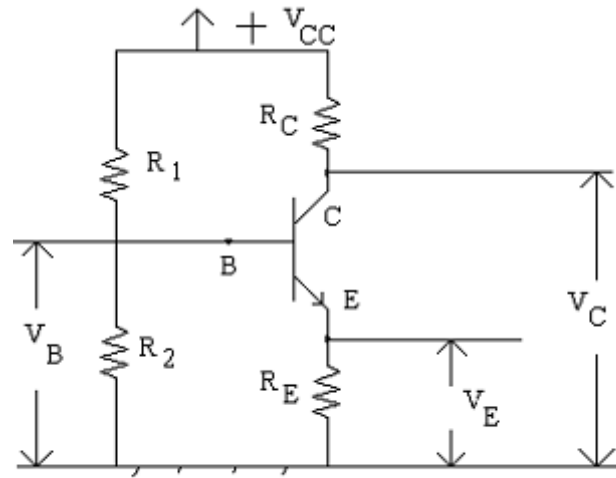
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1. (a) Mention the expression for V_o (contact potential or barrier voltage) in terms of concentration of dopant atoms for a PN junction diode and discuss its role in the Semiconductor device working under forward and reverse bias conditions.
(b) Draw the Energy Band diagram to explain Zener break-down phenomenon
(c) Discuss the various factors that contribute to the dependence of the semiconductor diode current on temperature. [6+6+4]
2. (a) Draw the output waveforms for Half Wave and Full Wave rectifier circuits for one cycle of AC input signal with supply frequency of 50 HZ and $V_S = 30 \sin(\omega t)$ for a Half Wave rectifier circuit, for the full wave rectifier circuit, $V_{S1} = 30 \sin(\omega t)$ and $V_{S2} = 30 \sin(\omega t + \pi)$
(b) For the above signals in Half wave and Full wave rectifier circuits, Calculate the magnitudes of V_{DC} , $V_{R.M.S}$ and ripple factors for both types of rectifier circuits. [4+12]
3. (a) Show that Bipolar junction transistor acts as an amplifier using NPN transistor.
(b) Draw a circuit for CE configuration using NPN transistor.
(c) Draw the input and output characteristics of a Common Emitter configuration and discuss the method of obtaining the characteristics. [5+3+8]
4. (a) Define the four hybrid parameters of a CE Transistor considering the Transistor as a four terminal network. Also mention the reasons for calling the Transistor h-parameters as the hybrid parameters.
(b) For following voltage divider bias circuit $R_1 = 62 \text{ K}\Omega$; $R_2 = 9 \text{ K}\Omega$; $R_C = 4 \text{ K}\Omega$; $R_E = 0.5 \text{ K}\Omega$ and $\beta = 80$; calculate the voltages, V_B ; V_C and V_E . (figure 4) [7+9]



C E Transistor with Voltage Divider Bias

Figure 4

5. (a) Discuss the four basic methods of coupling for cascading of amplifiers to obtain Multi-Stage amplifiers and mention the reasons for cascading of amplifiers.
 (b) Draw a typical block diagram of 3-stage CE Cascaded amplifier.
 (c) Derive the expressions for voltage gain and the resultant phase shift of cascaded amplifier of these 3-stages. [6+4+6]
6. (a) Draw the circuit of N-Channel FET amplifier with voltage divider biasing scheme and explain the working of the circuit.
 (b) Draw typical frequency response characteristic of FET amplifier. Define the various frequency regions on the characteristic. If $f_L = 100$ HZ and $f_H = 55,100$ HZ, calculate the amplifier bandwidth. [10+6]
7. (a) Draw the typical frequency response characteristics of normal amplifier and negative feedback amplifier. Compare and comment on the relevant values of gain, bandwidth and gain-bandwidth product values in both cases with relevant mathematical expressions.
 (b) An amplifier has a gain $A_V = 1000$ and upper corner frequency $W_2 = 10^5$ rad/sec. With the introduction of negative feedback into the amplifier, calculate the feedback factor β ; which will raise the upper corner frequency W_2 to W_{2f} of 10^6 rad/sec. Calculate the corresponding gain A_{VF} of the amplifier. Calculate the gain-bandwidth products in each case and comment on the results. [8+5+3]
8. (a) Mention the advantages of weinbridge oscillator circuit. Find the frequency of oscillations of a weinbridge oscillator circuit with $R_1 = R_2 = R = 33K\Omega$ and $C_1 = C_2 = C = 1000$ pf.
 (b) Why is the phase shift through the RC feedback network of R-C phase shift oscillator circuits 180° ? Explain.

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- (c) Determine the frequency of oscillations f_0 of a R-C phase shift oscillator circuit using a FET active device having $R_1 = R_2 = R_3 = R = 3.3K\Omega$ and $C_1 = C_2 = C_3 = C = 0.001\mu f$.
[6+6+4]

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1. (a) Draw the V_r versus I_r characteristics (reverse characteristic) of a semiconductor Diode and explain the salient features on the characteristic.
- (b) Explain the feature that is responsible for the diode to function as an open switch
- (c) A silicon sample of thickness (T) $100 \mu\text{m}$ is doped with 10^{17} phosphorus atoms/cm³. Calculate the resistivity of the semiconductor sample. Current through Semiconductor sample is 1 ma when placed in a transverse magnetic field 'B' of 10^{-5} wb/cm². Calculate the magnitude of the Hall voltage ' V_H '. [6+4+6]
2. (a) Draw the Half wave rectifier circuit using a step down Transformer with $V_S = 46 \sin(\omega t)$ and a semiconductor diode. Calculate the turns ratio of the Transformer windings when the primary voltage of the Transformer is 230 volts.
- (b) Explain the working of the Half wave rectifier circuit using signal waveforms at various points in the circuit.
- (c) Calculate the magnitude of the ripple factor for the given set of observations of $V_{A.C} = 24.2$ volts and $V_{D.C} = 20$ volts. Identify the type of rectifier circuit based on the knowledge of theoretical values of ripple factors for Half wave and Full wave rectifier circuits. [6+6+4]
3. (a) Draw the circuit diagram to obtain the UJT characteristics between the Emitter voltage ' V_E ' and the Emitter current ' I_E ' for a fixed value of ' V_{BB} '.
- (b) What is the reason for getting the negative resistance region in UJT characteristics? Explain.
- (c) Determine the peak-point Emitter voltage ' V_P ' required for UJT to switch into on state, if the Supply voltage ' V_{BB} ' is 20 Volts, Intrinsic stand-off ratio ' η ' = 0.75 and ' V_D ' = 0.5.
- (d) Mention some applications of UJT with suitable explanation [3+5+4+4]
4. (a) Draw a circuit diagram illustrating the potential divider biasing for a Transistor to act as an amplifying device. Explain how this circuit is superior to a Transistor amplifier circuit using fixed bias circuit as far as stability of quiescent operating point is concerned.
- (b) Define the hybrid parameters of a BJT in Common Base configuration considering the Transistor as a four terminal network. Mention typical values for the h-parameters

- (c) Discuss the effects of increase in temperature on Transistor currents and the reasons for the occurrence of 'Thermal Run away'. [6+6+4]
5. (a) What is a multistage amplifier circuit?
(b) Draw a block diagram to illustrate the concept of n-stage amplifier.
(c) Derive the expression for overall voltage gain of multistage amplifier and also show that the overall gain is the sum of individual amplifier gains in decibels. [4+4+8]
6. (a) Draw the potential divider bias circuit for P-Channel JFET and explain the function of each component in the circuit.
(b) Derive the expression for voltage gain of JFET model for self bias configuration. [8+8]
7. (a) Draw the typical frequency response characteristics of normal amplifier and negative feedback amplifier. Compare and comment on the relevant values of gain, bandwidth and gain-bandwidth product values in both cases with relevant mathematical expressions.
(b) An amplifier has a gain $A_V = 1000$ and upper corner frequency $W_2 = 10^5$ rad/sec. With the introduction of negative feedback into the amplifier, calculate the feedback factor β ; which will raise the upper corner frequency W_2 to W_{2f} of 10^6 rad/sec. Calculate the corresponding gain A_{VF} of the amplifier. Calculate the gain-bandwidth products in each case and comment on the results. [8+5+3]
8. (a) Mention the various building blocks of an oscillator circuit and explain the basic operations of the blocks, considering transistor R-C phase shift oscillator circuit.
(b) Discuss how the Barkhausen conditions for oscillations are satisfied for amplitude stabilization in the R-C phase shift oscillator circuit, showing necessary signal waveforms at the relevant points in the circuit. [8+8]

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1. (a) Discuss the significance of Forbidden Band Gap energy in Energy-Band Diagrams with reference to the difference in cut-in voltages for Silicon and Germanium diode working under forward Bias conditions.
(b) Mention the reason for Silicon devices to work at higher temperatures when compared to Germanium devices with necessary Energy Band diagrams.
(c) Calculate the magnitude of barrier voltage at 300⁰K for P-N junction with $N_A=10^{18}/\text{cm}^3$ on P-side and $N_D=10^{15}/\text{cm}^3$ on N-side of a Germanium semiconductor diode. Intrinsic carrier concentration $n_i=1.5 \times 10^6/\text{cm}^3$ and $V_T=25$ mv at 300⁰K. [6+6+4]
2. (a) Discuss the functioning of rectifier circuits in DC sources for Electronic circuits.
(b) Draw the circuit diagram of Full Wave rectifier using two semiconductor diodes and explain its working principle.
(c) Mention the expression for rectification efficiency
(d) Derive the expression for rectification efficiency [3+7+3+3]
3. (a) Draw a diagram showing Various currents in a PNP Transistor in CB mode.
(b) Explain the phenomenon of Base width modulation in Transistor operation and discuss its influence on Base current ' I_B ' in a Common Base operated Transistor.
(c) Draw the output characteristics of a Common Base operated Transistor and discuss the role of 'Early Effect' on the CB Transistor output characteristics.
(d) Explain the operation of a PNP Transistor in Common Base configuration. [3+3+4+6]
4. (a) Why biasing is necessary for a Transistor circuit in a given configuration. Mention the three different types of biasing a Bipolar Junction Transistor.
(b) Draw the Transistor biasing circuit using fixed bias arrangement and explain its principle with suitable analysis.
(c) Mention the DC load line equation for CE Transistor fixed bias circuit and describe the method of drawing the DC load line on the CE Transistor output characteristics. [6+6+4]
5. (a) Discuss the four basic methods of coupling for cascading of amplifiers to obtain Multi-Stage amplifiers and mention the reasons for cascading of amplifiers.

- (b) Draw a typical block diagram of 3-stage CE Cascaded amplifier.
- (c) Derive the expressions for voltage gain and the resultant phase shift of cascaded amplifier of these 3-stages. [6+4+6]
6. (a) Draw fixed biasing circuit of N-Channel FET and explain the function of each component in the circuit in fixing the quiescent operating conditions of amplifiers.
- (b) Explain the action of JFET amplifier using fixed biasing scheme. [8+8]
7. (a) Discuss the merits and demerits of negative and positive feedback amplifiers
- (b) It is required to have an amplifier with a closed loop gain $A_{Vf} = -100$ and a gain which should not vary by more than 1%, when the non-feedback amplifier gain varies by 20%. Compute the values of
- i. A_V and
 - ii. β
- [4+12]
8. (a) Draw the circuit of R-C phase shift oscillator circuit using JFET as the active device and discuss the nature of feed back used in the feedback path.
- (b) In the R-C phase shift oscillator circuit, discuss the passive of part of the circuit that is responsible to get the 180° phase shift.
- (c) Calculate the value of 'C' in the frequency-determining network of a FET ? RC phase shift oscillator circuit having $R = 2.5 \text{ K}\Omega$; assuming frequency of oscillation $f = 1.625 \text{ KHZ}$.
- (d) Repeat (c) if it is a BJT ? RC phase shift oscillator with $R_C = 4\text{k}\Omega$ [5+5+3+3]
