Model Questions on Analog Electronics

Semester-III

Semiconductor, P-N junction Diodes and their applications:

1 Marks Questions:

1. How does a semiconductor behave at absolute zero?
2. What are the charge carriers in semiconductors?
3. Give an example of indirect band gap semiconductors?
4. Give an example of direct band gap semiconductors?
5. What type of material is obtained when an intrinsic semiconductor is doped with pentavalent impurity?
6. What type of material is obtained when an intrinsic semiconductor is doped with trivalent impurity?
7. What is the resistivity of pure germanium under standard conditions?
8. Under what conditions do drift of carriers and diffusion of carriers occur in a semiconductor?
9. What is the order of resistance of a forward biased pn junction diode?
10. What is reverse saturation current in a p-n junction?
11. How the depletion capacitance varies with increase in the reverse bias in a junction diode?
12. What is the biasing condition of a photodiode?
13. Mention one use of photodiode.
14. What is PIN?
15. What do you mean by Zener break down?
16. What do you mean by degenerate and non-degenerate semiconductors?
17. Why do silicon or germanium diodes not emit light but GaAs diodes do?
18. What is the value of potential barrier for a (i) Ge diode & (ii) Si diode?
19. Fermi level represents the energy level with probability of its occupation of

(a) 0% (b) 25% (c) 50% (d)100%

2 Marks Questions:

1. What is direct band gap semiconductor? Give an example.
2. How the resistivity of semiconductor changes with temperature?
3. How a p-n junction acts as unidirectional switch?
4. Why the leakage current across a p-n junction is generated?
5. What is the method to differentiate between a p-type and an n-type semiconductor?
6. What is hole? Why effective mass of holes is higher than electron's?
7. Can one measure contact potential of a p-n junction using voltmeter? Justify your answer.
8. What is mass action law in semiconductor?
9. What is Fermi level?
10. Show that Fermi level of intrinsic semiconductor lies half way between the valence band and the conduction band.
11. Define drift and diffusion current?
12. What are the merits of silicon over germanium as a semiconductor material?
13. Which types of semiconductors are suitable for manufacturing LED? Why?

14. Distinguish between conductor, insulator and semiconductor on the basis of energy band diagram ?
15. Give the expression for drift current density.
16. Give the expression for diffusion current density.
17. Define PIV.
18. What is LED? Can it be designed using silicon?
19. Define ripple factor of a rectifier.
20. Draw the labelled diagram of a full wave rectifier circuit.
21. What is an extrinsic semiconductor?
22. Define 'ripple factor' of a full wave rectifier.
23. Give two examples of compound semiconductor.
24. Why in semiconductor devices people use Si instead of Ge?
25. At what temperature an intrinsic semiconductor behaves as an insulator?
26. What is the necessary condition for a circuit element to be nonlinear? Give one example of nonlinear circuit element.
27. What do mean by mobility of charge carriers? Which charge carrier is faster between hole and electron?
28. Why a filter is used after the rectifier circuit?
29. Explain the operation of capacitor filter in connection to rectifier circuit.
30. Draw a schematic diagram of the energy band structure of a forward biased p-n junction.
31. Explain the origin of forward biased capacitance of a p-n junction diode.
32. Define the term 'mobility' of a hole. Why is it less than that of an electron?
33. What are diffusion and drift currents for p-n junction diode?
34. Explain the term depletion region.
35. Write two causes of poor regulation in the circuit.

5 Marks Questions:

1. Draw the equilibrium energy band diagram of p-n junction in unbiased condition. Also draw how the diagram is modified in forward and reverse biased condition?
2. Establish diode equation.
3. Explain the mechanism of avalanche breakdown. Using band diagram explain the principle operation of zener breakdown.
4. What is zener diode? How it is used as a voltage regulator?
5. Describe the I-V characteristics and working principle of LED.
6. How is a potential barrier formed at the p-n junction? Define reverse saturation current? Why is it temperature dependent?
7. What are transition capacitance and diffusion capacitance?
8. Draw the I-V characteristics of a solar cell and explain.
9. Draw the circuit diagram of a bridge rectifier. What is the advantage of use such rectifier.
10. Draw the nature of output waveform for a half wave and full wave rectifier circuit.
11. What is filter circuit? Explain its function in rectifier circuit.
12. Show that effective mass of an electron under the influence external electric field moving in energy band is $m^* = \frac{\hbar}{\frac{\partial^2 E}{\partial k^2}}$.

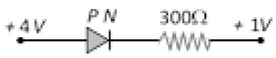
13. Explain, with suitable diagrams, the current-voltage characteristics of a tunnel diode. Mention the design considerations and uses of a tunnel diode.
14. What is efficiency of rectification? Compare half wave and full wave rectifiers in the context of rectification efficiency?
15. What is Zener breakdown of a p-n junction diode? Point out the conditions of Zener breakdown. How is it different from avalanche breakdown?
16. Explain the operating principle of a Zener diode based voltage regulator.
17. How the contact potential developed across a p-n junction? Explain the term potential barrier.
18. Define voltage regulation of power supply. Explain how zener diode can be used to regulate the voltage output?
19. Draw the circuit diagram of a full wave rectifier using centre tapped transformer and explain its working. Sketch the input and output wave forms.

<u>10 Marks Questions:</u>

1. Draw the circuit diagram of a half wave rectifier and its action. Calculate (a) dc load current, (b) rms value of current, (c) ripple factor and (d) efficiency of rectification.
2. Draw the circuit diagram of a full wave rectifier and its action. Calculate (a) dc load current, (b) rms value of current, (c) ripple factor and (d) efficiency of rectification.

Mathematical problems:

1. What is the value of current in the circuit given below,



2. The mobility of electron in Si at 300 K is 0.13 m^2/Vs. Calculate the diffusion constant of electron.
3. GaAs is a direct band gap semiconductor with energy gap 1.43 eV. Find the wavelength of the emitted radiation.
4. A silicon diode is in series with a $1k\Omega$ resistor and a $5V$ battery. If the anode is connected to the +ve battery terminal, the cathode voltage with respect to the negative battery terminal is (a) 0.7 V (b) 0.3 V (c) 5.7V (d) 4.3V (BHU'18)
5. A power supply has a voltage regulation of 2%. If no load voltage is 40 V, what is full load voltage?
6. A half wave rectifier circuit has $V_i = 100 \sin \omega t$ volts, $R_L = 900\ \Omega$ and $R_f = 100\ \Omega$. Find (i) the peak load current I_m, (ii) the d.c. load current I_{dc} and (iii) the efficiency η of the rectifier.
7. A 24 V, 600 mW Zener diode is to be used for providing a 24 volt stabilized supply to a variable load. If the input voltage is 32 volt, calculate (i) the value of the resistance to be connected in series and (ii) the current in the diode when R_L=1.2KΩ.
8. (i) Over what range of input voltage will the Zener regulating circuit maintain 30V across the load resistance 2000 ohm , assuming that the current limiting resistor R=200 ohms and that maximum Zener current is 25 mA.
9. A crystal diode having internal resistance R_f=20Ω is used for half wave rectification. If the applied voltage is E= 50 sin $100\pi t$ and the load resistance is 500Ω, find (i) I_{dc} (ii)I_{rms} (iii) a.c. input power, (iv) dc output power and (v) efficiency.

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Bipolar Junction transistors:

1 OR 2 marks

1. What is an emitter follower?
2. What is the main cause of drop in low frequency gain in a transistor RC coupled amplifier?
3. Explain Early Effect in transistor.
4. It is not possible to design a transistor by joining two diode side by side-Explain?
5. BJT is a current controlled device but JFET is a voltage controlled device-Comment on the statement.
6. Define the DC load line of transistor.
7. Why is the base of a transistor made very thin and lightly doped?
8. Give the circuit diagram of a common emitter transistor amplifier
9. Define α and β of a transistor. Find the relation between them.
10. Why do we need biasing of a transistor?

5 marks

1. What do you mean by stability of bias point of a bipolar junction transistor? With neat circuit diagram, discuss the bias stability of an emitter bias circuit.
2. Draw a self –biased transistor circuit. Explain qualitatively why such a circuit improves bias stability?
3. Calculate the stability factor for a fixed bias circuit? Comment on the result.

Mathematical Problems:

1. The value of α of a transistor is 0.99. What is the value of β of the transistor?
2. A n-p-n transistor is connected in CE configuration in which collector supply is 8V and the voltage drop across resistance R_L connected in the collector circuit is 0.5 V. The value of R_L =800Ω. If α is 0.96, determine (i) the collector emitter voltage and (ii) the base current.
3. A silicon transistor with $\beta = 100$ is used as a CE amplifier with collector to base bias arrangement. The load resistance $R_L = 1000\ \Omega$ and V_{cc}= 12 V. Find R_B so that V_{CE}= 6 Volt.

Field Effect transistors:

1 OR 2 marks

1. What are the advantages of JFET over BJT?
2. What are differences between BJT and FET?
3. Why FET more thermally stable than BJT?
4. Define pinch off voltage of a JFET.

5 marks

1. Define trans-conductance, ac drain resistance and amplification factor of a FET.
2. Sketch the basic structure of N channel JFET and describe its biasing arrangement.
3. Draw and explain the I –V characteristics of N channel JFET.
4. Sketch the basic structure of P- channel JFET and show its biasing arrangement. Describe the principle of operation of an P-channel JFET.
5. Draw a family of common source drain characteristics of a typical n-channel JFET. Draw a biasing circuit for an enhancement MOSFET. Explain how the gate-source junction is forward-bias.

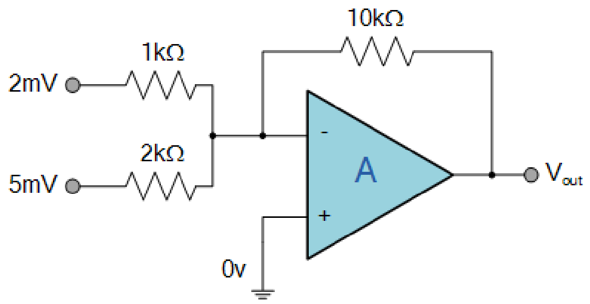
Amplifiers:

1 OR 2 marks

1. Why h-parameter model of BJT is not valid for high frequencies?
2. State two advantages of negative feedback in amplifiers.
3. What is the Barkhausen criterion for a feedback amplifier to function as an oscillator?
4. Define Class AB amplifier?
5. Write on advantage of negative feedback of an amplifier.
6. What do you mean by virtual ground of an OPAMP.
7. Define half power frequency of an amplifier.
8. Write the full form of the term 'CMRR' of OP AMP.
9. What is virtual ground in case of an OP AMP?
10. Draw the OPAMP based differentiator circuit.
11. Write down two merits of a CE transistor amplifier over a CB amplifier.
12. Discuss the effect of negative feedback in an amplifier.
13. Write down four important properties of an ideal OPAMP.
14. Define slew rate of OPAMP.
15. Draw the neat diagram of an OPAMP based integrator circuit.
16. For power amplification a class B amplifier is more useful than a class A amplifier-why?
17. What do you mean by virtual ground of an OP-AMP?
18. Draw a labelled circuit diagram of a unity gain buffer amplifier.
19. What is a Class A amplifier?
20. Derive an expression for the closed loop gain of a negative feed back amplifier.
21. Explain the term frequency response of a RC coupled amplifier.
22. What do you mean by class-B amplifiers

5 marks

1. What will be the magnitude of V_{out} in the circuit shown below? Derive the formula you use.



2. Explain the function of Wien-Bridge oscillator with a neat diagram.
3. Explain the operation of weighted resistor DAC (digital to analog converter).
4. How can you use an operational amplifier as an adder? Comment on the properties of the following parameters of an ideal OP- AMP:
   (i) Output and input impedance
   (ii) Band width

5. Derive an expression for the voltage gain of an amplifier with feedback. Discuss the advantages of negative feedback.
6. Draw the OP AMP circuit of a voltage-to-current converter. Explain its operation. Mention one use of this circuit.

7. With the help of a neat circuit diagram, explain the operation of non-inverting operational amplifier.
8. Show that a negative feedback arrangement increases the stability of an amplifier but reduces its gain.
9. With necessary assumptions derive an expression for closed loop gain of an amplifier with feedback. Obtain Backhausen condition for self sustained oscillation.
10. What is an OP-AMP? What are the characteristics of an OP-AMP? Give the circuit symbol and state its applications.
11. Describe inverting and non-inverting OP-AMP.
12. Obtain the small signal low frequency ac equivalent circuit using hybrid parameters of a BJT in CE configuration and find the expression of current gain.

10 marks

1. What do you mean by h- parameter? Obtain the h- parameter equivalent circuit of a transistor amplifier in CE mode. Hence find the expression for current gain and voltage gain of the amplifier.
2. Draw the circuit diagram of a two stage RC coupled CE transistor Amplifier. Find out an expression for mid frequency gain of a single stage of this amplifier.
3. With a neat circuit diagram explain the operation of a Hartley oscillator. Find an expression of its oscillation frequency.
4. With a suitable circuit diagram explain the operation of an RC phase shift oscillator. Find the expression for frequency of oscillation and condition of oscillation.
5. With a proper circuit diagram discuss the principle of operation of RC phase shift oscillator. Obtain the expression of frequency in this oscillator.

Mathematical Problems:

1. A transistor amplifier has a voltage gain of 50. The input resistance of the amplifier is 1 k ohm and the output resistance is 40 K ohms. The amplifier is now provided with 10% negative voltage feed back in series with the input. Calculate the voltage gain.
2. An inverting amplifier has R_1 = 20 kΩ and R_f = 100kΩ. Find the output voltage, input current for an input voltage of 1 V.
3. The mid band gain of an RC coupled amplifier is 100. At frequencies 100Hz and 100kHz the gains falls to 60. Calculate the lower and upper cut off frequencies and Bandwidth of the amplifier.
4. The hybrid parameters of a transistor used as an amplifier in CE configuration are h_{ie}=800Ω, h_{fe}=46,h_{oe}=80× 10^{-6}mho and h_{re}=5.4× 10^{-4}. If the load resistance is 500K Ω and the effective source resistance 500 Ω, calculate the (i) current gain, (ii) the input resistance, (iii) voltage gain, (iv) output resistance.