B.E. MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM. (Old), - 2018

Subject: ELECTRONICS **Time: Three Hours** **Full Marks: 100**

Answer any **FIVE** questions. 5x20

(Questions must be answered serially and
All parts of the same question must be answered at one place only)

1. (a) Define i) ripple factor and ii) rectification efficiency.
   (b) Derive their expressions.
   (c) Evaluate them for a half-wave and a full-wave rectifier and compare.
   (d) The saturation current density of a Ge p-n diode at 27°C is 300 mA/m^2. What voltage must be applied to the diode to yield a forward current density of $6x10^5$ A/m^2? 4+3+8+5=20

2. (a) Show that the thermal equilibrium hole concentration is given by, .
   (b) The carrier effective masses in a semiconductor are $m_n^*=0.62m_0$ and $m_p^*=1.4m_0$. Determine the position of the intrinsic Fermi level with respect to the centre of the bandgap at T=300 K. Repeat the above problem if $m_n^*=1.10m_0$ and $m_p^*=0.25m_0$.
   (c) What is the junction capacitance? How does it help to determine built-in voltage V_{bi} across a p-n junction? 6+8+6=20

3. (a) Why the base width of a BJT is kept narrow? Why the device is named BJT?
   (b) Define α and β of a transistor. Derive the relation between them.
   (c) Show with the help of a diagram, the different current components with proper directions for an n-p-n transistor.
   (d) An n-p-n transistor with $\beta = 100$ is operated in the CB configuration. If the emitter current is 3 mA and the reverse saturation current is $I_{CO} = 10\mu A$, what are the base current and the collector current? (2+2)+(4+3)+4+5=20

4. (a) Draw a collector-to-base-biased transistor circuit in CE mode. Explain its working principle.
   (b) Derive the expressions for the input resistance, the output resistance and the voltage, current and power gains for a transistor amplifier using h-equivalent model. 5+5x3=20

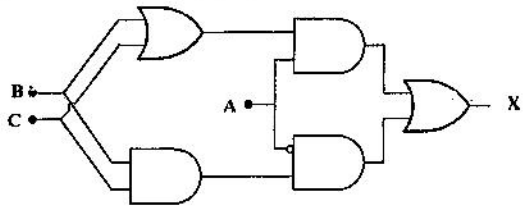
5. (a) Define pinch-off voltage of a JFET.
   (b) Describe capacitive action of MOS structure for all accumulation, depletion and inversion regions.
   (c) Define FET parameters μ, r_d and g_m. Derive and draw the small signal a.c. equivalent circuit of a FET.
   (d) Mention three advantages of FET over BJT. 2+6+(6+3)+3=20

6. (a) State the characteristics of an ideal OPAMP.
   (b) Define CMRR.
   (c) Differentiate between virtual ground and an actual ground.

(d) Explain the performance of a i) differential amplifier and a ii) differentiator using an OPAMP. 6+2+2+10=20

7. (a) Derive the logic expressions of a full-adder circuit from its truth table.
   (b) Perform the addition of 11011 and 10011 using block level diagrams of full-adder.
   (c) What is the fundamental difference between combinational and sequential digital circuits?
   (d) Explain the operation of a clocked (i) S-R and (ii) D flip-flop. 6+4+2+8=20

8. (a) In the following circuit, which of the following expressions give the output X?
   (i) $A\overline{B}+B\overline{C}+C\overline{A}$, (ii) $AB+BC+CA$, (iii) $\overline{A}.\overline{B}+\overline{B}.\overline{C}+\overline{C}.\overline{A}$



   (b) Show that, $A \oplus B = \overline{\overline{A+B}+\overline{A+B}}$
   (c) Draw a logic circuit using NOR gates to implement the Boolean expression $AB+\overline{B}.\overline{C}$.
   (d) Derive the logic expressions of a full-adder circuit from its truth table. 4x5=20