B.Sc. in TE (2-yr)
Semester: 3rd

Date: December 15, 2023
Time: 1.30 pm - 4.30 pm

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: EEE 4793
Course Title: Advanced Electronics

Winter Semester, A.Y. 2022-2023
Time: 180 Minutes
Full Marks: 150

There are **6 (six)** questions. Answer **6 (six)** questions. All questions carry equal marks. Marks in the margin indicate full marks. Do not write on this question paper. Symbols carry their usual meanings.

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1. a) Briefly explain direct and indirect semiconductors. From (E, k) diagram, describe direct and indirect electron transition semiconductors. 5

   b) Define fermi-dirac distribution function. What will be the shape of Fermi-dirac distribution function at T = 0 K and also at higher temperatures for the following cases. 10
   (i) $E < E_F$
   (ii) $E > E_F$
   (iii) $E = E_F$

   c) A Si sample is doped with 10^{19} As atoms/cm^3. What is the equilibrium hole concentration n_0 at 470 K? Where is E_F relative to E_i? ($n_i = 1.5 \times 10^{10}$, assuming $n_0 = N_d$) 10

2. a) What is effective mass? Calculate the density-of-states effective mass of electrons in Si. Discuss the temperature dependence of carried concentrations. 5

   b) Derive the expressions for concentration of electrons and holes in a semiconductor at equilibrium. 10

   c) Show schematically electrons and holes at thermal equilibrium by using fermi-dirac distribution function, density of states and band diagram for 10
   (i) Intrinsic semiconductors
   (ii) N-type semiconductors
   (iii) P-type semiconductors

3. a) Briefly discuss lattice scattering and impurity scattering. 5

   b) Show that current density is proportional to electric field. Use the derivations. Also show current density in terms of mobility. 10

   c) A Si bar 1.57 cm long and 152 cm^2 in cross-sectional area is doped with 10^{18} cm^{-3} phosphorus. Find the current at 343 K with 18.5 V applied. How long does it take an average electron to drift 1 cm in pure Si at an electric field of 100 V/cm? 10

4. a) Explain the Optical Absorption Process and Photoluminescence. 15

   b) A 0.46 mm-thick sample of GaAs is illuminated with monochromatic light of hv = 2eV. The absorption coefficient a is 5 X 10^4 cm^{-1}. The power incident on the sample is 10 mW. Find the total energy absorbed by the sample per second. 10

5. a) Explain the diffusion process of forming a Junction. 12

b) An abrupt Si p-n junction has $N_a = 10^{18}$ cm^{-3} on one side and $N_d = 5 \times 10^{15}$ cm^{-3} on the other. Calculate the Fermi level positions at 300 K in the p and n regions. 13

6. a) Sketch and explain the load line of a Transistor. 12

b) Describe the fundamental working principle of BJT with proper diagram. 13