Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S3 (S, FE) (FT/WP/S1PT) Examinations May/June 2026 (2019 Scheme)

Course Code: ECT201

Course Name: SOLID STATE DEVICES

Max. Marks: 100 Duration: 3 Hours

PART A

*Answer **all** questions. Each question carries **3 marks***

		Marks
1	Explain the variation in the position of Fermi level with doping of semiconductor?	(3)
2	Explain indirect recombination mechanism.	(3)
3	Explain the variation in mobility with respect to doping?	(3)
4	Explain Hall effect	(3)
5	Plot the minority carrier distribution across forward biased PN junction	(3)
6	Define work function and electron affinity?	(3)
7	Explain the impact of work function difference in the threshold voltage of a MOS device.	(3)
8	Differentiate between Enhancement and Depletion mode MOSFETs	(3)
9	Explain velocity saturation effect in short channel MOSFETs.	(3)
10	List the advantages of FinFET over MOSFET?	(3)

PART B

*Answer **any one full question** from each module. Each question carries **14 marks***

Module 1

11(a)	State and derive law of mass action	(10)
(b)	The Fermi level in a Si sample at 300K is located at 0.3eV below the bottom of the conduction band. The effective density of states $N_C=3.22\times10^{19}cm^{-3}$ and $N_V=1.83\times10^{19}cm^{-3}$. Determine (i) the electron and hole concentration at 300K (ii) the intrinsic carrier concentration at 300K	(4)
12(a)	Consider Si doped with 2×10^{15}donors/cm^3.Assume that $\tau_n = \tau_p = 5$ μs. Calculate the recombination coefficient α_r for the low-level excitation. Find the steady state excess carrier concentration $\Delta n = \Delta p$, if the sample is uniformly exposed to a steady state optical generation rate,	(4)

$gop = 10^{19}$ EHP/cm^3-s.

(b) Explain the temperature dependence of Fermi Dirac distribution in semiconductors (10)

Module 2

13(a) Derive continuity equation and Diffusion equation for electrons in a semiconductor. (7)

(b) A sample of Ge is doped with 10^{14} donors/cm^3 and $7x10^{13}$ acceptors/cm^3.If the intrinsic resistivity of the sample at a particular temperature is 60Ωcm, find the current density due to an applied electric field of 2V/cm at that temperature. (μ_n=3900cm^2/Vs ; μ_p=1900cm^2/Vs) (7)

14(a) Derive the expression for diffusion current density. (10)

(b) A sample of Si is doped with 10^{17} phosphorus atoms/cm^3. Calculate the resistivity, Hall coefficient and Hall voltage of the sample 100 μm thick, if μ_n=700cm^2/Vs, I_x = 1 mA and B_z = 1 kG = 10^{-5} Wb/cm^2. (4)

Module 3

15(a) Derive the terminal currents of p-n-p transistor (10)

(b) Calculate the contact potential V_0 of a Si p-n junction operating at 300K for Na=10^{15}cm^{-3} and N_d=10^{18} cm^{-3}. Also determine the maximum electric field E_0 at the junction. (4)

16(a) In an ideal PN junction at T=300K, find the magnitude of reverse bias voltage required to reach 75% of its reverse saturation current? [k=$1.38x10^{-23}$JK^{-1}, h=$6.625x10^{-34}$Js and q=$1.6x10^{-19}$] (7)

(b) With the aid of energy band diagram, explain how a metal N type Schottky act as a rectifying contact (7)

Module 4

17(a) Explain accumulation, depletion and inversion modes in MOS capacitor, with the aid of energy band diagram. (8)

(b) For a MOSFET with V_T = 1V and W = 50 μm, L = 2 μm, calculate the drain current at (i) V_G = 5 V, V_D = 0.1V and (ii) V_G = 3V, V_D = 5V. Assume an electron channel mobility μ_n= 200 cm^2 /V-s and the substrate is connected to the source. (6)

18(a) Derive the expression for drain current in the linear region and saturation region of a MOSFET. (7)

(b) Find the maximum depletion width, minimum capacitance C_i, and threshold voltage for an ideal MOS capacitor with a 10-nm gate oxide ($Si0_2$) on p-type Si with $N_a = 10^{16}$ cm^{-3}.[dielectric constant of Si=11.8, dielectric constant of oxide=3.9] (7)

Module 5

19(a) Distinguish between constant voltage scaling and constant field scaling (7)

(b) Explain the structure and operation of FinFET (7)

20(a) Explain subthreshold conduction in a MOSFET. Explain slope factor and its significance (7)

(b) Explain drain induced barrier lowering and hot carrier effect in a short channel MOSFET (6)

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