Name:

Enrolment No:

UPES

End Semester Examination, Dec 2024

Programme Name: MSc Physics **Semester: I**

Course Name: Analog Electronics **Time: 03 hrs**

Course Code: ECEG7034 **Max. Marks: 100**

Nos. of page(s):2

Instructions: [a] A scientific calculator is allowed. [b] Symbols have their usual meanings

SECTION A
Answer all questions

S.No.		Marks	CO
Q 1	Derive the expression for the intrinsic carrier concentration (n_i) in a semiconductor.	**5**	**CO1**
Q 2	For a reverse-biased P-N junction, derive the expression for junction capacitance (Cj) and explain how it varies with the applied reverse voltage.	**5**	**CO2**
Q 3	A silicon P-N junction diode has a reverse saturation current of $I_s = 10^{-12} A$ at 300K. Calculate the forward current when the diode is forward-biased with a voltage of 0.7 V. (Use kT/q=0.0259V).	**5**	**CO3**
Q 4	What is Op-Amp. Briefly describe the five practical applications of Op-Amps in the electronics industry.	**5**	**CO4**

SECTION B
Answer all questions (Q 5 has an internal choice)

Q 5	In a silicon sample at 300 K, the electron mobility μ_n is 1350 cm^2/V-s, and the hole mobility μ_p is 480 cm^2/V-s. An electric field E of 1000 V/cm is applied across the sample. Calculate the drift current density J_{drift} if the electron concentration $n=10^{16}$ cm^{-3} and the hole concentration $p=10^{15}$ cm^{-3}. **OR** Derive the Einstein relation (relationship between diffusion coefficient and mobility) for a semiconductor.	**10**	**CO1**
Q 6	Sketch the I-V characteristics of an LED. Explain how LEDs emit light, and describe one application of LEDs in optoelectronics.	**10**	**CO2**
Q7	Explain the purpose of adding an emitter resistor R_E in a common-emitter amplifier circuit. How does the emitter resistor contribute to the stability of the amplifier's operating point?	**10**	**CO3**
Q8	An ideal Op-Amp integrator has a feedback capacitor, C=1μF and an input resistor, R=100kΩ. If a constant input voltage V_{in}=1V is applied, find the output voltage V_{out} as a function of time.	**10**	**CO4**

SECTION C **Answer any one question (Question 10 has an internal choice)**			
Q 9	What is FET? What are the differences between FET and BJT? Give the construction and working of n channel JFET with a proper diagram. Explain the output characteristics and transfer characteristics of n-channel JFET.	**2+5+7 +6**	**CO3**
Q 10	[a] What is feedback? Explain the negative feedback with a diagram. Derive the expression of its voltage gain. [b]An inverting amplifier circuit is built with an operational amplifier, where the input resistor R_{in}= 5kΩ and the feedback resistor R_f = 50 kΩ. If the input voltage V_{in}= 0.5V, calculate the output voltage V_{out}. Assume an ideal op-amp. OR [a] Explain how an Op-Amp works as an integrator. Provide an example of a real-world application [b] Derive the Barkhausen criterion for oscillation and explain why it is necessary for oscillator circuits	**10+10**	**CO4**