Roll No. ……

Name of the Department	:	Department of Physics and Astrophysics
Name of Course	:	B.Sc. Hons. - CBCS
Semester	:	IV - Semester
Name of the Paper:	:	Analog Systems and Applications
Unique Paper Code	:	32221403_OC
Question paper Set number	:	Set 2
Duration	:	3 hours
Max. Marks	:	75 marks

Attempt <u>FOUR</u> questions in all. All questions carry equal marks

(Given : $\varepsilon_o = 8.85 \times 10^{-12}\ F/m$; $k = 1.38 \times 10^{-23}\ J/K$; $q = 1.6 \times 10^{-19}$C)

Q1

(a) Sketch the variation of the space charge, depletion region, electric field and electrostatic potential barrier as a function of distance across the junction, for an unbiased *p-n* Junction. Obtain an expression for the width of depletion region for an unbiased *p-n* junction diode. (15)

(b) Determine the forward bias voltage applied to a silicon diode to cause a forward current of $10mA$ and reverse saturation current of 2.5 μA at room temperature. (3.75)

Q2

(a) In a full-wave rectifier, the voltage applied to each diode is *240sin377t*, the load resistance is 2000Ω and each diode has a forward resistance of 400Ω. Determine the (i) Peak, average and *rms* value of current (ii) efficiency of the rectifier and (iii) ripple factor. (7)

(b) Determine the maximum allowable Zener current for a Zener diode (20 V, 1200 mW) working as a voltage regulator. Also determine the range of input voltage to keep Zener diode under regulation if the values of limiting resistance and the fixed load resistance are $1k\Omega$ and $20k\Omega$ respectively. Support your answer with the voltage regulator circuit diagram. (8)

(c) Give two advantages and two limitations of using a LED. What is the wavelength of emitted electromagnetic radiation if the band gap value of a semiconductor is 1.43 *eV*. (3.75)

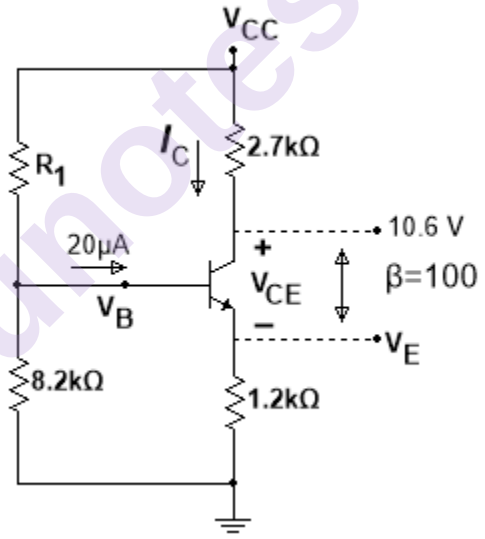
Q3

(a) Describe the construction of a transistor including emitter, base and collector. Explain how current flows due to charge carriers in *npn* transistor. (3.75)

(b) Define current gain in CB configuration (α) and current gain in CE configuration (β). Derive the relation between them. (3)

(c) Find the following for the circuit below, (12)

(i) I_C.
(ii) V_E.
(iii) V_{CC}.
(iv) V_{CE}.
(v) V_B.
(f) R_1.



Q4

(a) Draw the circuit diagram of an RC coupled amplifier. Give the AC equivalent circuit in low, mid and high frequency range and state the associated assumptions for each frequency range . Derive an expression for voltage gain in low frequency region. (8.75)

(b) Define stability factor. Explain how addition of emitter resistance enhances the stability of the fixed bias circuit. (6)

(c) For an *npn* transistor $\alpha = 0.98$, $I_E = 10\ mA$ and the leakage current I_{CBO}=0.4μA. Calculate the values of I_C , I_B , β and I_{CEO}. (4)

Q5

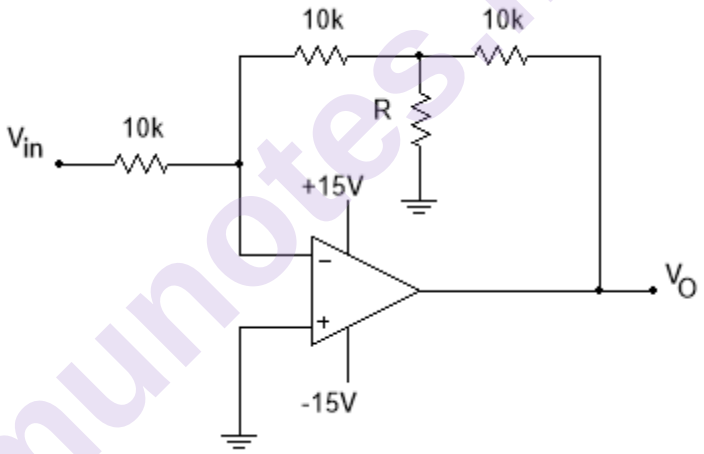
(a) An amplifier has a mid-band gain of 100 and a bandwidth of 250 *kHz*. If 4% negative feedback is introduced, find the new bandwidth and gain. (4)

(b) Derive the expression for frequency of oscillation and the condition for sustained oscillations for a RC phase shift oscillator. (9)

(c) A Colpitts oscillator is designed with capacitor $C_1 = 100pF$ and $C_2 = 7500pF$ and a variable inductor. Determine the range of inductance, if the frequency of oscillations is to vary between 950 kHz to 2050 kHz. (5.75)

Q6

(a) Determine the value of the resistance R the given circuit if the gain of the circuit is 10. (5)



(b) Derive an expression for frequency of oscillations and the condition for sustained oscillations for a Wien bridge oscillator using op-amp. In which frequency range it can be used. (8.75)

(c) Derive an expression for output of an ideal integrator. What are the limitations of ideal op-amp integrator? Give the circuit of practical integrator and explain how these limitations can be overcome. (5)