Question Paper Set No. : Set B

Roll No. ……

Name of Course	:	B.Sc. Hons. Physics-CBCS_Core
Semester	:	IV- Semester
Name of the Paper:	:	Analog Systems and Application
Unique Paper Code	:	32221403
Duration	:	2 hours
Max. Marks	:	75 marks

Attempt FOUR 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

This sample is doped with 10^{14} donor *atoms/cm*^{3} and 5×10^{13} acceptor *atoms/cm*^{3}. The resistivity of pure Ge is 65 *Ω-cm* at the room temperature. Find the total current density if the applied electric field is 2.2 *V/cm*. (Given $\mu_N = 3800 cm^2 V^{-1} s^{-1}$ and $\mu_P = 1800 cm^2 V^{-1} s^{-1}$

In a *pn*-junction diode, J is the total current density when a forward bias voltage V is applied across it. Determine the relationship between J and V.

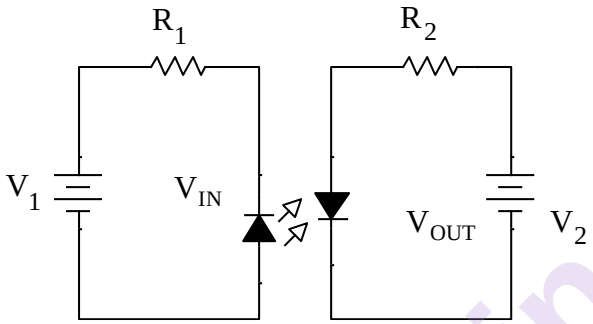
An abrupt *pn* junction at 27°*C* is doped with acceptor concentration of 5×10^{16} *atoms/cm*^{3} and donor concentration of 8×10^{15} *atoms/cm*^{3}. Determine the capacitance per unit area of the device if a reverse bias of 0.2*V* is applied across the diode. (Given $\varepsilon_r = 11.7$; $n_i = 1.5 \times 10^{10}$ *per cm* ^{3}).

Q2

A full-wave bridge rectifier is to be designed to produce a peak output voltage of 20 *V* and 180 *mA* current to the load. An input line voltage of 100 *V* (rms), 60 Hz is available. Calculate the transformer turn ratio and the value of the capacitor to produce an output with a ripple of not more than 12 percent. Draw the complete circuit of the designed rectifier. (Assume the diode cut-in voltage as 0.7*V*).

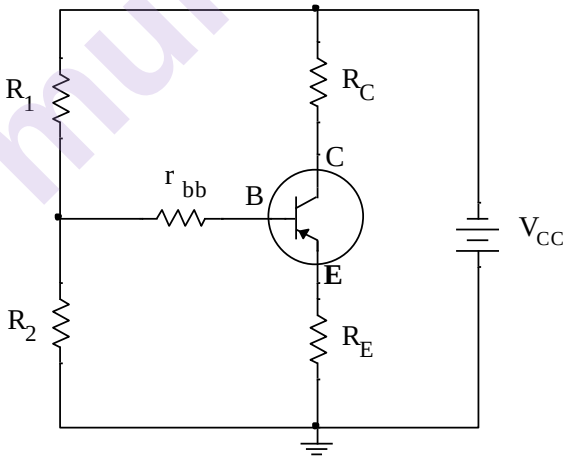
List any two features of a pn-junction diode which exhibits a negative resistance region. Plot its I-V characteristics and explain with the help of energy band diagrams the conduction mechanism in the negative resistance region.

Draw the I-V curve across both the types of diodes in the following figure.



Q3

Discuss how addition of emitter resistance stabilizes the voltage-divider bias circuit. The self-biased transistor as shown in figure below has following the specifications; V_{CC} = 4.5 *V*, R_C = 1.5 *kΩ*, R_E = 0.27 *kΩ*, R_1 = 27 *kΩ*, R_2 = 2.7 *kΩ* and β = 44. Find the value of the stability factor and also determine the Q-point when resistance r_{bb} is neglected, as well as when $r_{bb} = 690\ \Omega$ is taken into account.



Q4

For any transistor amplifier prove that

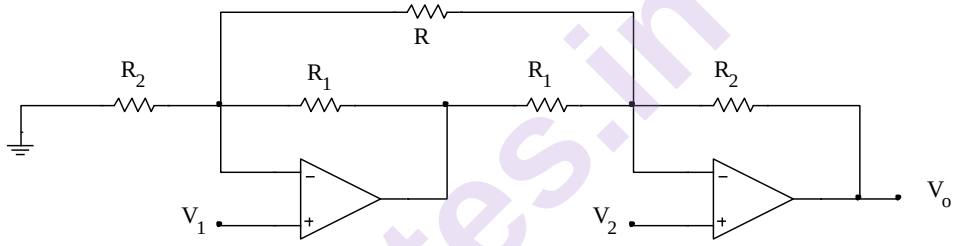
$$R_i = \frac{h_i}{1 - h_r A_V}$$

The following information is available for generalized feedback network. Open loop voltage amplification A_V = -100, input voltage of the system V_i = 1 *mV*. Determine closed loop voltage amplification, output voltage, feedback voltage, input voltage to amplifier and type of feedback for β = 0.01. Also determine percentage variation in closed loop voltage amplification resulting from 100 percent increase in open loop voltage amplification.

Q5

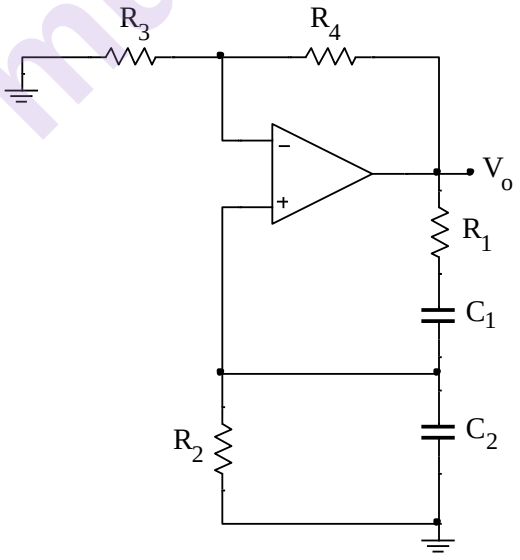
For the circuit shown below show that

$$V_o = \left(1 + \frac{R_2}{R_1} + \frac{2R_2}{R}\right)(V_2 - V_1)$$



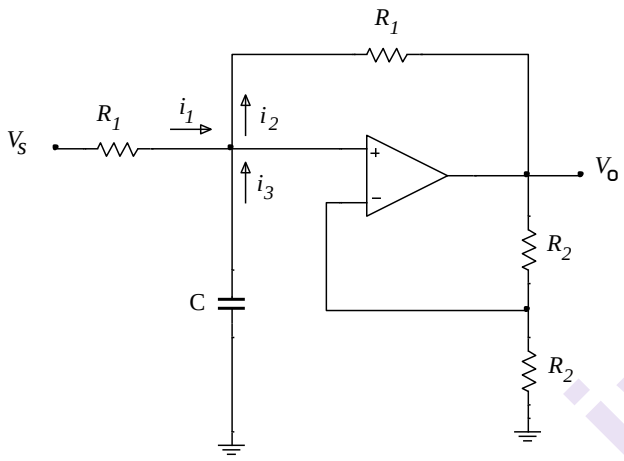
Deduce an expression for the frequency of oscillations for the circuit below if

$$R_1 = R_2 = 1.5k\Omega \;\; ; \;\; R_3 = 1k\Omega \;\; ; \;\; R_4 = 2k\Omega \;\; ; \;\; C_1 = C_2 = 4.7\,\mu F$$

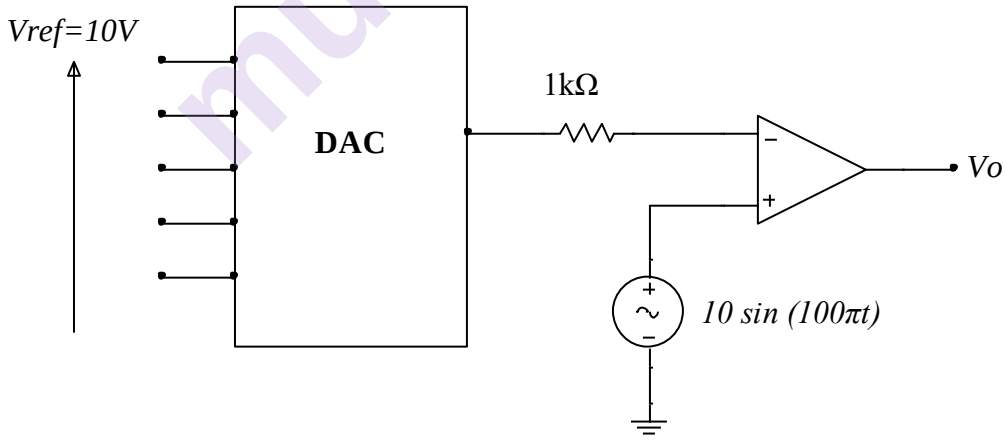


Q6

For the circuit given below determine the relation between *Vo* and *Vs*. Also comment on the function of the circuit.



The output corresponding to a digital input 11001 and V_{ref} =10*V* of an op-amp based 5-bit binary weighted DAC is fed to the inverting terminal and an *ac* signal *10 sin100πt volts* is fed to the non-inverting terminal of another op-amp as shown in the figure. Show the complete circuit of the DAC if $R_F = 1k\Omega$ and $R = 32k\Omega$. Also determine the output V_o and draw its waveform.



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