INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date 02/02/2011 FN / AN Time : 2 / 3 Hrs. Full Marks 60 No. of Students 600

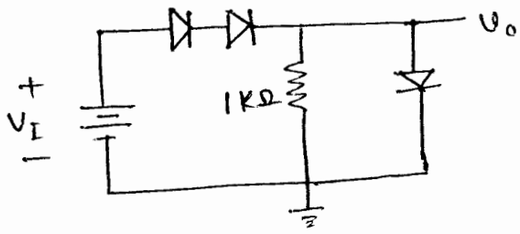
Autumn / Spring Semester, Deptt. E & ECE Sub. No EC 21101

2nd Yr. B.Tech. (H) / B.Arch. (H) / M.Sc. Sub. Name

Instruction

1.

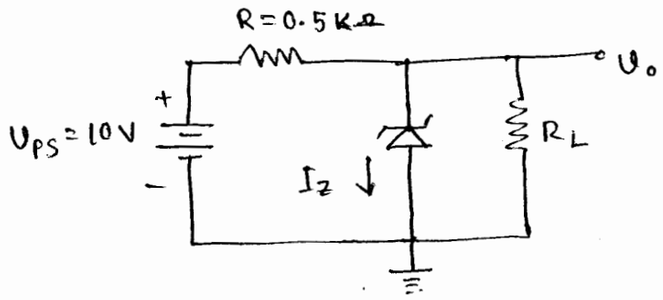
a) The reverse-saturation current of each diode in the circuit shown in figure is Is = 2×10^{-13} A. Determine the input voltage V_I required to produce an output voltage of V_0 = 0.60 V. 6



b) A pn junction diode is in series with a 100-kΩ resistor and a 3.5 V power supply. The reverse saturation current of the diode is Is =5 nA. Determine the diode current and voltage if the diode is forward bias and reverse bias. 6

2.

a) Consider the zener diode circuit shown in figure. The zener breakdown voltage is Vz=5.6 V at Iz = 0.1mA and the incremental zener resistance is r_z=10 Ω . Determine Vo with no load (R_L= ∞) and find the change in output voltage if V_{ps} = 10 V and R_L= 2 KΩ. 7



b) A voltage regulator consists of a 6.8 V zener diode in series with a 200 Ω resistor and a 9 V power supply. Neglect r_z. Determine the diode current and power dissipation. 5

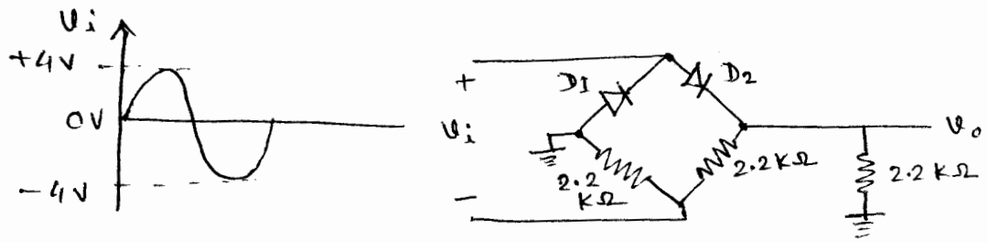
3.

a) The reverse-saturation current of a silicon pn junction diode at 300 K is Is=10^{-12} A. Determine the temperature range over which Is varies from 0.5 pA to 50 pA . 6

b) A pn junction diode has saturation current Is=10^{-15}A. Determine the diode voltage if I_D=150 μA. Also determine the diode current for V_D= 0.2V, 0 V and -3 V. 6

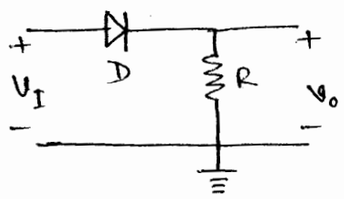
4.

a) Sketch Vo vs time for the circuit given in figure. Assume that Vγ=0 V. 6



b) For the circuit in figure show that for $v_I > 0$, output voltage is given by 4

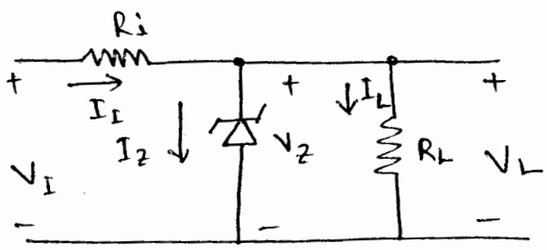
$v_o = v_I - V_T \ln(v_o/I_s R)$



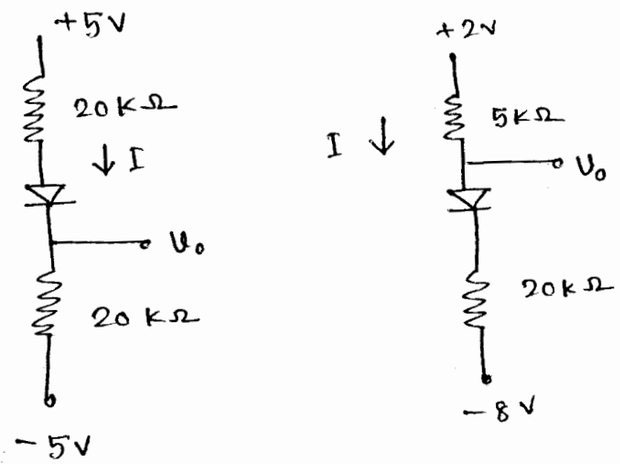
c) Mention advantages of bridge rectifier over conventional full-wave rectifier. 2

5.

a) In the voltage regulator circuit in Figure, let V_I=6.3 V, R_i= 12 Ω and V_z = 4.8 V. The zener diode current is to be limited to the range 5< I_z < 100 mA. Determine the range of possible load currents and load resistances. Also determine the power rating required for the zener diode and load resistor. 6



b) If the diode cut-in voltage is 0.7 V , then determine the out-put voltage(V_0) for the following circuits. 6



Avogadro's number	$N_A = 6.02 \times 10^{23}$ molecules/mole
Boltzmann's constant	$k = 1.38 \times 10^{-23}$ J/K
	$= 8.62 \times 10^{-5}$ eV/K
Electronic charge (magnitude)	$q = 1.60 \times 10^{-19}$ C
Electronic rest mass	$m_0 = 9.11 \times 10^{-31}$ kg
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-14}$ F/cm
	$= 8.85 \times 10^{-12}$ F/m
Planck's constant	$h = 6.63 \times 10^{-34}$ J-s
	$= 4.14 \times 10^{-15}$ eV-s
Room temperature value of kT	$kT = 0.0259$ eV
Speed of light	$c = 2.998 \times 10^{10}$ cm/s

1 Å (angstrom) $=10^{-8}$ cm	Prefixes:		
1 μm (micron) $= 10^{-4}$ cm	milli-,	m-	$= 10^{-3}$
1 nm $= 10$ Å $= 10^{-7}$ cm	micro-,	μ-	$= 10^{-6}$
2.54 cm = 1 in.	nano-,	n-	$= 10^{-9}$
1 eV $= 1.6 \times 10^{-19}$ J	pico-,	p-	$= 10^{-12}$
	kilo-,	k-	$= 10^{3}$
	mega-,	M-	$= 10^{6}$
	giga-,	G-	$= 10^{9}$

A wavelength λ of 1 μm corresponds to a photon energy of 1.24 eV.

		E_g (eV)	μ_n (cm^2/V-s)	μ_p (cm^2/V-s)	m^*_n/m_o (m_l, m_t)	m^*_p/m_o (m_{lh}, m_{hh})	a (Å)	ϵ_r	Density (g/cm^3)	Melting point (°C)
Si	(i/D)	1.11	1350	480	0.98, 0.19	0.16, 0.49	5.43	11.8	2.33	1415
Ge	(i/D)	0.67	3900	1900	1.64, 0.082	0.04, 0.28	5.65	16	5.32	936
SiC (α)	(i/W)	2.86	500	—	0.6	1.0	3.08	10.2	3.21	2830
AlP	(i/Z)	2.45	80	—	—	0.2, 0.63	5.46	9.8	2.40	2000
AlAs	(i/Z)	2.16	1200	420	2.0	0.15, 0.76	5.66	10.9	3.60	1740
AlSb	(i/Z)	1.6	200	300	0.12	0.98	6.14	11	4.26	1080
GaP	(i/Z)	2.26	300	150	1.12, 0.22	0.14, 0.79	5.45	11.1	4.13	1467
GaAs	(d/Z)	1.43	8500	400	0.067	0.074, 0.50	5.65	13.2	5.31	1238