EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST SEMESTER 2009/2010
SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN INSTRUMENTATION AND CONTROL ENGINEERING

ICEN 221 - ELECTRONICS DEVICES

STREAM: **TIME:** 2 HRS

DAY: TUESDAY, 8.30 – 11.30 A.M. **DATE:** 08/12/2009

Instructions

i. *Answer any five questions*
ii. *All questions carry equal marks*
iii. *Exam takes 2 hours 30 minutes*
iv. *Do not write on the question paper*
v. *All the rough work should be done the answer booklet*

Constants:

Charge of an electron:	**1.6×10^{-19} C**
Mass of an electron:	**9.1×10^{-31} Kg**
Planck's constant:	**6.625×10^{-34} JHz^{-1}**
Permittivity of free space:	**8.854×10^{-12} C^{2}J^{-1}m^{-1}**
Boltzmann's constant:	**1.38×10^{-23} J/k**

Question 1

a) A germanium atom has an atomic number 32, and energy gap of 0.72 eV,

i. Draw the electrons distribution diagram **[2 marks]**

ii. If an electron recombines with a hole, compute the wavelength of the resulting radiation **[2 marks]**

iii. Compute the energy of an electron revolving in the conduction band **[4 marks]**

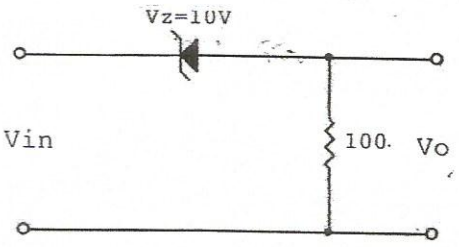
iv. What is the radius of the valence orbit? **[2 marks]**

2, 4, 6, 7, 5, 3

b) From the circuit given below,

i. Calculate the value of Vo, for Vin=6V and for Vin=20V **[2 marks]**

ii. Explain the results obtained in part (i) **[2 marks]**



Question 2

a) Explain What courses the following phenomenon in a P-N junction **[8 marks]**

i. Formation of depletion layer

ii. Existence of barrier potential

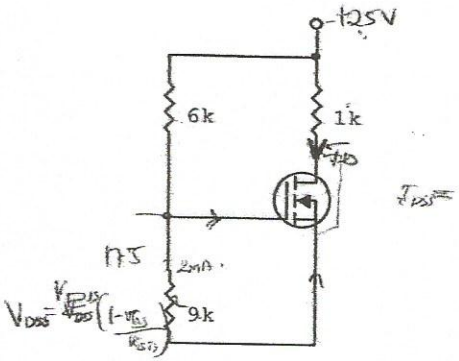
iii. Existence of junction capacitance

iv. High resistance in reverse bias

b) State two reasons why, Gallium arsenide (GaAs) is one of the compound semiconductor grapping the area of microwave semiconductor devices. **[2 marks]**

c) The data sheet of E-MOSFET in the circuit below gives $I_{D(on)} = 4mA$ at $V_{GS}=10V$ and $V_{GS(th)}=5V$. Calculate the V_{GS} and V_{DS} for the circuit. **[4 marks]**

Supply V=25V.



Question 3

a) A half-wave rectifier using silicon diode has a secondary e.m.f of 14.14V (rms) with internal resistance of 0.2Ω. The diode has a forward resistance of 0.05Ω and a threshold voltage of 0.7V. If the load resistance is 10Ω, determine **[6 marks]**

i. DC load current

ii. DC load voltage

iii. Efficiency

b) With the aid of a circuit diagram explain the working of a BJT as switch **[4 marks]**

c) State the difference that exist in conductivity of the following

i. Metals and semiconductors

ii. P-type and N-type semiconductors

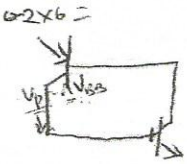
[4 marks]

Question 4

a) A given UJT has an inter-base resistance of 10K. It has R_{B1}=6K with I_E=0. Find
   i. UJT current if V_{BB}=20V and V_E is less than V_P **[2 marks]**
   ii. Intrinsic standoff ratio η and V_A **[2 marks]**
   iii. Peak point voltage V_P **[2 marks]**

b) With reference to MOSFETs explain the formation of virtual Channel **[6 marks]**

c) Define the following terms with reference to IC technology.
   i. Circuit probing
   ii. Metallization **[2 marks]**



Question 5

a) Manufacturers data sheets shows that an LED has maximum forward voltage of 1.8V, reverse breakdown voltage of 10V, if the LED maximum forward current is 15mA,
   i. Design a power on indicator circuit that feeds on AC. **[3 marks]**
   ii. State two other applications that LEDs are used. **[2 marks]**

b) The reverse saturation current of a NPN transistor in common – base circuit is 12.5μA. For an emitter current of 2mA, collector current is 1.97mA. Determine the current gain and the base current **[3 marks]**

c) Using the two transistor analogy, explain the operation of SCR **[6 marks]**

Question 6

a) Discuss the working of JFET with the help of its drain characteristics **[8 marks]**

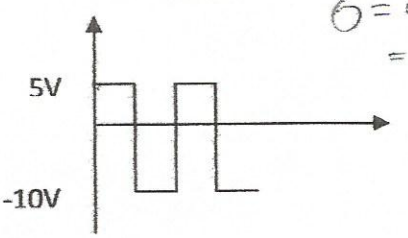
b) Silicon is doped with acceptor atoms to a density of $10^{22} m^{-3}$. If it is assumed that all the acceptor centres are ionized, calculate the conductivity of the extrinsic silicon, given that the intrinsic density is $1.41 \times 10^{16} m^{-3}$, mobility of electron = $0.145 m^2/V\text{-}s$ and mobility of holes= $0.05 m^2/V\text{-}s$. **[4 marks]**

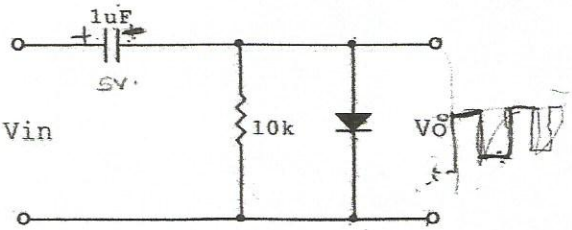
c) Explain the zener breakdown mechanism **[2 marks]**

Question 7

a) The input signal in the figure below is applied to the clamper circuit adjacent,
   i. Draw the output waveform Vo
   ii. State the necessary condition for the circuit to operate as a clamper circuit
   iii. Draw the waveform when R is changed to 100Ω
   iv. Comment on the shape obtained in part (iii). **[8 marks]**

f=1000Hz



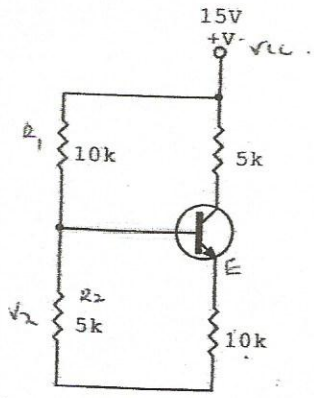


b) From the basic transistor current equations derive the relationship between α and β. **[4 marks]**

c) Explain how thermal runaway condition is attained in a transistor **[2 marks]**

Question 8

a) Find the VCE and VE for the circuit given below **[4 marks]**



$I_C \cong I_E$

$V_{CE} = V_{CC} - I_C(R_C + R_E)$

$= 15 - 0.5\times10^{-3}(5 + 10)$

$= 15 - 0.0075$

$= 14.99\,V$

$V_2 = V_{CC} \times \frac{R_2}{R_1+R_2} = \frac{15\times5}{15} = 5V$

$I_E = \frac{V_2 - V_{BE}}{R_E} = \frac{5}{10\times10^3} = 0.5$

$V_E = 0.5\times10^{-3}\times10^{+3} = 5V$

b) Explain why the output signal of CE circuit is 180° out of phase **[2 marks]**

c) Compare abrupt- junction and hyperabrupt-junction varactor diodes **[4 marks]**

d) State three roles of a bleeder resistor in a power supply **[3 marks]**

e) State the precaution that would take when handling MOSFETs out of circuit **[1 mark]**

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