Assiut University Faculty of Science Physics Department	Final Exam for Amorphous & Glassy Materials (P457)	Fourth Level-Physics Time allowed :3 h Date: 26-12-2018

Answer five only from the following questions: (50 Marks)

Part I: Answer this question: (10 Marks)

Q.1: Choose the correct answer to these statements:

1- The viscosity of the solids materials when transforms from solid to liquid state undergoes:

a)- strong decrease b)-strong increase c)- slight increase d)- remain constant

2- At the crystallization region of amorphous solids, the temperature of the material generally :

a)- decreases b)- increases c)-remain the same d) very strongly decreases

3)-Addition of Alkali oxides to silicate glass resulted in:

A)-increase network connectivity b) increases the viscosity

c)- decreases diffusion coefficient d)- reducing chemical resistance

4)- The easiest and popular technique generally used to prepare amorphous thin films is:

a)- melt quench b)- CVD c)- Thermal evaporation d)-MBE

5)- The refractive index of amorphous thin films depends on :

a)-materials type b)-wavelength of incident photons

c)- Film thickness d) all the above mentioned

6)-For amorphous semiconducting material of band gap 3.5 eV, band to band electronic absorption takes place for wavelengths lies in the

a)_ IR region b)- UV region c)- VIS region d)- FIR region

7)- Glass former elements usually of high valance state and forms with oxygen

a)- convent bonds b)- ionic bonds c)- metallic bonds d)- a,b

8)- Variable range hopping conduction takes place:

a)- between nearest neighbor atoms b)- between dopant atoms at low temperature

c)-between localized states at Fermi level d)- inside conduction band

9)- During DSC experiments, the chemical potential energy in the glassy sample changes to heat during:

a)-glass transition region b)- crystallization region

c) melting region d)- All the above

10)- The x-ray diffraction technique can be used to characterize the amorphous materials to determine:

a)- its unit cell parameters b) the chemical composition

c)- d) the average coordination number d)-the bond type

Part II:

(40 Marks)

Answer[four only] from the following questions (all questions are of equal marks -10 marks for each):

Q.1:

a)- State briefly why for the following:

i) Addition of soda –ash to SiO_2 during glass preparation is very important

ii)- Amorphous solids soften over a range of temperature

iii)- The density of crystalline quartz glass is greater than that of viperous silica

b)- Using bond sketch diagram describe what will happen when alkaline earth oxide is added to i)- Silicate glass (SiO_2) ii)- borate glass (B_2O_3)

Q.2:

a)- Write a mathematical expression for the following:

1- The free volume (V_f) of a glass:

.....

2- The average coordination number of a binary amorphous alloy A_xB_y

.....

3- The optical loss of photon energy in a glassy sample

.....

4- The Einstein relation (in 3-D) for ionic conductivity (σ) when E> 0

.....

5- Tauc relation for the band to band absorption of photons in amorphous semiconductors

.....

b)- Explain briefly <u>two only</u> from the following:

i)- Zaharissen rule for oxide glass formation.

ii)- Main parts of thermal analyzer instruments.

iii)- Advantages and disadvantageous of thermal evaporation technique for thin film preparation.

Q.3:

a)- Compare between extended state and variable. –range hopping conduction mechanism in amorphous semiconductors. Explain how you can use the σ vs T experimental data to determine the activation energy (ΔE) for extended state conduction.

b)- The development of smart glasses depends mainly on the phenomena's of electrochromic and photochromic glasses. Discuss this statement and what are the new applications in our everyday life.

Q.4:

a)-Write on two only from the following:

i- Chalcogenide glasses and their properties.

ii- Factors affect the density of glasses.

iii- Pauling,s rule for polyhedron oxide glass formation;

b)- Explain how you can use the experimental data of the absorption coefficient (α) vs hv in the Uv-IR range of spectrum for amorphous semiconductor thin film to calculate:

i- The optical energy gap (Eg).

ii- The Urbach band tail (Ee).

Q.5:

a)- Plot a sketch diagram for DSC experiment for a glassy sample at three different heating rates from room temperature to the above melting point of the material.
i- Explain what happens to the sample and the surrounding at each stage.
ii- How you can extract some data from these thermograms to calculate Et and Ec using Kissinger equation.

b)- Discuss briefly the optical loss mechanisms in these materials:

i- Amorphous optoelectronic semiconductors.

ii- Soda-lime glass.

With my best wishes

Prof. Dr. Atta Y. Abdel-latief

Faculty of science Physics department	Semiconductor physics, thin films and its application (451p) Date: 15/1/2019 time: 3hrs	

Answer the following questions:

Q1. (a) Explain in details ***two only*** of the following (preparation, characterization and application) :

1. Light emitting diodes.
2. Solar cells.
3. Semiconductor laser diode.
4. Photodiode and photo-detector.

(b) Drive an equation for the density of electrons in the intrinsic semiconductors. Discuss the different types of exciton absorption process in semiconductors.

(12 mark)

Q2. (a) Discuss the different types of exciton absorption process in semiconductors.

(b) The complex dielectric constant of CdS is given by the relation:

$$\varepsilon * = 8.2 + i\,2.5$$

At wavelength $\lambda = 480\ nm$. Deduce the refractive index (n), the phase velocity (υ), the extinction absorption coefficient (α) and the reflectivity (R).

(c) The band gap of an alloy semiconductor gallium arsenide phosphide is 1.98 eV. Calculate the wavelength of radiation that is emitted when the direct recombination from conduction band to valence band between electrons and holes occurs. **(12 mark)**

Q3.(a) Explain in details ***two only*** of the following:

(1).Photoluminescence emission and recombination process of charge carriers in semiconductors. (2).Thermo-luminescence process. (3).Determination of minority carrier life time in P- type semiconductor from A.C photoconductivity measurements.

(b) Deduce an expression for allowed and forbidden direct absorption transition.

(12 mark)

Q4.(a) Write an essay on the different types of experimental techniques of thin films preparation.

(b) Determine the position of Fermi level and calculate the density of holes and electrons for an intrinsic semiconductor at 450 °K where the energy band gap, E_g= 3.2 eV, $m^*_p = 8\ m^*_e$ and $C=4.83*10^{22}$. **(14 mark)**

With my best regards

Prof. M. A. Osman

Ω η δ β ρ σ ξ μ φ θ ζ π α Θ ν λ τ γ = ~

Assiut University Faculty of Science Department of Physics	Term: fall 2018 - 2019 Date : Jan. 3rd, 2019 Time: 3 hours

Final Exam/ Course Title: Selected topics in Physics (1) (491P)

The exam in 2 pages (50 marks)

Answer all of the following questions:

Question (I): (15 Marks, 5 marks per each)

1. Derive the eigenvalue equation for the transverse magnetic (TM) mode in an infinite slab waveguide. Throughout your answer, define the effective refractive index, the mode number, the normalized frequency, and the cut off frequency.

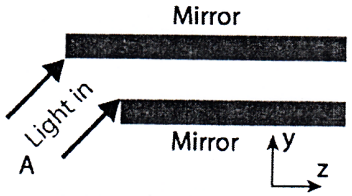
2. Prove that the envelope of the intensity pattern of two interfered beams is inversely proportional to the half-width at half maximum of the spectral line of these beams.

3. In the below figure, light is reflected successively between two surfaces of lossless mirrors. The incident light with an angle 45°, at A, is expressed as a plane wave having an electric field in the plane of the paper. The light is propagated in the z-direction. Estimate the ratio between the longitudinal component and the transverse component of the electric field. Also, calculate the phase velocity in the z-direction.

Hint: Start with the electric field in the form of plane wave:

$$E = \mathrm{Re}\{E_0 e^{i(k.r-\omega t)}\}$$

where $E_0 = (E_x, E_y, E_z)$, $r = (x, y, z)$, and the prpogation constant $k = (k_x, k_y, k_z)$



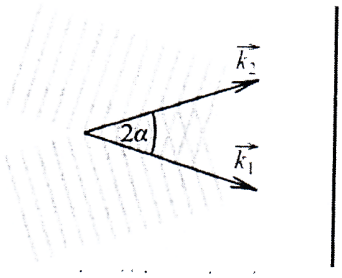
Question (II): (15 Marks, 7.5 marks per each)

1. Calculate the optical power in two waveguides optically coupled in the forward direction. Throughout your answer, show the conditions of the phase matching and non-phase matching and explain the physical meaning of the mutual coupling coefficients.

2. If atoms emit light with an electric field $E = E_0 \sin(\omega_0 t) e^{-\gamma t}$. In high-pressure, strong collisions among the atoms vanish the emission of light. Assuming τ is the mean time between the collisions, derive an expression for the intensity of the spectrum in the frequency domain.

Question (III): (10 marks, 5 marks per each)

1. As shown in the front figure, two plane waves of the same frequency and amplitude propagate through vacuum with an angle 2α formed between the wave vectors. Calculate the density of electric energy of the resulting electromagnetic wave on a screen $w_E = {}^1/_4\, \varepsilon_0 \vec{E} \cdot \vec{E}^*$ that is is perpendicular to the sum wave vector $\vec{k}_1 + \vec{k}_2$. Presume that the amplitude of the electric field of both waves is perpendicular to the plane given by the wave vectors $\vec{k}_1$ and $\vec{k}_2$. Use the following complex descriptions of the waves $\vec{E}_1 = \vec{E}_0 e^{j(\omega t - \vec{k}_1 . \vec{r})}$ and $\vec{E}_2 = \vec{E}_0 e^{j(\omega t - \vec{k}_2 . \vec{r})}$.



Look at the back page

2. Using the Fresnel integral, derive the optical intensity diffracted from a finite slit with width D which is uniformly illuminated.

Question (IV): (10 marks, 5 marks per each)

1. In multilayer thin films, describe the relation between the electric and magnetic fields at the layer i and those of the preceding layer $i-1$ for the P-polarization.

2. In the below Figure (Fig. a), a grating with a groove period b having n slits and is illuminated with light of wavelength λ. A screen is positioned parallel with the grating at a distance L.
Calculate the distribution of the light intensity on the screen, assuming that the slits are linear sources of cylindrical waves where the electric field of one cylindrical wave at distance r from its source slit is

$$\vec{E}_{cyl} = \frac{\vec{E}_0}{r} e^{j(\omega t - \vec{k}.\vec{r})}$$

Hints: In this problem,
(i) Calculate the total electric field E at a point on the screen using the below schematic graph (Fig. b).
(ii) The intensity is given by $I = (1/2Z_0)EE^*$ where Z_0 is the impedance and E is the total electric field at a point on the screen.

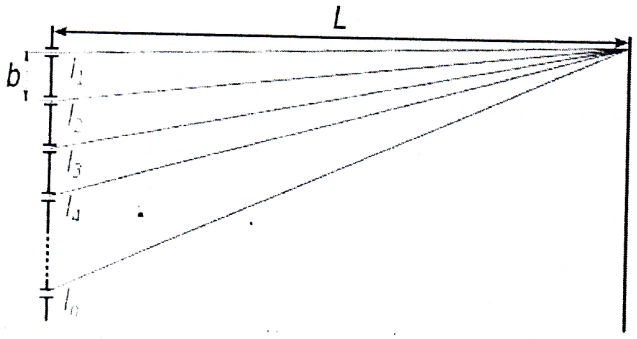


Fig. a

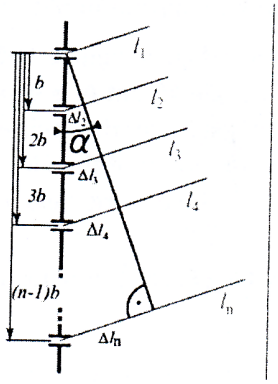


Fig. b

End of exam,
***Best wishes!* Dr. Hesham Fares**

Assiut University Faculty of Science Physics Department		Level: Undergraduate Date:13.01.2019 Allowed time: 3 hours
Course code: P453	Course Title: NMR & Mössbauer spectroscopy	

Question (1): Please put (T) for true and (F) for False for each of the following statements (20 points)

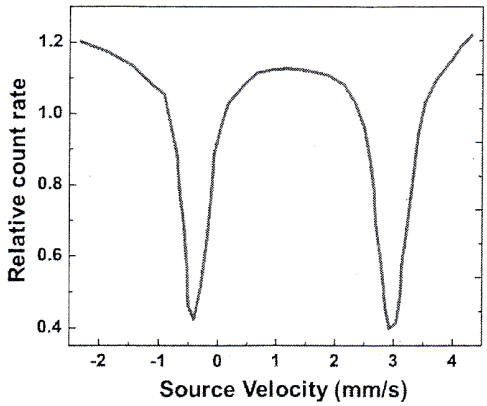
1) The Larmor frequency depend on the static external magnetic field.
2) Nuclear Magnetic Resonance (NMR) measures the absorption of electromagnetic radiation in the microwave-frequency region.
3) Mössbauer spectroscopy is recoil-free emission and absorption of gamma rays.
4) In NMR, the more shielded proton, the lower field is absorbed.
5) The relaxation of spin system occurs as transverse (spin-lattice) and longitudinal (spin-spin).
6) In Quadrupole splitting, the more asymmetric charge distribution, the higher value of the electric field gradient (EFG).
7) In Mössbauer spectroscopy we use Doppler effect to change the energy of the photon.
8) In Shell Model of the nucleus, each nucleon is considered to move in some potential and classifies the energy levels in terms of quantum numbers n, l and j, in the same way as the wavefunctions of individual electrons.
9) System with cubic symmetry has quadrupole splitting QS $\neq$ 0.
10) Nuclei with spin >1/2 have symmetric charge distribution.

Question (2): 10 Points

From the Figure below extract the following:

1. Isomer shift (δ)
2. Quadrupole splitting (ΔE_Q)

Then explain the origin of each parameter.



Question (3): 10 Points

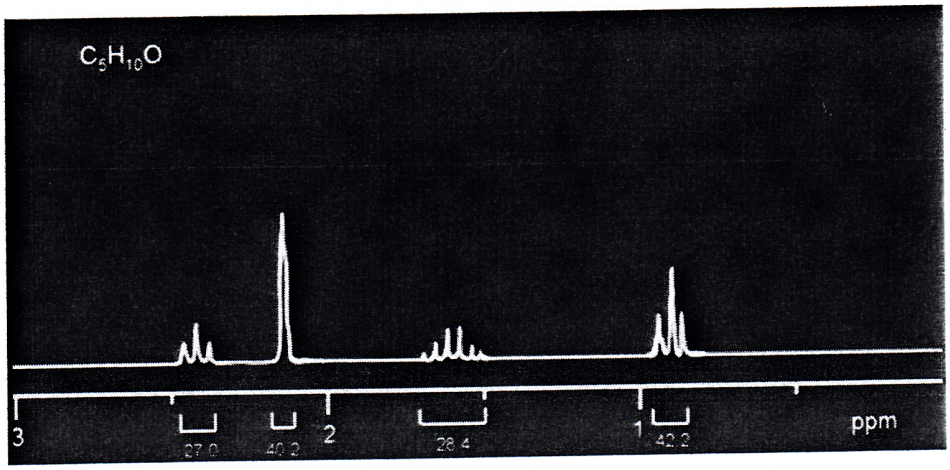
Deduce an expression for spin-orbit interaction energy? Then apply this formula to calculate the fine structure of sodium atoms (3p state).

Question (4): 10 Points

Discuss in details Jahn-Teller effect? Does the spin system (high spin v. low spin) of a molecule play a role in Jahn-Teller Effects? Use diagrams to enhance your answer.

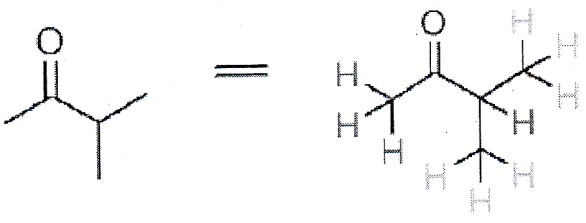
Question (5): 10 Points

Provide a structure of a compound having a molecular formula $C_5H_{10}O$. Show your work and assign all relevant peaks in the figure below.



Question (6): 10 Points

Predict NMR spectra for the molecular formula below. Show your work and assign all relevant peaks.



Best Wishes

Assiut University
Faculty of Science
Department of Physics
First semester 2018-2019

Course: *Atomic and Molecular Spectroscopy*
Code: P432
Time: 3 Hour
Final Exam (50%)

Answer only five (5) questions from the following:

Question (1): *(10 Mark)*

a- Show that the wavelength difference between adjacent transitions in the normal Zeeman effect is given approximately by

$$\Delta\lambda \approx \frac{\lambda^2 \mu_B B}{hc}$$ *(5 Mark)*

b- A sample of a certain element is placed in a 0.3 T magnetic field and suitably excited. How far apart are the Zeeman components of the 450 nm spectral line of this element? *(5 Mark)*

Question (2): *(10 Mark)*

a- You have a system of two electrons whose orbital quantum numbers are $\ell_1 = 2$ and $\ell_2 = 4$ respectively. Find the possible values of the following:
(i) L (total orbital angular momentum quantum number) for the system.
(ii) S (total spin angular momentum quantum number) for the system.
(iii) J (total angular momentum quantum number) for the system. *(5 Mark)*

b- For hydrogen atoms in a $3d$ state, draw all the possible orientations of the orbital angular momentum vector $\vec{L}$ with respect to the z axis. Use units of $\hbar$ along the z axis and calculate the allowed angles of $\vec{L}$ with respect to the z axis. What is $L_z^2 + L_x^2$ for the $m_\ell = -1$ component? *(5 Mark)*

Question (3): *(10 Mark)*

a- Prove that, the electron potential energy ΔE due to the spin-orbit interaction is proportional to $\vec{S}.\vec{L}$ *(5 Mark)*

b- Estimate the electron potential energy ΔE due to the spin-orbit interaction for an electron in the 2p state of a hydrogen atom using the Bohr model. *(5 Mark)*

Followed ⟹

Question (4): *(10 Mark)*

a- By using the quantum treatment of the simple harmonic oscillator, prove that the energy difference between any two successive levels of the vibrational energy of the diatomic molecule is constant. *(5 Mark)*

b- The CO molecule shows a strong absorption line at the frequency $6.42 \times 10^{13}\ Hz$.
(i) Calculate the effective force constant for this molecule.
(ii) What is the classical amplitude of vibration for a CO molecule in the $v = 0$ vibrational state? *(5 Mark)*

Question (5): *(10 Mark)*

a- Conclude the Lande' g-factor for a single electron. *(5 Mark)*

b- Two atoms, one is in a $^2D_{3/2}$ state and the other is in a $^2D_{3/2}$ state. What is the magnetic moment μ_J and the possible values of the z component of the magnetic moment μ_{Jz} for each one. *(5 Mark)*

Question (6): *(10 Mark)*

a- Stern–Gerlach experiment clearly showed evidence for space quantization and demonstrated the existence of a spin magnetic moment for the electron, discuss that. *(5 Mark)*

b- The $\ell = 0$ to $\ell = 1$ rotational transition of the CO molecule occurs at a frequency of $1.15 \times 10^{11}\ Hz$.
i. Use this information to calculate the moment of inertia of the molecule about its center of mass.
ii. Calculate the bond length of the molecule. *(5 Mark)*

Electron chaege e	1.6×10^{-19} C		Plank's constant h	6.626×10^{-34} Joul.sec
Electron mass m_e	9.1×10^{-31} kg		Light velocity c	3×10^{8} m.sec^{-1}
Proton mass m_p	1.672×10^{-27} kg		Coulomb constant k	9×10^{9} J.m.C^{-2}
Bohr radius a_o	0.529×10^{-10} m		Rydberg constant R	1.097×10^{7} m^{-1}
Bohr magneton μ_B	9.274×10^{-24}J.T^{-1}		Ionization energy of the hydrogen atom E_o	13.6 eV
mass of a carbon atom	1.994×10^{-26}kg		mass of an oxygen atom	2.6567×10^{-26}kg

WITH MY BEST WISHES *Hesham Al-Attar*

Assiut University **Faculty of Science** **Department of Physics**		**Term: Fall 2018- 2019** **Date: 9 January, 2019** **Time: 3 Hours**

Course Title: Quantum Mechanics 2 – Code P411 – Final Exam. (50 Marks)

Answer only four questions:

1- ***a-*** Prove that Parseval's formula has the form:

$$\int_{-\infty}^{\infty} \left|\Psi(\vec{r},t)\right|^2 d^3r = \int_{-\infty}^{\infty} \left|\Phi(\vec{p},t)\right|^2 d^3p$$

b- Show that the time-dependent Schrodinger equation in matrix mechanics is given by:

$$i\hbar \frac{dC_m(t)}{dt} = \sum_n H_{mn}\, C_n(t)$$

2- Find the eigenvalues and normalized eigenvectors for the operator σ_x in the representation by Paul's matrices in which $\hat{\sigma}_z$ is diagonal.

3- ***a-*** Verify that the spin wave functions $S_{+1/2}$ and $S_{-1/2}$ are orthogonal to each other.

b- Show that:

$$\left[\hat{S}_x, \hat{S}_y\right] = i\hbar \hat{S}_z, \quad \left[\hat{\sigma}_y, \hat{\sigma}_z\right] = 2i\hat{\sigma}_x, \quad \hat{\sigma}_x\hat{\sigma}_y + \hat{\sigma}_y\hat{\sigma}_x = 0$$

4- Use the time-independent Perturbation theory for non-degenerate case to estimate the energy in the first order Perturbation.

5- Show that any arbitrary (2x2) matrix can be written as a linear combination of $\hat{\sigma}_x, \hat{\sigma}_y,$ $\hat{\sigma}_y$ and I, the (2x2) unit matrix.

***** **Good Luck** *****

Assiut university **Faculty of science** **Physics department**	**Final Exam in physics of semiconductors and thin film application Phys. 451** **Summer- 2018**	**Phys & phys/chem. 4th level** **Date:4/09/2018** **Time: 3hours**

Answer five only from the following questions: (50 marks)

- All questions are of equal marks (10 Marks).
- Question **No.1 must** be answered.
- Use the following physical constants when you need them: e =1.6×10^{-19} C , K=1.38×10^{-23}J/k, ε_{si}= $12\times8.85\times10^{-14}$ F/m , n_i for Si at 300k=$10^{10}/cm^3$

Q.1:

Choose the correct answer for the following statements:

1- For the Si single crystal, the number of the nearest neighbor atoms is :

a)- 8 b)-6 c)- 4 d)-2

2-For an n-type semiconductor sample, the donner ionization energy equals:

a)- E_c b)- E_A-E_v c)- E_c-E_D d)-E_c-E_v

3-The probability of an energy state being occupied by an electron F(E) at E=E_f equals 0.5 at :

a)-T=0k only b)-T>0k only c)- all values of T

d) None of these

4-The electron and hole mobility in semiconductors has the dimensions of :

a)-cm^2/V.A b)-Cm^3/V.C c)-Cm^2/V.s d)-N/C.S

5-The d.c conductivity of n-type semiconductors increases with increasing:

a)-only T b)- only Nd c)-Nd and T d)- None of these

6- During electronic devices fabrication using Si wafers, the most complicated step is :

a)-ion implementation b)- Si oxidation c)- SiO2 lithography

d)- Annealing& Diffusion

7- The Epitaxial growth technique can be used for growing thin films of

a)- amorphous b)- sigle crystalline c)- ploy-crystalline d) all these

8- For a P-N diode at equilibrium, the built-in electric field E(x) is maximum at :

a)- x<x_p b)_x>x_n c)- x=0 d)-x=x_p

9)- The breakdown potential due to impact ionization (VB) is proportional to:

a)- N_d b)-N_a c)-N_a+N_d d)- I/Na+1/N_d

10)- The emitted wave length (λ) from a LED is mainly controlled by :
a)- the Eg of the material used for p-N fabrication b)- the biased potential
c)- a and b d) None of these

Q.2:

a- Prove that D_n and μ_n for electrons in n-type semiconductors are related with the following expression: $\frac{D_n}{\mu_n} = \frac{KT}{q}$

b- For Si sample in equilibrium at 300K, where is the Fermi level (E_f) when the sample is doped such that $n=10^{17}/cm^3$ and $p= 10^{14}/cm^3$. [consider for Si at 300K that: $N_c=2.8x10^{19}/cm^3$ and $N_v=1.04x10^{14}/cm^3$].

Q.3:

a-Discuss in details the factors play the dominant rule at the carrier mobility (μn and μp) for doped semiconductor samples at equilibrium.

b- A bar of Si (at 300K) is doped with boron at $10^{15}/cm^3$, it is subjected to light such that electron –hole pairs are generated throughout the bar at a rate of $10^{20}/s.cm^3$. The recombination life time is 10 μs. What are:
a)-P_0, b)-n_0, c)-p", d)-n", e)- p, f)-n and g)- p.n ?

Q.4:

a- Using only the sketch diagrams to express the following:
1- The main steps generally used for electronic devices fabrication by using Si wafers.
2- Dry /wet techniques used for oxidation of Si wafers. What are the factors control the oxide thickness during these processes.

a- An abrupt silicon p-n Junction at 300k and zero bias, has impurity doping concentrations of $Na = 5x10^{16}/cm^3$ and $Nd =10^{15}/cm^3$, [consider ni for silicon at 300k = $1x10^{10}/ cm^3$, $\varepsilon_{si}=12x8.85x10^{-14}$ F/m]. Calculate :

1- ϕ_{bi} 2- W_{dep} at $V_R=0$ and $V_R=5V$
3-E_{max} at at $V_R=0$ and $V_R=5V$

Q.5:

a- Compare between resistive heating thermal evaporation and sputtering techniques for thin film deposition. The comparison includes : [the main ideas, sketch diagram, the advantageous and the disadvantageous of each technique].
b- writ **a mathematical expression** for the following :
1- The breakdown voltage (V_B) for the Zener diode.

2- The excess of the minority carriers n"(x_p) of electrons at $x=x_p$ for a p-N junction under forward bias voltage (v).
3- The hole diffusion current (Jp_n) in the N side of a P-N diode under forward bias voltage (v).
4- The total solar cell current.
5- The emitted wave length (λ) from LED under forward bias.

Q.6:

a- Write in details in **only one** of the following optoelectronic devices:

1- The solar cell. 2- The light emitting diodes (LED)

[This includes the main idea, structure, biasing, performance, applications].

b- The total junction capacitance of a GaAs p-n junction at T = 300k is found to be 1.1 PF at V_R=1V, the doping concentration in one region is measured and found to be $8x10^{16}/cm^3$ and ϕ_{bi}=1.2V , ni for GaAs at 300k=$1.8x10^6/cm^3$,

ε_{GaAs} =13. 1x8.85x10^{-14} F/m.

Determine:

I- The doping in the other region of the p-n junction

II- The cross – section area of the junction (A).

iii-The revers – biased voltage is changed and the capacitance is found to be 0.8PF what is the new V_R.

With my best wishes **Prof. Dr. A. Y. Abdel-Latif**

Assiut University
Faculty of Science
Department of Physics

Term: Summer 2018
Date: 29 August, 2018
Time: 3 Hours

Course Title: Radiation Physics – Phy 444 – Final Exam (50%)

Answer the following question:

Question #1 **Circle the correct answer for the following questions:** **(20 points)**

1. Of the following the one which can penetrate through 20cm thick steel plate is:
   (a) positive rays (b) α-rays (c) β-rays (d) γ-rays

2. Half-lives of two radioactive substances A and B are respectively 20 minutes and 40 minutes. Initially the sample of A and B have equal number of nuclei. After 80 minutes the ratio of remaining number of A and B nuclei is:
   (a) 1:16 (b) 4:1 (c) 1:4 (d) 1:1

3. A simple contains 16g of radioactive material, the half-life of which is 2 days. After 32 days the amount of radioactive material left in the sample is:
   (a) 1gm (b) 0.25gm (c) 0.5gm (d) < 1mgm

4. A nucleus (with mass number A and atomic number Z) disintegrates emitting an α-particle. The resulting nucleus has mass number and atomic number respectively equal to:
   (a) A-2 and Z (b) A- 4 and Z-2 (c) A-4 and Z-1 (d) A+4 and Z+1

5. As a result of radioactive decay a $^{238}_{92}U$ nucleus is changed to $^{234}_{91}Pa$ nucleus. During this decay the particles emitted are:
   (a) two β-particles and one proton (b) two β-particles and one neutron
   (c) one α-particle and one β-particle (d) one proton and two neutrons

6. The relation between half-life $T_{1/2}$ of a radioactive sample and its mean life τ is:
   (a) $\tau = 2.718\,T_{1/2}$ (b) $\tau = 0.693\,T_{1/2}$ (c) $\tau = T_{1/2}$ (d) $T_{1/2} = 0.693\,\tau$

7. The decay constant λ of a radioactive sample:
   (a) is independent of the age (b) depends on the nature of activity
   (c) increases as the age of atoms increases (d) decreases as the age of atoms increases

8. A gamma ray photon creates an electron positron pair. If the rest mass of electron is *0.5 MeV* and the total kinetic energy of the electron positron pair is *0.78 MeV*, the energy of gamma ray photon must be:
   (a) *0.28MeV* (b) *1.28MeV* (c) *1.78MeV* (d) *0.78MeV*

9. How many radioactive disintegrations per second are defined as Becquerel:
   (a) 10^6 (b) 3.7×10^{10} (c) 1 (d) none of the above

10. The half-life period of a radioactive sample depends upon:
    (a) nature of substance (b) temperature (c) pressure (d) all of the above

Question #2 **(10 points)**

(a) ***What*** is meant by **only two** of the following:

Cloud Chamber - Germanium Detector - Photo-multiplier Tube.

(b) The amount of radiation from a point source is inversely proportional to the distance from the source. If a Geiger counter 1 meter from a small sample reads 360 counts per minute, ***what will*** be its counting rate 2 meters from the source? 3 meters from the source?

Question #3 **(10 points)**

(a) ***Define***: Rontgen – Rad – Gray.

(b) ***Calculate*** the amount of Radon ($^{222}_{86}\mathrm{Ra}$) and Uranium ($^{238}_{92}\mathrm{U}$) that have 1 *Ci* of radioactivity? ($T_{1/2} = 3.82$ dys of $^{222}\mathrm{Ra}$ and $T_{1/2} = 4.5 \times 10^{9}$ yrs of $^{238}\mathrm{U}$).

Question #4 **(5 points)**

The radioactive decay series begins with $^{238}_{92}U$ and ends with $^{206}_{82}Pb$..

- ***How*** many α-decays are there in this chain?
- ***How*** many beta-decays are there in this chain?
- ***How*** many energy is released in this complete chain?

Question #5 **(5 points)**

If you have one gram of radioactive strontium $^{90}\mathrm{Sr}$ has a half time 28 years, where 1 year= 3.15×10^{7} sec.

Calculate: The decay constant λ - Primary radioactivity A_o - Average age τ Radioactivity after one year.

****Good Luck ****

***Prof. Dr.* A. A. Ebrahim**