

Assiut University faculty of Science Physics Department	The final Exam Semiconductors & Thin films and their Applications (p451) "Summer Corse" 2016/2017	Second Level Phys, Phys-Chem &computer sci Time:3 h Date:25-08-2017

Answer five only from the following questions: "50 Marks"

- Questions No,s (1) and (2) must be answered
- All questions are of equal marks (10 mark)
- Use these constants when needed:
- $K_B = 1.38x10\text{-}23$ J/K , $e=1.6x10^{-19}$ C
- $N_A=6.02x10^{23}$ /mole , $m_{o=9.1.x10}{}^{-31}$kg
- These parameters for Si at 300k:

$n_i=1.5x10^{10}/cm^3$ $\varepsilon_{Si}=11.1x8.85x10^{-14}F/m$

Q.1: Choose the correct answer for the following:

1- The probability of existence of electrons in the valance band for n-type S. C sample at T= 0 K equals:

a) 1/2 b) zero c) one d >1/2

2- The ionization energy for acceptor atoms in p-Type S.C sample in simply

a) $> E_g$ b) $> E_f - E_v$ c) $= E_f - E_v$ d) $< E_f - E_v$

3- The mobility of charge carriers in a S.C sample due to impurity scattering changes with temperature such that

a) $\mu_i \propto T$ b) $\mu_i \propto T^{1/2}$ c) $\mu_i \propto T^{3/2}$ d) $\mu_i \propto T^{-3/2}$

4-The total current density of electrons in an N– type S.C sample increases with the:

a) Only n b) dn/dx c) only E d) all these

5- The light generated excesses minority carriers n`(t) decreases with time after light off by a relation of the form:

a) $n`(t) \propto e^{-x/L}{}_n$ b) $n`(t) \propto e^{t/\tau_n}$ c) $n`(t) \propto e^{-\tau n/t}$ d) $n`(t) \propto e^{-t/\tau}{}_n$

6) The depletion layer width in a p-n junction diode increases with:

a) Doping concentration b) forward biased c) reverse biased d) Non- of these

7- The built-in electric field (E) inside the depletion layer in a P-N junction in equilibrium changes with distance (x) such that

a) $E \propto x$ b) $E \propto x^{-1}$ c) $E \propto x^{-1/2}$ d) $E \propto x^{1/2}$

8- The break down voltage in Zener diode decreases with:

a) Φ_{bi} b) E_{crit} c) E^2_{crit} d) Φ^2_{bi}

9- The diffusion length of minority carriers in a forward biased P-N diode changes with the carrier diffusion constant D by relation of the form:

a) $L_n \propto D_n$ b) $L_n \propto Dn^{-1}$ c) $L_n \propto Dn^{1/2}$ d) $L_n \propto Dn^{-1/2}$

10) The output power of the solar cell depends on

a) I_{SC} b) V_{OC} c) $I_{SC} \times V_{OC}$ d) I_{SC} / V_{OC}

Q. 2:

2-a) – Write a mathematical expression for the following statements:

1- **Density of states function for holes below the edge of the valance band.**

2- **The charge neutrality equation for a doped semiconductor sample.**

3- **The recombination rate of minority carriers in P-type S.C sample.**

4- **The dependence of the diode current (I) on the forward biased potential (V) and temperature (T).**

5- **The condition for the achievement of population inversion for LASER Diodes.**

2-b)- Put down (√) or (x) in front of each sentences:

1- **The photon absorption is easier in non – direct band gap S.C materials compared with direct band gap.** ( )

2- **The wave length of the emitted photons in LED increases with the energy gap (Eg) of the material used for diode Fabrication.** ( )

3- **The Hall Effect experimental can be used to determine the diffusion constant (D) of the carriers in the S.C sample.** ( )

4- **The CVD method can be used to obtain high melting point material thin films.** ( )

5- **The deposition rate in the sputtering technique is higher than that in the resistive heating thermal evaporation technique.** ( )

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Q.3:

Q3-a)-Prove that the potential barrier in a P-N junction in equilibrium is given by $\Phi_{bi} = \frac{KT}{q} ln\left(\frac{NaNd}{n_i^2}\right)$

3-b) Consider a silicon sample at 300k, a hall effect device has been fabricated with the following parameters: d=5x10^{-3} cm W=5x10^{-2}cm, L=0.5cm. The electrical parameters measured are: I_x=0.50 mA, V_x=1.25V and B_Z=6.5x10^{-2}Tesla, the hall field E_H=-16.5 mV/cm.

Determine:

a) **The Hall voltage.**
b) **The conductivity type.**
c) **The majority carrier concentration**
d) **The majority carrier mobility**

Q.4:

4-a) - Give a reason (or reasons) for the following:

1- **Very low pressure is very important for good quality films using thermal evaporation technique.**
2- **The width of the depletion layer decreases with the forward biased in P-N junction.**
3- **The mobility of charge carriers decreases with increasing doping concentration N_d and N_a.**
4- **The current in P-N diode under forward biased increases with increasing the operating temperature.**

4-b) – For a Si sample at room temperature, given :

μ_P=470 cm^2/V.S, what is the drift velocity at E=10^3V/cm- what is τ_{mp} and the mean free path for holes. (consider: $m_p^* = 0.39\ m_o$, $V_{th}= 2.2x10^7$cm/s).

Q.5:

5-a): Write on two only of the following:

i)-Zener diode break down.

ii)-Solar cell and the parameters controlled it's effiancy.

ii)- Laser diodes and the condition necessary for population inversion.

iv)- Chemical vapor deposition (CVD) for thin film preparation.

5-b) - Explain how you can experimentally use the depletion layer capacitance C_{dep} change with the reverse biased potential (V_R) in P-N junction to determine:

i)-The built-in potential Φ_{bi}

ii)-The doping concentration N_D or N_A in one side P-N junction.

Q. 6:

6-a)- Compare between the resistive heating evaporation and D.C sputtering techniques for thin film deposition. What are the disadvantages for each.

6-b) Fore a Ge sample at 300 k has:

μ_n=0.36 cm^2/V.S, μ_P=0.17 cm^2/V.S, the electrical conductivity σ=2.12$\Omega^{-1}m^{-1}$, calculate the energy band gap (E_g) for Ge (consider N_c=5.64x10^{18}/cm^3, N_v=1.02x10^{19}/cm^3).

With my best wishes Prof. Dr. Atta . Y. Abdel-latief

كلية العلوم – قسم الفيزياء

جامعة أسيوط

Aug: 2017 **Summer Course "Special topics in physics (1)" (491 P)** Time: 3 hours

Answer only Five Questions:

1. a) Use he eqn. of motion of the electron under applying electric field to prove that the optical conductivity: $\sigma = ne^2 / m\omega^2\tau$. deduce the relative dielectric constant dependence on σ, then modify the eqn. of electric displacement.

b) Apply the thermodynamic eqn. $dS = C_v \frac{dT}{T} + (\frac{\partial P}{\partial T})_v dV$ in radiation physics to determine the change of entropy in terms of total radiation energy. Find the relation between radiation temp. and corresponding volume for adiabatic process.

2. a) Find the homogeneity degree of the potential energy resulting from the surface tension of a liquid.

b) A magnetic bar with cross-section area A, and length L is located in an external magnetic field (J),

(i) determine the work done on the magnetic material in terms of the total magnetic flux density

(ii) Prove that the resulting equation represents a modification of the 1St low of thermodynamic in magnetization.

3. a) Explain a different thermodynamic processes on (S-T)-curve of paramagnetic salts to show availability of obtaining a certain minimum temperature.

b) Find an expression of induced and free charges in terms of the relative dielectric constant, apply G. theorem in the absence and presence of a dielectric, respectively. Discuss the physical significance.

4. a) prove that the lengths and times of symmetric mechanical paths are related as: $(\ell' / \ell)^{1-K/2} = (t' / t)$, Apply this relation on electron of the hydrogen atom during its revolving around the nucleus. Discuss the physics meaning.

b) Use thermodynamic eqn.: $(\frac{dE}{dV})_T = [(\frac{\partial P}{\partial T})_v - P]dV$ to find an expression of Stephan's low for thermal radiation.

5. a) Use the definition of Gamma funs.: $\Gamma(Z)\Gamma(1-Z) = [Z\Pi_{n=1}^{\infty}(1 - Z^2 / n^2)]^{-1}$, to determine $\Gamma(3/2)$, use the obtained result to prove that the concentration of electrons in (C.B) of S.C:, $n = N_c \exp(E - E_f) / KT$. find the pre-exponential factor.

b) Find the dispersion relation in terms of the refractive index, then prove that the imaginary part of propagation wave depends on the absorption index.

6. a) Use the Maxwell EM eqn. : $\nabla^2 E = \mu_0(\varepsilon_0 \frac{\partial^2 E}{\partial t^2} + \sigma \frac{\partial E}{\partial t})$ to express the modification of dispersion relation

b) According to Lambert's low the absorption coefficient: $\alpha = 2\omega K / C$, use the previous modification to prove that $\varepsilon_r = (\alpha / 2\omega) + n^2$, explain the physical significance.

انتهت الأسئلة

تمنياتي بالتوفيق والتفوق.....ا.د. عبد المنعم سلطان.....

Assiut University		**Semester: Summer 2017**
Faculty of Science		**Date: 23 August 2017**
Physics Department		**Time Allowed: 3 hours**

Final Exam of Radiation Physics – Course Code: P444 - (50 Marks)

Answer the following questions:

Q1: (a) Discuss the main parameters that specific energy loss (Bethe formula) dependence on? [3 Marks]

(b) Define the binding energy, then Calculate the binding energy of deuterium, ^{2}H. Give a short comment on your result. Where the masses of ^{2}H = 2.01410178 u, proton = 1.00727647 u, neutron = 1.00866491 u, and electron = 0.00054858 u. [4 Marks]

(c) For 140 keV gamma rays, the mass attenuation coefficients for hydrogen and oxygen are 0.26 and 0.14 cm^2/g, respectively. What is the mean free path in water at this energy? [3 Marks]

Q2: (a) Write a short description about four ONLY from the following: [6 Marks]

i. Proportional counter
ii. Conductivity Detectors
iii. Scintillation Detectors
iv. Thermoluminescence Detectors
v. Activation Effect

(b) Determine by Q-value analysis whether ^{64}Zn can undergo radioactive transformation by β^+, EC, or β^- transition. See Constants in the end of the page! [4 Marks]

Q3: (a) Discuss in details the radiation damage mechanisms to DNA. [4 Marks]

(b) What Follows Chromosome Damage by ionizing radiation? [3 Marks]

(c) What Follows DNA Damage by ionizing radiation? [3 Marks]

Q4: (A) Define: Exposure, absorbed dose, and Equivalent dose [3 Marks]

(b) A radioactive source with an activity of 0.2 μCi is used to determine the counting efficiency of a radiation detector. (a) If the response of the detector is 66,600 counts per minute (c/m), what is the detector efficiency? (b) What is the efficiency if the source activity is 20 kBq? [4 Marks]

(c) As an application of RANGE, any detector that is to measure the full incident energy of a charged particle must have an active thickness that is greater than the range of that particle in the detector material. Discuss in short? [3 Marks]

Q5: (A) Write short note about five ONLY: [for heavy charged particles]: [6 Marks]

i. Stopping power
ii. Energy straggling
iii. Bragg curve
iv. RANGE
v. Stopping time
vi. Bragg-Kleeman rule (Scaling Laws)

(B) What is main difference between negatron and positron Interactions? in short! [4 Marks]

$N_a = 6.022\times10^{23}\,\frac{\text{atom}}{\text{mol}}$, $^{64}_{29}Cu(63.92976\text{u})$, $^{64}_{30}Zn(63.929147\text{u})$, $^{64}_{31}Ga(63.936838\text{u})$, $\rho_w = 1\,\frac{g}{cm^3}$.

End of Exam *Good Luck*

Dr. Hani Negm

امتحان نهاية الفصل الدراسي الصيفي :جميع المستويات المقرر: أخلاقيات المهنة والسلامة المهنية رقم المقرر ورمزه: F300	كلية العلوم	الزمن: ساعتان ٢٤ أغسطس ٢٠١٧ الاجابة في نفس الورقة

السؤال الأول: ضع علامة ✓ أو X امام العبارات التالية : **(١٠ درجات)**

١ـ مقرر أخلاقيات المهنة لا يتعلق فقط بالجوانب الفنية في عمل ما وإنما أيضاً بالأساس الأخلاقي لهذا العمـل.( )
٢ـ تدخل السلامة والصحة المهنية في كل مجالات الحياة . ( )
٣ـ وجود ميثاق أخلاقي للمهنة هام لحل اي خلافات او جدل في مجال المهنة ( )
٤ـ الأنشطة الطلابية تسهم في اكساب الطلاب عديد من الأخلاقيات . ( )
٥ـ من اهم اهداف تدريس هذا المقرر تنمية القدرة على التقييم الأخلاقي للأفعال والأقوال في إطار العمل. ( )
٦ـ أخلاقيات المهنة تعني فقط الالتزام بالقوانين الحاكمة للعمل. ( )
٧ـ الالتزام الأخلاقي يسهم في شيوع الرضا الاجتماعي. ( )
٨ـ من مبررات إفشاء الأسرار المختبرية الخاصة بالمريض حماية النفس والدفاع عن شرف مهنته . ( )
٩ـ تسهم السلامة المهنية في مواقع العمل في ابعاد المخاطر عن العاملين. ( )
١٠ـ المواليد المستنسخة تعيش عادة لفترة أطول . ( )

السؤال الثاني: اكتب باختصار خمسا من المبادئ الأساسية لأخلاقيات البحث العلمي **(٥ درجات)**

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٣ـ	٤ـ
٥ـ	

السؤال الثالث: أنت في جميع الأحوال قدوة للآخرين بفعلك وإن لم تقصد . علق في خمس نقاط **(٥ درجات)**

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٣ـ
٤ـ
٥ـ

انظر خلفه