Ministry of Higher Education
& Scientific Research
Al-Muthanna University
College of Science
Physics Department

Subject:Adv. Solid state
Stage:M.Sc
Date: / 6 /2019
Time: 3 hrs

02. 09. 2019

((Assessment of the final exam for the 2nd semester))
Academic year 2018 -2019

45

Note: Total mark 70. 7 marks for Each question.

Q1- According to the situations of the valance electrons, discuss the energy gap in metal and insulators.
Q2-How alkali and alkaline earth metal classified as metals or insulators.
Q3- Write the classification and labelling of semiconductor atoms..
Q4- Compare between direct and indirect absorption process for optical absorption by sketching diagram. .
Q5- 1-Define intrinsic mobility.
2-Write the units of the following: mobility, electrical conductivity, peltier coefficient.
3- Find the ratio between electron and hole mobility, when the collision time of a hole is three times that for electron.
4-Explain the negative sign of Peltier coefficient.

Q6- Write the wave vector q_0 according BCS theorem in terms energy gap and electron velocity .
Q7- A squre periodic potential is given by: $U_0 = (\hbar^2 Q^2 /2m) + \varepsilon$,using Krong-penny model find the solution of Schrodinger equation for electron in energy gap.
Q8- Define Boher radius of the donor and donor ionization energy.
Q9- Which model is more profitable for describing energy gap. Why?
Q10- Explain physically the origin of energy gap. Drive an equation of effective mass for a hole.

With best invocations

Assistant prof
Ali S. Ali
Head of Department

Prof.Dr
Qahtan A. Abdulqader
Lecturer

Ministry of Higher Education
& Scientific Research
AlMuthanna University
College of Science
Department of physics

Subject: Adv. Electromagnetics
Stage: MSc.
Date: / / 2019
Time : 3 hr.

05. 09. 2019

((Assessment of the final exam for the Second semester))
Academic year 2018 -2019

45

Q1. In free space, $\vec{E} = 150\sin(\omega t - \beta z)\vec{a}_x \ V/m$. Calculate the total power passing through a rectangular area of sides 30 mm and 15 mm in z=0 plane.

(10 Marks)

Q2. A. Find the amplitude of displacement current density in the free space at a point within a large power distribution transformer where,
$\vec{B} = 0.8\cos[1.257\times10^{-6}(3\times10^{8}t - x)]\vec{a}_y \ T$.

(5 Marks)

B. In general, the propagation constant can be expressed in terms of the properties of the medium as, $\gamma = \sqrt{j\omega\mu(\sigma + j\omega\varepsilon)}$, derive an expression for the phase shift constant.

(5 Marks)

Q3. Find the amplitude of the displacement current density,
(a)In the air near car antenna where the field strength of EM signal is,
$\vec{E} = 80\cos(6.277\times10^{8}t - x)\vec{a}_z \ V/m$;
(b) Inside a capacitor where $\varepsilon_r = 600$, and $\vec{D} = 3\times10^{-6}\sin(6\times10^{6}t - 0.3464x)\vec{a}_z \ C/m^2$.

(10 Marks)

Q4. A. Given $\vec{E} = E_m\sin(\omega t - \beta z)\vec{a}_y$, in free space, find the fields $\vec{D}$, $\vec{B}$, and $\vec{H}$. Sketch $\vec{E}$ and $\vec{H}$ at $t = 0$, with the assumption that β, and E_m are positive.

(5 Marks)

B. Consider the behavior of retarded potentials when the fields are varying with the time, to obtain Lorentz condition as,

$$\nabla\cdot\vec{A} = -\mu\varepsilon\frac{\partial V}{\partial t}$$

(5 Marks)

Lecturer
Assist. Prof.Dr. Hassan M. Jaber

Lecturer
Assist. Prof. Dr.Hadi

Head of Dept.
Assist. Prof. Ali S. Ali

Ministry of Higher Education
&Scientific Research
Al-Muthanna University
College of Science
Physics Department

Class /M.Sc.
Subject /Adv. Electromagnetics
Time / 4 hour
Date: - / /2019

05. 09. 2019

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The Final Examination for the Second Semester 2018-2019

Q5/ Evaluate both sides of Stokes theorem for the field $\mathbf{H}= 6xy\mathbf{a}_x - 3y^2\mathbf{a}_y$ A/m and the rectangular path around the region, $2 \le x \le 4$, $-2 \le y \le 2$, $z = 0$. Let the positive direction of $d\mathbf{S}$ be $\mathbf{a}_z$. (10.0 Mark)

Q6/ Given the current density $J = -10^4[\sin(2x)e^{-2y}a_x + \cos(2x)e^{-2y}a_y]$ kA/m^2. (a) Find the total current crossing the plane y =1 in the a_y direction in the region $0 < x < 1$, $0 < z < 2$. (b) Find the total current leaving the region $0 < x$, $y < 1$, $2 < z < 3$ by integrating J. dS over the surface of the cube . (c) Repeat part (b), but use the divergence theorem. (10.0 Mark)

Q7/ A uniform volume charge density of 80 μC/m^3 is present through the region 8 mm < r < 10 mm . Let $\rho_v = 0 < r < 8$ mm. (a) Find the total charge inside the spherical surface r=10 mm. (b) Find D_r at r=10 mm. (c) If there is no charge r > 10 mm. find D_r at r=20 mm. (10.0 Mark)

****Good Luck****

Assist.Prof.Dr. Hussah M. Jaber AL-Ta'ii

Head of Department

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08. 09. 2019

Muthanna University
College of Science
Physics Dept.
Postgraduate studies

Subject: Advanced Nuclear Physics
Time Allowed: 4 hours
Date: / / 2019

Final examination for MSc student – first semester (2018 – 2019)

Answer all the following questions:

Q1: (a) Define the isotopic quantum number for mirror nuclei, give its value for stable nuclei. (3 marks)

(b) Why the nuclei for which l = 0, Poses zero dipole moment? (4 marks)

Q2- (a) In gamma spectroscopy, explain What is meant by the annihilation peak? What is the meaning of single and double escape peaks? Draw a general figure illustrate the various spectrum components. (4 marks)

(b) A collimated beam of (1.25MeV) gamma rays strikes a thin (NaI) detector. What is the probability that a photon will traverse thickness of (0.2cm) without an interaction? (μ for NaI crystal = 0.187 m^{-1}). (4 marks)

Q3- (a) For $_6C^{12}$ nucleus find the orbital and spin magnetic moments. (3 marks)

(b) What are the differences between Mott and Rutherford scattering. Which is more proper for determining nuclear binding energy. (4 marks)

Q4- (a) Explain What is meant by the alpha spectroscopy.
The α -particle from Th^{232} source have an initial energy of (8.8MeV) and a range in standard air of (8.6 cm). Find their energy loss per cm in standard air at a point (4cm) distance from a thin source. (4 marks)

(b) A sealed box was found which stated to have contained an alloy compose of equal parts by weight of two metals (A) and (B). These metals are radioactive, with half-lives of (12 years) and (18 years) respectively. When the container was opened it was found to contain (0.53 kg) of (A) and (2.20 kg) of (B).
1- Deduce the age of the alloy.
2- What is the specific activity of element (B) if it is equal to $_5B^{10}$? (4 marks)

Q5- (a) Define deuteron. What its importance for studying semi-empirical binding energy for oil drop model. (3 marks)

(b) Write the advantages and disadvantages of measuring of nuclear size by electron scattering. Estimate the required scattering energy. (4 marks)

Q6- (a) Prove that for even–even nuclei the charge density is: $\rho = (3Zc/4\pi r2)A$. (4 marks)

(b) What are the properties and characteristics of fermi gas model. (3 marks)

Q7- (a) What is meant by the Bateman equation for a radioactive chain? (2.5 marks)

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08. 09. 2019

(b) Consider an electron with $T = 5$ MeV.

1- What fraction of its energy is lost as bremsstrahlung as it starts moving in air?

2-What is the total energy radiated as bremsstrahlung.

3- What is the total stopping power for electron (assume that air consist of 21% $_8O^{16}$, 79% $_7N^{14}$, and the ionization energy loss equal to 0.253 MeV/m). (4.5 marks)

Q8- (a) Classify the nuclear models according to their dependent and independent properties. (3 marks)

(b) Define fermi energy for nucleus, and prove that this energy for hydrogen nucleus is 33MeV. (4 marks)

Q9- Consider Pauli principle, discuss that the total symmetry function is depend of the quantum numbers S, L and T. (5 marks)

Q10- (a) Consider a charged particle traveling through a certain material. Indicates why the collision with atomic electrons are more numerous than with nuclei, and what is the result of the passage of the charged particle? (3 marks)

(b) The nuclear reaction which results from the incidence of sufficiently Energetic α-particles on nitrogen nuclei is [$_2\alpha^4 + {}_7N^{14} \rightarrow {}_zX^A + {}_1H^1$]. What is the decay product ($_zX^A$)? What is the minimum α-particle kinetic energy required to initiate the above reaction? (Take masses in amu: $H^1 = 1.0081$, $He^4 = 4.0039$, $N^{14} = 14.0075$). (4 marks)

With best wishes

A. K. Farhood

Asst. Prof. Ali S. Ali
Head of physics dept.

Prof. Dr. Qahtan A. Abdulqader

Prof. Dr. Abdulameer K. Alkhafaji

Ministry of Higher Education
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Al Muthanna University
Faculty of Science
Physics Department

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The Final Examination for the
First Semester 2018-2019

Class / MSC
Subject / Adv
Quantum Mechanics
Time / 3:30 hours
Date: - /01/2019

12. 09. 2019

Q1 / A. If $J_+ = J_x + iJ_y$, $J_- = J_x - iJ_y$, use Dirac representation to show,

$J_\pm |jm\rangle = \hbar\sqrt{j(j+1) - m(m\pm 1)}\,|j, m\pm 1\rangle$

B. Show that for a harmonic oscillator,

$< n|(a + a^+)^4|n >= 6n^2 + 6n + 3$

(10 Mark)

Q2 / Consider a particle in a central potential. Given that $|lm\rangle$ is an eigenstates of L^2 and L_z. Compute the sum $\Delta L_x^2 + \Delta L_y^2$ by using the raising and lowering operators.

(10 Mark)

Q3 / Consider a three dimensional problem. In a given orthonormal basis the Hamiltonian is represented by the matrix :

$$h = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & -2 \end{pmatrix} + \begin{pmatrix} 0 & A & 0 \\ A & 0 & 0 \\ 0 & 0 & A \end{pmatrix}$$

where $A << 1$. (a) Find the exact eigenvalues of h. (b) Use the second order perturbation to determine eigenvalues. (c) Compare the results of parts (a) and (b).

(10 Mark)

Q4 / Obtain the matrix of Clebsch-Gordan coefficients when two angular momenta $j_1 = \frac{3}{2}; j_2 = \frac{1}{2}$ are coupled.

(10Mark)

Q5 / Consider a spin-half system, (a) Find the eigenvalues and eigenvectors of the operator $S_x + S_y$. (b) Assume that $|\alpha\rangle$ designates the eigenfunction of $S_x + S_y$ that belongs to the maximal eigenvalues, and that the particle is in state $|\alpha\rangle$. If we measure the spin in the z- direction, what are the values and their probabilities.

(10Mark)

Ministry of Higher Education
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The Final Examination for the
First Semester 2018-2019

Class / MSC
Subject / Adv
Quantum Mechanics
Time / 3:30 hours
Date: - /01/2019

12. 09. 2019

Q6 / Consider a harmonic oscillator with a force constant k and a reduced mass m.
The small perturbation $w = \lambda x^3$ is applied to the oscillator. Compute the first order correction to the wave functions and first nonvanishing correction to the energies.

(10Mark)

Q7 / Consider a particle in a one-dimensional potential $V(x) = \lambda x^4$. Using the variational theorem, find an approximate value for the energy of the ground state. Compare it to the exact value $E_0 = 1.06\frac{\hbar^2}{2m}k^{1/3}$, where $k = \frac{2m\lambda}{\hbar^2}$. Choose as a trial function $\psi = (2\alpha/\pi)^{1/4}\exp(-\alpha x^2)$.

(10Mark)

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Best of Luck

Asst. Prof. Dr. Hadey K. Mohamad

Ass. Prof. Ali S. Ali
Head of Department

Ministry of Higher Education
& Scientific Research
AlMuthanna University
College of Science
Department: Physics

Subject: Mathematical physics
Stage: M.Sc
Time: 3:30
Date: / /2019 16. 09. 2019

((Assessment of the final exam for the first semester))
Academic year 2018-2019

45

Q1// **(i)** Prove that $u=x^2-y^2-2xy-2x+3y$ is harmonic. Find a function v such that $f(z)=u+iv$ is analytic. Also express $f(z)$ in term of z

(ii) Solve in series $2x(1-x)\frac{d^2y}{dx^2}+(5-7x)\frac{dy}{dx}-3y=0$.

---------- (14 Marks)

Q2// **(i)** Expand the function in Laurent's series $f(z)=\frac{(z-2)(z+2)}{(z+1)(z+4)}$ in the region

a) $|z|<1$ **b)** $1<|z|<4$

(ii) Find the characteristic equation of the matrix $A=\begin{pmatrix}1 & 2 & 3\\ 2 & -1 & 4\\ 3 & 1 & -1\end{pmatrix}$. Show that the equation is satisfied by A.

---------- (14 Marks)

Q3//**(i)** Evaluate $\oint_c \frac{(12z-7)}{(z-1)^2(2z+3)}dz$, where c is the circle $|z|=2$.

(ii) (a) Define covariant and contravariant vectors (Tensor of rank one).

(b) Show that $\frac{\partial\phi}{\partial x^i}$ is covariant vector, where ϕ is a scalar function.

---------- (14 Marks)

Q4// **(i)** Determine the poles of the following function and residue at each pole

$$f(z)=\frac{z^2}{(z-1)(z-2)^2}$$

(ii) If A_{ij} is a skew-symmetric tensor, prove that $\left(\delta^i_j\delta^k_l+\delta^i_l\delta^k_j\right)A_{ik}=0$

---------- (14 Marks)

Q5// **(i)** Show that characteristic roots of a triangular matrix are just the diagonal elements of the matrix.

(ii) Let *ABCD* be a squire. Construct the group table for C_{4v} (Gayley's table)

(iii) Show that $\frac{d}{dx}\left[x^nJ_n(ax)\right]=ax^nJ_{n-1}(ax)$

---------- (14 Marks)

Best of luck

M.M.KRADA
Lecturer
Assist.prof. Mousa Makey

Head of Department
Assist.prof. Ali Salman Ali