EXAM. SEAT NO.: _____

7.a
640

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

F.S.B.E.-I [C.M.E.Chem.,Met.,Eln.,Comp.Sci.,IWM,Text. Engg., Text. Tech., Text. Proc.] **Examination**

Day Thursday **Date** 16-11-2017 **Time:** 11:30 AM to 2:30 PM

Subject: [APH1101] Applied Physics-I

Note : 1. Answer to the two Sections must be written in two separate answer books. **Max. Marks: 100**
2. Figures to the right indicate marks.
3. If necessary, assume data with appropriate justification

Data : Boltzmann constant $k_B = 1.38 \times 10^{-23}$ J/K; Planck constant $h = 6.63 \times 10^{-34}$ J.s,
mass of electron $m_e = 9.1 \times 10^{-31}$ kg, mass of proton = 1.67×10^{-27} kg
permittivity of free space $\epsilon_0 = 8.85 \times 10^{-12}$ coul^2/N-m^2, permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ N/A^2

SECTION-I

Q.1 Answer the following questions by choosing the most appropriate option from the given choices. Write the answer to these questions in the Table form shown at the end of the paper. **[10]**

(1) Which of the following pairs of light sources are coherent?
(A) two headlights of a car (B) one point source and its image in a plane mirror
(C) two pinholes uniformly illuminated by the same point source. (D) two candles

(2) In a Michelson interferometer set up with a light source of wavelength 500 *nm*, the movable mirror is displaced through 0.025 *mm*. The number of fringes that crosses the field of view will be
(A) 100 (B) 50 (C) 150 (D) 200

(3) When a diffraction grating is illuminated with white light, the first-order maximum of green light
(A) is closer to the central maximum than that of blue light.
(B) is closer to the central maximum than that of red light.
(C) overlaps the second order maximum of the red light.
(D) overlaps the second order maximum of blue light.

(4) If a is width of the slits in a diffraction grating and b is width of the opaque space between the slits, the second order in the diffraction pattern will be absent if
(A) $a = 2b$ (B) $2a = b$ (C) $a = b$ (D) None of these

(5) In a calcite crystal, the angle between any two faces meeting at a blunt corner is
(A) acute (B) obtuse (C) right-angle (D) None of these

(6) Two linearly polarized light waves, $x = a\sin(\omega t + \delta)$ and $y = b\sin(\omega t)$ are superposed. The resultant light wave will be circularly polarized if
(A) $\delta = \pi;\ a \neq b$ (B) $\delta = \pi;\ a = b$ (C) $\delta = \frac{\pi}{2};\ a \neq b$ (D) $\delta = \frac{\pi}{2};\ a = b$

(7) Which one of the following statement is NOT true for a laser?
(A) Rate of emission must be greater than rate of absorption
(B) Lifetime of electrons in metastable state is of the order of few *ms*
(C) Ruby laser is a continuous laser beam.
(D) Rate of spontaneous emission must be lesser than rate of stimulated emission

(8) The radiation in laser cavity obeys
(A) Rayleigh-Jeans law (B) Planck's radiation law (C) Wein's law (D) None of these

(9) Which of the following components is responsible for the rectification action in a rectifier?
(A) capacitor (B) load resistance (C) transformer (D) diode

(10) Which of the following is true?
(A) Solar cells are temperature sensitive.
(B) Most of the solar cells give above 50 % efficiency.
(C) Solar cell is not a photovoltaic device.
(D) Solar cell requires external dc source for operation.

[P.T.O.]

(3) A closely coiled helical spring made from round stee
800 N for a permissible shear stress of 120 MN/m
diameter of helix 90 mm and G for the ma
(b) number of turns required for t

7.b

640 Q.2 Answer any **FOUR** of the following:

(a) Describe the set up to obtain Newton's rings. Derive the expression for the diameter of dark rings. What does this equation suggest about the characteristics of the rings?

(b) What are the differences between interference and diffraction? Draw sketch of the normal interference pattern and the diffraction pattern for a single slit. Which are the types of diffraction? Describe each of them in brief.

(c) Define the dispersive power and resolving power of a grating. State the physical meaning of each term involved in the expressions. Explain the differences between dispersive power and resolving power of a grating.

(d) In two independent experiments, He-Ne laser beams are incident normally on a glass slab and a slab of calcite crystal. What will be the difference in the pattern when the beams coming out of the slabs are collected on the screens? What is the reason for the difference? What is the function of a half wave-plate? How can it be constructed using a calcite crystal?

(e) Explain the difference between spontaneous emission and stimulated emission. Derive the expressions giving the relationship between the Einstein's coefficients.

(f) Which are the types of solar cells? What is DSC? Define the Fill Factor and Efficiency of a solar cell. What could be the maximum value of the fill factor? Obtain the relationship between the two. Draw a sketch of I-V characteristics of a solar cell indicating the maximum power rectangle.

Q.3 Answer any **FOUR** of the following: **[20]**

(a) A thin film having an index of refraction of 1.5 is surrounded by air. It is illuminated normally by white light and is viewed by reflection. Analysis of the resulting reflected light shows that the wavelengths 360, 450 and 602 *nm* are the only missing wavelengths in or near the visible spectrum. (i) What is the thickness of the film? (ii) What visible wavelengths are brightest in the reflected interference pattern?

(b) X-rays of wavelength 10 Å is incident on a laboratory diffraction grating with 15000 lines/inch. Can we get the diffraction pattern? Explain your answer. What should be the grating element to get 3 orders in the diffraction pattern of X-rays? Comment on the answer regarding such a grating.

(c) Suppose a telescope with an objective lens of 5 *m* diameter is constructed on the dark side of the moon. The viewing there (except for brief periods of sunlight) would be excellent. What would be the separation between two objects that could just be resolved on the planet Mars in 500 *nm* light? The distance to Mars at closest approach is 8.05×10^7 *km*.

(d) The thickness of a quarter-wave plate for a light of wavelength λ is 14.7 μm. What will be the thickness of a half-wave plate for the same light? For the material used in the both plates $\mu_o = 1.55$ and $\mu_e = 1.54$.

(e) A pulse from a ruby laser ($\lambda = 694.3$ Å) has an average power of 10 MW and lasts 1.5 *ns*. (i) What is the total energy of the pulse? (ii) How many photons are emitted in this pulse?

(f) The four diodes used in a bridge rectifier circuit have constant forward resistances 1Ω and infinite reverse resistance. The ac supply voltage is 220 V r.m.s. and load resistance is 480 Ω. Calculate (i) mean load current and (ii) power dissipated in each diode.

SECTION-II

Q.4 Answer the following questions by choosing the most appropriate option from the given choices. Write the answer to these questions in the Table form shown at the end of the paper. **[10]**

(1) Which of the following statements for the ultrasonic waves is true?
(A) They travel faster than the audible sound waves in air.
(B) They are longitudinal waves.
(C) They possess frequency between 20Hz to 20kHz.
(D) They can travel in the vacuum.

7.d
640.

(b) Prove that a vector $\vec{F} = yz\hat{i} + zx\hat{j} + xy\hat{k}$ representing a force field can be expressed as a gradient a scalar V. Also obtain V and div$(\vec{F})$. Give your comments about the force field from the results.

(c) State Faraday's law of electromagnetic induction. Derive the differential form this law in terms of the electric and magnetic fields.

(d) Write the expression for energy of an electron trapped permanently in a three dimensional cube of volume 1.0 nm^3. Calculate the energy emitted by the electron (in eV) and wavelength of radiation when the electron makes a transition from energy state E_{212} to E_{111}.

(e) A thermocouple has a linear sensitivity of 30 μV/°C, calibrated at a cold junction temperature of 0 °C. It is used to measure an unknown temperature with the cold junction temperature of 30 °C. Find the actual hot junction temperature if the emf generated is 3.0 mV.

(f) A vessel of 6.2 liter volume is evacuated using an exhaust pump with minimum attainable vacuum of 10^{-4} torr. If the pumping speed is 800 cm^3/s, calculate the time taken to reduce the pressure in the vessel from 760 torr to 10^{-2} torr.

****

Write the answers to Q.1 and Q.4 in the following format:

Q. No.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ans.										

Only one choice for each answer is permissible.

)]

THE MAHARAJA SAYAJIRAO UNIV
F. S. OF B. E. II (C, IWM, M, E, Ch
Day: MONDAY Date: 28th NOVEMBER Year: 201
SUBJECT: MATERIALS AND STRUC

Q.4 Answer the following in brief:
a) Write expressions for surface and
b) Explain the polarizabilities of two
c) Derive the Gauss's law for dielec
d) What are linear dielectrics? Show
e) Explain Lorentz force.

(3) A closely coiled helical spring made from round stee
800 N for a permissible shear stress of 120 MN/n

Ultrasonic waves, when used for the purpose of diagnosis or therapy, pass through different parts of human body. Which of the following is true?
(A) It will travel faster in the bones compared to the muscles.
(B) It will travel faster in the muscles compared to the bones.
(C) It cannot travel in the bones.
(D) It cannot travel in the muscles.

(3) The continuity equation in the electrodynamics represents the law of conservation of
(A) energy (B) linear momentum (C) angular momentum (D) electric charge

(4) For a conservative force field ($\vec{F}$)
(A) $\vec{\nabla} \cdot \vec{F} = 0$ (B) $\vec{\nabla} \times \vec{F} = 0$ (C) $\vec{\nabla}\vec{F} = 0$ (D) None of these

(5) The speed of the electromagnetic waves in a free space is equal to
(A) $\sqrt{\mu\epsilon}$ (B) $1/\sqrt{\mu\epsilon}$ (C) $\sqrt{\mu_0\epsilon_0}$ (D) $1/\sqrt{\mu_0\epsilon_0}$

(6) What is the degeneracy of ground state energy of a particle trapped in three dimensional box?
(A) 2 fold (B) 3 fold (C) 4 fold (D) ground state is non-degenerate

(7) Which of the following equipment works on principle of quantum mechanical tunneling?
(A) TEM (B) STM (C) SEM (D) XRD

(8) Which of the following uses electromagnetic radiation from hot object/region for non-contact temperature measurement?
(A) graded mercury thermometer (B) bimetallic strips
(C) pyrometer (D) thermocouple

(9) Which of the following forms of temperature sensor displays significant nonlinear change in its resistance with temperature?
(A) platinum resistor (B) thermocouple
(C) thermistor (D) bimetallic thermometer

(10) Which of the following is working principle of diffusion pump?
(A) transfer of momentum (B) positive displacement
(C) gas entrapment (D) mechanical displacement

Q.5 Answer any **FOUR** of the following: **[20]**

(a) What are the differences between the ultrasonic waves and the electromagnetic waves? What are the different principles for the production of the ultrasonic waves? Explain any one(just the principle).

(b) State and prove the divergence theorem.

(c) Write the Maxwell's equations in differential form. Which basic law of electricity and/or magnetism each equation represents? What is Maxwell's contribution to these equations? What is its physical significance?

(d) Starting from plane wave solution of standard wave equation, obtain the time dependent Schrödinger equation.

(e) Which physical properties of materials are mainly used to design thermometers? Describe the principles of thermoelectric thermometers and pyrometers.

(f) Define the degree of attainable vacuum for an exhaust pump. Derive Gaede's equation for the intrinsic speed of the pump. Define the intrinsic speed using this equation.

Q.6 Answer any **FOUR** of the following: **[20]**

(a) (i) A quartz crystal of thickness 5 *mm* is vibrating at resonance. Calculate the fundamental frequency of vibration for which ultrasonic waves are generated. The Young's modulus for quartz is 7.9×10^{10} N/m^2 and density of quartz is 2650 kg/m^3. Calculate the speed of the waves in the crystal. (ii) A ship sends a pulse of ultrasound towards the seabed and receives an echo 0.3 *s* later. If the speed of the ultrasonic waves in the water is 1500 *m/s*, calculate the depth of the seabed from the surface of the sea.

[3]

(PTO)

44-a
6880

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

F.S.B.E.-I [C,M,E,Chem.,Met.,Eln.,Comp.Sci.,IWM,Text. Engg., Text. Tech., Text. Proc.] Examination

Day Thursday **Date** 24-11-2016 **Time:** 11:30 AM to 2:30 PM

Subject: Applied Physics-I [APH1101]

Note : 1. Answer to the two Sections must be written in two separate answer books. **Max. Marks: 100**
2. Figures to the right indicate marks.
3. If necessary, assume data with appropriate justification

Data : Boltzmann constant $k_B = 1.38 \times 10^{-23}$ J/K; Planck constant $h = 6.63 \times 10^{-34}$ J.s,
mass of electron $m_e = 9.1 \times 10^{-31}$ kg, mass of proton = 1.67×10^{-27} kg
permittivity of free space $\epsilon_0 = 8.85 \times 10^{-12}$ coul^2/N-m^2, permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ N/A^2

SECTION-I

Q.1 Answer the following questions by choosing the most appropriate option from the given choices. Write the answer to these questions in the Table form shown at the end of the paper. **[10]**

(1) Which of the following does not use the principle of division of amplitude for obtaining coherent sources?
(A) Michelson interferometer (B) Fresnel's biprism (C) Newton's rings (D) All of these

(2) In the Newton's rings experimental set up, the diameter of 4th dark ring is found to be 0.25 cm. The diameter of 16th dark ring would be
(A) 0.50 cm (B) 0.125 cm (C) 0.75 cm (D) 0.625 cm

(3) A beam of white light is incident on a diffraction grating. The angle of diffraction will be largest for the color
(A) violet (B) green (C) red (D) yellow

(4) If the diameter of the objective lens of a telescope is reduced to half, the resolving power of the telescope will be
(A) the same (B) halved (C) doubled (D) None of these

(5) Which of the following is true for the magnitude and the orientation of the electric field vectors in a circularly polarized light?
(A) the magnitude and the orientation both vary continuously.
(B) the magnitude changes and its orientation remain same.
(C) the magnitude remains the same and its orientation changes.
(D) the orientation remains the same but nothing can be said about the magnitude.

(6) Nicol's prism works on the principle of
(A) reflection (B) selective absorption (C) interference (D) double refraction

(7) The light from a laser source is considered to be monochromatic because all the emitted photons
(A) are in phase (B) have same energy
(C) have same amplitude (D) are in the same direction

(8) In CO_2 laser, population inversion is achieved by
(A) electrical pumping (B) optical pumping (C) chemical pumping (D) X-ray pumping

(9) The peak inverse voltage (PIV) of a diode in rectifier circuit is
(A) maximum voltage that can be applied across the diode in the non-conducting direction
(B) maximum voltage that can be applied across the diode in the conducting direction
(C) voltage corresponding to rated maximum voltage
(D) none of the above.

(10) Solar cells work on the principle of
(A) photoelectric effect (B) stimulated emission
(C) electron-hole recombination (D) photovoltaic effect

[P.T.O.]

Q.2 Answer any **FOUR** of the following: [20]

(a) Where are anti-reflection films used? Derive the equations to determine the thickness of the film and the refractive index of the material to be used for the film.

(b) Write the equation for a diffraction grating which gives the condition for obtaining principal maxima in the diffraction pattern. State the physical meaning of each term in the equation. Derive the expression for the maximum number of orders that can be observed. Also, obtain the condition for absent spectra in the diffraction pattern.

(c) Define the resolving power of a telescope and a microscope. Discuss the factors that control the resolving power of a telescope and a microscope.

(d) Describe the phenomenon of double refraction. Explain Huygen's theory for double refraction.

(e) What is population inversion? How is it attained in (i) Ruby laser, (ii) He-Ne laser and (iii) CO_2 laser. What is the role of mirrors/reflecting surfaces in these lasers?

(f) Describe the construction and working of half-wave rectifier with necessary circuit. Derive an expression for the efficiency of this rectifier. What will be the maximum efficiency?

Q.3 Answer any **FOUR** of the following: [20]

(a) In a double-slit experiment with a monochromatic light, interference fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 0.05 m towards the slit, the change in fringe width is 3×10^{-5}m. (i) If the distance between the slits is 10^{-3}m, calculate the wavelength of the light used. (ii) When the screen is at a distance 10 cm from the slits, a thin transparent plate of thickness 0.05 cm is introduced in the path of one of the slits. It is found that the interference pattern shifts by 0.5 cm. Calculate the refractive index of the plate.

(b) A lens of focal length 100 cm forms a Fraunhoffer diffraction pattern of a single slit of width 0.04 cm in its focal plane. The incident light contains two wavlengths λ_1 and λ_2. It is found that the fourth minimum corresponding to λ_1 and the fifth minimum corresponding to λ_2 occur at the same point 0.5 cm from the central maximum. Calculate λ_1 and λ_2.

(c) Find the minimum number of lines in a plane diffraction grating required to just resolve the sodium doublet (5890 Å and 5896 Å) in the (i) first order and (ii) second order.

(d) Two plane-polarized light waves with amplitudes a and b are superposed on each other. The phase difference between them is δ. What will be the nature of the polarization of the resultant light wave if (i) $\delta = 0$, (ii) $\delta = \pi/2$, (iii) $\delta = \pi/2$ and $a = b$? Explain using an appropriate equation.

(e) A laser beam has a power of 50 mW. It has an aperture of 5×10^{-3} m and wavelength 7000 Å. A beam is focused with a lens of focal length 0.2 m. Calculate the areal spread and intensity of the image.

(f) In the bridge rectifier circuit, the primary to secondary turns ratio of is 4. The load resistance is 200 Ω and the input ac voltage is 230 V with a frequency of 50 Hz. Find (i) dc output voltage, (ii) peak inverse voltage and (iii) output frequency. The diodes are assumed to be ideal.

SECTION-II

Q.4 Answer the following questions by choosing the most appropriate option from the given choices. Write the answer to these questions in the Table form shown at the end of the paper. [10]

(1) The speed of the ultrasonic waves in vacuum is equal to
(A) the speed of audible sound in air (B) 20 times greater than the speed of audible sound in air
(C) zero (D) 20 times smaller than the speed of audible sound in air

(2) The frequency of ultrasonic waves produced by magnetostriction method is f. The length of the ferromagnetic rod is L. If the length of the ferromagnetic rod is reduced to L/2 and necessary changes in the circuit are made, the frequency of the ultrasonic waves produced will be equal to
(A) $f/2$ (B) $2f$ (C) f (D) $4f$

(3) Differential form of the continuity equation is expressed as

(A) $\frac{\partial \rho}{\partial t} - \vec{\nabla} \cdot \vec{j} = 0$ (B) $\frac{\partial \rho}{\partial t} \times \vec{\nabla} \cdot \vec{j} = 0$ (C) $\frac{\partial \rho}{\partial t} + \vec{\nabla} \cdot \vec{j} = 0$ (D) $\frac{\partial \rho}{\partial t} + \vec{\nabla} \cdot \vec{j} = 0$

(4) The concept of displacement current introduced by Maxwell indicates

(A) the current passing through the insulator when the electric field is changing with time.
(B) the current passing through the conductor when the magnetic field is changing with time.
(C) that the changing magnetic field produces an electric field.
(D) that the changing electric field produces a magnetic field.

(5) Which of the following set of equations represents the equation of motion of the electromagnetic waves in free space?

(A) $\vec{\nabla}^2\vec{E} + \varepsilon_0\mu_0 \frac{\partial^2 \vec{E}}{\partial t^2} = 0; \vec{\nabla}^2\vec{H} + \varepsilon_0\mu_0 \frac{\partial^2 \vec{H}}{\partial t^2} = 0$

(B) $\vec{\nabla}^2\vec{B} + \varepsilon_0\mu_0 \frac{\partial^2 \vec{E}}{\partial t^2} = 0; \vec{\nabla}^2\vec{E} + \varepsilon_0\mu_0 \frac{\partial^2 \vec{B}}{\partial t^2} = 0$

(C) $\vec{\nabla}^2\vec{E} + \varepsilon_0\mu_0 \frac{\partial^2 \vec{B}}{\partial t^2} = 0; \vec{\nabla}^2\vec{B} + \varepsilon_0\mu_0 \frac{\partial^2 \vec{E}}{\partial t^2} = 0$

(D) $\vec{\nabla}^2 \times \vec{E} + \varepsilon_0\mu_0 \frac{\partial^2 \vec{E}}{\partial t^2} = 0; \vec{\nabla}^2 \times \vec{H} + \varepsilon_0\mu_0 \frac{\partial^2 \vec{H}}{\partial t^2} = 0$

(6) The wave function for a particle must be normalizable because

(A) the particle's charge must be conserved.,
(B) the particle's momentum must be conserved.
(C) the particle's angular momentum must be conserved.
(D) the particle must be somewhere.

(7) Which of the following is the kinetic energy operator in one dimension?

(A) $i\frac{\hbar^2}{2m}\frac{d}{dx}$ (B) $i\frac{\hbar^2}{2m}\frac{d^2}{dx^2}$ (C) $-\frac{\hbar^2}{2m}\frac{d^2}{dx^2}$ (D) $\frac{\hbar^2}{2m}\frac{d^2}{dx^2}$

(8) An electron trapped in a box is in the ground state where its energy is 2.5 eV. Considering one dimensional case, its energy in the next higher level would be closest to:

(A) 5.0 eV (B) 10.0 eV (C) 12.5 eV (D) 15.0 eV

(9) Radiation pyrometer is normally used for temperature range

(A) below 0 °C (B) between 0 °C to 300 °C
(C) between 300 °C to 800 °C (D) more than 800 °C

(10) Conductivity of an NTC sensor will increase if

(A) temperature increases (B) temperature remains constant for long time
(C) temperature decreases (D) temperature reaches zero °C

Q.5 Answer any **FOUR** of the following: **[20]**

(a) What are ultrasonic waves? Compare the speed of ultrasonic waves in solid, liquid and air medium. Hence, describe the most suitable method for the production of ultrasonic waves in MHz range.

(b) Write the conditions for which a given vector field would be (i) irrotational and (ii) solenoidal. Give appropriate examples of irrotational and solenoidal fields. Define curl of a vector field $\vec{F}$ in a determinant form.

(c) Obtain the differential form of the Maxwell's equations from its integral form.

(d) What is wave function of a system? Explain why the admissibility conditions are needed for a function to be a valid wave function. Also list the admissibility conditions.

(e) (i) Explain the working of a diffusion pump with proper diagram. (ii) What is a fore-pump? Why is it needed in case of evacuating a chamber using diffusion pump.

(f) Discuss the working principle of (i) bimetallic thermometer (ii) platinum resistance thermometer (iii) pyrometers.

P.T.O.

44-d/68

Q.6 Answer any **FOUR** of the following: [20]

(a) A piezo-electric crystal of Young's modulus 7.9×10^{10} N/m^2 and density 2650 kg/m^3 having thickness 3mm is vibrating at its resonance frequency. Calculate the frequency of oscillator required to produce ultrasonic waves.

(b) With the help of Maxwell's equations in free space, derive the wave equation for the electromagnetic waves propagating in free space in terms of electric field vector($\vec{E}$). Prove that the speed of these waves is equal to the speed of light.

(c) For a vector field $\vec{P} = (yz^2)\hat{i} + (xy)\hat{j} + (yz)\hat{k}$, prove that div(curl $\vec{P}$) = 0.

(d) An electron is permanently trapped in a box of width a. Write the normalized one dimensional wave function for the electron. Calculate the probability of finding this electron between $0.4a$ to $0.6a$ and compare it with classical analog.

(e) A 3.0 liter chamber is to be evacuated from atmospheric pressure (760 Torr) to 1 Torr in 30 seconds. Considering the leak rate of 20 cm^3/s, estimate the required pumping speed.

(f) The resistance of a platinum resistance thermometer is 4.2 Ω and 4.9 Ω at 0 °C and 100 °C respectively. Calculate its resistance at 80 K and 120 K.

****

Write the answers to Q.1 and Q.4 in the following format:

Q. No.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ans.										

Only one choice for each answer is permissible.

—×—

19-9/180

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

SS of B.E.-I (Electrical Engineering/Electronics Engineering/Computer Science Engineering)

Day: Saturday **Date:** 09 JULY **Year:** 2022 **Time:** 11:30 am- 2:30 pm

SUBJECT: (APH 1201/ APH 1202/APH 1203/ APH 1204) APPLIED PHYSICS II

(APH1208) **Total marks: 100**

Instructions:
1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.
3. **Data:** ($h=6.6 \times 10^{-34}$Js; $m_e=9.1 \times 10^{-31}$kg; $k=1.38 \times 10^{-23}$J/K;;Wien's constant$=2.9 \times 10^{-3}$ mK)
4. Answer MCQ in a table. **Just an example:**

1	A	11	C	21	B
2	B	12	D	22	D
3		13		23	

Section-I

Q-I **Choose the correct Answer. Each question carries EQUAL marks.** 25

1. The energy of a one-dimensional harmonic oscillator in the first excited state is?
(A) 0 (B) $\frac{\hbar\omega}{4\pi}$ (C) $\frac{3\hbar\omega}{4\pi}$ (D) $\frac{5\hbar\omega}{4\pi}$

2. The relation between coefficient of reflection R and transmission T for a particle incident on a potential step with energy E greater than height of the step is
(A) R=T (B) R+T=0 (C) R+T=1 (D) R=$\frac{1}{T}$

3. In Kronig-Penney model of electrons in a linear lattice if the strength of the periodic potential increases, the width of the allowed energy band
(A) Increases (B) Decreases
(C) Remains constant (D) None of these

4. Suppose the energy near the valence band edge of a crystal is given by $E = -Ak^2$, where $A = 10^{-39} Jm^2$. The effective mass of the electron is given by
(A) $5 \times 10^{-30} kg$ (B) $-5 \times 10^{-31} kg$ (C) $5.5 \times 10^{-31} kg$ (D) $-5.5 \times 10^{-30} kg$

5. In the approximate expression of Tunneling transmission probability $T = e^{-2k_2 L}$, the expression of k_2 is given by
(A) $k_2 = \frac{2\pi\sqrt{2m(V-E)}}{h}$ (B) $k_2 = \frac{\sqrt{2m(V-E)}}{h}$
(C) $k_2 = \frac{2\pi\sqrt{2m(E-V)}}{h}$ (D) $k_2 = \frac{\sqrt{2m(E-V)}}{h}$

6. The reflection coefficient of reflection for a particle incident on a potential step with energy E less than height of the step is
(A) 1 (B) 0 (C) $\frac{1}{2}$ (D) $\frac{1}{3}$

7. Photons obey which of the following statistics
(A) Maxwell-Boltzmann (B) Fermi-Dirac (C) Bose-Einstein (D) None of these

8. The Fermi-Dirac distribution function is given by
(A) $f(E) = \frac{1}{e^{\alpha} e^{E/kT}+1}$ (B) $f(E) = \frac{1}{e^{\alpha} e^{E/kT}-1}$
(C) $f(E) = \frac{1}{e^{\alpha} e^{-E/kT}+1}$ (D) $f(E) = \frac{1}{e^{\alpha} e^{-E/kT}-1}$

9. Three particles are to be distributed in 4 levels a, b, c and d. All possible ways to distribute them if the particles are Bosons is

19-b/180

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

SS of B.E.-I (Electrical Engineering/Electronics Engineering/Computer Science Engineering)

Day: Saturday **Date:** 09 JULY **Year:** 2022 **Time:** 11:30 am- 2:30 pm

SUBJECT: (APH 1201/ APH 1202/APH 1203/ APH 1204) APPLIED PHYSICS II

Total marks: 100

(A) 10 (B) 4 (C) 64 (D) 20

10. The wavelength corresponding to the maximum energy for blackbody radiation at 2000 K and 5000 K respectively are
(A) 580 nm and 1450 nm (B) 1450 nm and 580 nm
(C) 1540 nm and 850 nm (D) 850 nm and 1540 nm

11. Copper contains 8.5×10^{-30} free electrons per cubic meter. Assuming free electron model, the Fermi energy for these electrons is
(A) 7.03 eV (B) 100 eV (C) 0.005 eV (D) None of these

12. Einstein's specific heat model reduces to classical Dulong-Petit law at
(A) Low temperature (B) High temperature
(C) Room temperature (D) None of these

13. Free electrons do not contribute to the specific heat of solids because
(A) Of the energy distribution of Fermi -Dirac (B) They are free
(C) They are not Bosons (D) None of these

14. In p-type semiconductor, accepter level forms near
(A) Conduction band (B) Valance band
(C) At the center of the band gap. (D) None of these

15. When the scattering in metal is isotropic, which of the following is true:
(A) Relaxation time is larger than mean collision time
(B) Relaxation time is smaller than mean collision time
(C) Relaxation time is equal to mean collision time
(D) Cannot compare relaxation time and mean collision time

16. Electrical resistivity at very low temperature is essentially determined by
(A) Lattice vibrations (B) Imperfections
(C) Impurities (D) Both impurities and imperfections

17. The transition temperature of superconductor
(A) Increases with increasing isotopic mass
(B) Decreases with increasing isotopic mass
(C) Independent of isotopic mass
(D) Decreases with decreasing isotopic mass

18. The Meissner-Ochsenfeld experiment requires the characterization of a superconductor by
(A) $\rho=0$ (B) $B=0$ (C) $E=0$ (D) Both a and b

19. For a superconductor the relative permeability is
(A) Very large (B) Positive (C) Negative (D) Zero

20. In semiconductors, in equilibrium at temperature T, the rate of recombination depends on
(A) Density of holes (B) Density of electrons
(B) Only temperature (D) Product of density of holes and electrons

21. In the metals, the relaxation time which determine the conductivity refers to
(A) Drift velocity (B) Diffusion velocity
(C) Fermi velocity (D) Electron velocity

19-C
180

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

SS of B.E.-I (Electrical Engineering/Electronics Engineering/Computer Science Engineering)

Day: Saturday **Date:** 09 JULY **Year:** 2022 **Time:** 11:30 am- 2:30 pm

SUBJECT: (APH 1201/ APH 1202/APH 1203/ APH 1204) APPLIED PHYSICS II

Total marks: 100

22. The Einstein's relation between the diffusion constant and the mobility
(A) $D = \mu k_B T$ (B) $D = \mu k_B T^2$ (C) $D = \mu k_B T^3$ (D) $D = \mu k_B T^4$

23. At very high temperature p-type semiconductor behaves as
(A) n-type semiconductor (B) Intrinsic semiconductor
(C) p-type semiconductor (D) Super-conductor

24. In p-type semiconductor which carry no electron or hole current, the excess electron density will disappear _____ with time.
(A) Linearly (B) Quadratically (C) Exponentially (D) Algebraically

25. The work function of the semiconductor is the energy required to extract an electron located at
(A) Center of the band gap (B) Fermi level
(C) Conduction band (D) Valance band

Q-II Attempt **ANY SIX.** Each question carries **TWO** marks. **12**

1. Explain in short, the Rayleigh-Jeans law for the blackbody radiation. Also explain why it fails?
2. What were the basic assumptions of Planck's blackbody radiation law in comparison to that of the classical approach that led Planck to get the correct distribution to match with the experimental results?
3. What are allowed and forbidden bands? Use them to explain the difference between semiconductors and conductors and insulators.
4. Derive Einstein's specific heat of solids formula. Explain in short, the Debye theory (only in words).
5. What is the difference between mean collision time and the relaxation time? In which cases are they likely to differ?
6. What is the evidence to show that the electrons transfer energy to the lattice due to collisions?
7. Super-current in a wire flows only on the surface of the super-conducting wire. Why?
8. Comment on the expression: $2\pi \int P(\theta) \sin\theta \, d\theta = 1$. What is the nature of $P(\theta)$ in case of the electron scattering in metals?

Q-III Attempt **ANY THREE.** Each question carries **THREE** marks. **09**

1. Explain the Tunneling effect of quantum particles in detail. Write any two applications of the same.
2. In case of particle incident on a potential step V with energy E less than the potential V, define and derive the expression of the terms "Leakage Probability" and "Penetration Distance".
3. What is Bloch theorem. Use it to describe the Kronig-Penney model of energy bands.
4. Starting with F(t), the probability of electron to remain uncollided for time t,

obtain the value of the mean collision time. State the assumptions involved.

5. The transition temperature of Pb is 7.2 K. However, at 5 K, it loses the superconducting property if subjected to a magnetic field of 3.3×10^4 A/m. Find the maximum value of H which will allow the material to retain its superconductivity at 0 K.

Q-IV Attempt **ANY ONE.** Each question carries **FOUR** marks. 04

1. Explain the three different types of statistics of particles. Write and explain at least 5 major differences between them.

2. Show that the number of free electrons in an intrinsic semiconductor is given by n_i = constant exp(-W_g /2kT), where the constant may depend on temperature.

Section-II

Q-I **Choose the correct Answer. Each question carries EQUAL marks.** 25

1. Find the magnitude of $\vec{}$ for a dielectric material in which E = 10MV/m and =
5.

(A) $8.295 \times 10^{-10} \frac{C}{m^2}$ (B) $8.295 \times 10^{-6} \frac{C}{m^2}$

(C) $5.295 \times 10^{-10} \frac{C}{m^2}$ (D) $5.295 \times 10^{-6} \frac{C}{m^2}$

2. The magnitude of induced dipole moment in an atom or molecule is____.
(A) proportional to the applied electric field
(B) inversely proportional to the applied electric field
(C) proportional to the square of the applied electric field
(D) inversely proportional to the square of the applied electric field

3. Curl of magnetization ($\vec{}$) is equal to____.
(A) bound surface current density
(B) free surface current density
(C) bound volume current density
(D) free surface current density

4. A long solenoid with 40 tuns/cm has an aluminum core and carries a current of 2A. Calculate the magnetization developed in the core. The magnetic susceptibility of aluminum is 2.3×10^{-5}.
(A) 0.18 A/m (B) 0.0018 A/m (C) 0.1 A/m (D) 0.01 A/m

5. The equation $\nabla \times H = \varepsilon \frac{\partial E}{\partial t}$ is valid in
(A) Dielectrics in the presence of steady state current
(B) Dielectrics in the presence of time varying current
(C) Dielectrics when current is zero
(D) Only conducting medium

6. The term $\int(\vec{} \times \vec{}).\vec{}$ represents____
(A) the electromagnetic energy stored in volume V

19-E/180

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

SS of B.E.-I (Electrical Engineering/Electronics Engineering/Computer Science Engineering)

Day: Saturday **Date:** 09 JULY **Year:** 2022 **Time:** 11:30 am- 2:30 pm

SUBJECT: (APH 1201/ APH 1202/APH 1203/ APH 1204) APPLIED PHYSICS II

Total marks: 100

(B) the rate at which energy flows out of the bounding surface S
(C) the rate at which energy is dissipated in the form of Joule heat in the volume V
(D) None of the these

7. Poynting's theorem is the statement of _____ for electrodynamics.
(A)conservation of momentum (B) conservation of energy
(C) work-energy theorem (D) None of these

8. Diagonal terms in Maxwell's stress tensor represents_____.
(A) pressure
(B) shear stress
(C) electromagnetic energy density
(D) momentum carried by electromagnetic field

9. Unit of Poynting's vector is ____.
(A) Watt / sec (B) Watt (C) Intensity / sec (D) Intensity

10. The power of the electromagnetic wave with electric and magnetic field intensities given by 12 V/m and 15 (V-sec / m^2) is ____.
(A) 180 (B) 120 (C) 90 (D) 45

11. Consider $\vec{D} = (10x\,\hat{i} - 4y\,\hat{j} + kz\,\hat{k})\frac{uC}{m^2}$ and $\vec{B} = 2\hat{j}$ mT. To satisfy the Maxwell's equation for region $\sigma = 0$ and $\rho = 0$, the value of k will be___.
(A) -8 uC/m^3 (B) -6 uC/m^3 (C) -4 uC/m^3 (D) -2 uC/m^3

12. The electric field in the electromagnetic wave passing through a dielectric medium is given by $E = 500\cos(1.2 \times 10^7 x - 2.04 \times 10^{15} t)\,\hat{j}$, where all quantities are in SI units. What will be the relative permeability of the medium?
(A) 2 (B) 5/3 (C) 4/3 (D) 1

13. An electron is thrown perpendicular to the magnetic field then
(A) magnetic field will not affect the motion of an electron.
(B) electron will move in the same direction with increasing momentum
(C) electron will move in the opposite direction with increasing momentum
(D) electron will start moving in a circle.

14. When an electron passes from the region of lower potential to higher potential_____.
(A) it accelerates and bend towards normal
(B) it accelerates and bends away from the normal
(C) it accelerates but doesn't bend at all
(D) it doesn't accelerate but bends towards normal

15. Lagrange-Helmholtz theorem____.
(A) states that angular magnification is directly proportional to the linear magnification
(B) is the law of conservation of energy in geometrical optics
(C) is also valid outside paraxial region without additional proof
(D) all of the above

16. Which of the following is the main factor causing decrease of resolving power?
(A) chromatic aberration (B) coma (C) astigmatism (D) spherical aberration

13-F/180

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

SS of B.E.-I (Electrical Engineering/Electronics Engineering/Computer Science Engineering)

Day: Saturday **Date:** 09 JULY **Year:** 2022 **Time:** 11:30 am- 2:30 pm

SUBJECT: (APH 1201/ APH 1202/APH 1203/ APH 1204) APPLIED PHYSICS II

Total marks: 100

17. In case of a ten-stage electron multiplier tube having $\sigma=2$, the approximate total amplification factor η = ____.
(A) 10^2 (B) 10^3 (C) 10^4 (D) 10^5

18. In electron microscope, spherical aberration increases____
(A) linearly with aperture angle (B) as square of the aperture angle
(C) as cube of the aperture angle (D) as fourth power of the aperture angle

19. Focusing effect of longitudinal magnetic field can be used for___
(A) electron-optical imaging (B) mass spectroscopy
(C) electromagnetic separation of isotopes (D) both (b) and (c)

20. The relation between the velocity of charged particle (of charge e and mass m) and the potential difference is
(A) $v = \sqrt{\frac{eU}{m}}$ (B) $v = \sqrt{\frac{2eU}{m}}$ (C) $v = 2\sqrt{\frac{eU}{m}}$ (D) $v = \sqrt{\frac{eU}{2m}}$

21. If F1 and F2 represents the principal foci of electrons moving from right to left and left to right respectively between two coaxial cylinders with potentials U1 and U2 (such that U2>U1) respectively then
(A) F1>F2 (B) F2>F1 (C) F1=F2 (D) None of these

22. For electrons moving from the source in axially symmetric electric field and in paraxial approximation
(A) the diverging paths have smaller curvature
(B) all paths have same curvature
(C) the diverging paths have larger curvature
(D) the diverging paths may have both have smaller and larger curvature

23. For electrons moving in axially symmetric electric field and in paraxial approximation, if f1 and f2 represents the foci on both sides of the lens for the different potentials then the relation between focus and potential is
(A) $\frac{f2}{f1} = \sqrt{\frac{U1}{U2}}$ (B) $\frac{f1}{f2} = \sqrt{\frac{U1}{U2}}$ (C) $\frac{f1}{f2} = \frac{U1}{U2}$ (D) $\frac{f2}{f1} = \frac{U1}{U2}$

24. For electrons moving in axially symmetric magnetic field, the focusing effect will happen
(A) depending on both the direction of field lines and the initial velocity of electron
(B) depending only on direction of field lines
(C) depending only on the initial velocity of electron
(D) irrespective of both the direction of field lines and the initial velocity of electron

25. Which of the following is false for electron microscopes?
(A) Have greater resolution with respect to optical microscope
(B) Works on the principle of de-Broglie wavelength of electrons
(C) Contrast is determined by difference in absorption at respective points of the object
(D) All of the given options

Q-II Attempt **ANY SIX.** Each question carries **TWO** marks. **12**

19-5
180

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

EXAM. SEAT NO.: _____

SS of B.E.-I (Electrical Engineering/Electronics Engineering/Computer Science Engineering)

Day: Saturday **Date:** 09 JULY **Year:** 2022 **Time:** 11:30 am- 2:30 pm

SUBJECT: (APH 1201/ APH 1202/APH 1203/ APH 1204) APPLIED PHYSICS II

Total marks: 100

1. What are Linear Dielectrics? Obtain the relation between Displacement field $\vec{D}$ and polarization $\vec{P}$.
2. Explain the physical significance of bound current and obtain the relation between volume bound current density ($\vec{J}_b$) and magnetization ($\vec{M}$).
3. How Maxwell's equations will be modified when Electromagnetic wave is propagating in loss free linear dielectric medium?
4. Newton's 3rd law is not obeyed in electrodynamics. Explain the statement.
5. The motion of slow secondary electron towards the surface of emitter strongly depends on whether the emitter material is metal, semi-conductor or insulator." Explain the given statement in regards to electron multiplier tube.
6. State and prove Bethe's law for electron refraction.
7. A diverging magnetic lens is impossible to design. Explain the given statement.
8. Explain how dark field image yields microphotographs of an object with higher contrast compared to bright field image.

Q-III Attempt **ANY THREE.** Each question carries **THREE** marks. **09**

1. A short cylinder of radius 'a' and length 'L' carries a uniform polarization P, parallel to its axis. Find the bound charge, and sketch the electric field for (i) L >> a (ii) L << a and (iii) L ~ a.
2. A plane electromagnetic wave with angular frequency $\omega = 5 \times 10^{14}$ rad/s travels along the direction $\hat{} + \hat{2} + \hat{}$ in a medium with relative permittivity 2.25 and relative permeability 1. The electric field has an amplitude of 10 V/m. Write an expression for a possible electric field as a function of x, y, z and t.
3. Electric field between the plates of the parallel plate capacitor is in x-direction. write down the Maxwell's stress tensor for given situation and find out the pressure felt by negative plate.
4. An electron beam is incident at an angle of 40o with an interface between two regions. The potential of the regions is constant and are respectively U1=1000 V and U2=1100 V. Assuming the electron to be at rest when potential is zero, calculate the angle of refraction and corresponding refractive index.
5. In an electron microscope, the accelerating voltage used is 10KV. If the aperture angle is of the order of 1/10th of a degree, calculate the limit of resolution of such a microscope.

QIV Attempt **ANY ONE.** Each question carries **FOUR** marks. **04**

1. Obtain the equation of conservation of momentum in case of electrodynamics.
2. Derive Lagrange Helmholtz equation in electron optics.

Slip No.: 1 EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Comp.Sc., Electronics, Textile Processing) Examination

Day: Friday Date: 11 Oct Year: 2019 Time: 3:00 to 6:00 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

N. B.: 1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.
3. Boltzmann constant; $k=1.38\times10^{-23}$ J/K, Planck's constant: $h=6.63\times10^{-34}$ Js

SECTION – I

Q.1	Answer the following in brief.		16
	a)	Define barrier potential	
	b)	Explain conductors and semiconductors using band theory	
	c)	Give equation for zero point energy	
	d)	Define Fermi energy	
	e)	What is the difference between mean collision time and the relaxation time?	
	f)	Explain Meissner effect	
	g)	What are intrinsic and extrinsic semiconductors?	
	h)	Show graphically the variation of conductivity with temperature for an extrinsic semiconductor	
Q.2	a)	Write Schroedinger equations and solutions for all the three regions of a barrier potential.	10
	b)	Find rms speed of O_2 at 30 °C (mass of O_2, $m=5.31\times10^{-26}$ kg)	07
		OR	
Q.2	a)	Compare Maxwell-Bolzmann, Bose-Einstein and Fermi-Dirac statistical methods with suitable examples	10
	b)	For an ideal gas derive the formula for the average molecular energy.	07
Q. 3	Answer the following:		17
	a)	Derive an expression for conductivity of metals and explain its variation with temperature.	
	b)	The critical field for niobium is 1×10^5 A/m at 8 K and 2×10^5 A/m at 0 K. Calculate the transition temperature of the element.	
		OR	
Q.3	Answer the following:		17
	a)	Obtain Silsbee's rule for maximum current carried by a super-conducting wire.	
	b)	The electron and hole mobilities in a silicon single crystal at room temp are respectively 0.17 and 0.025 m^2/volt-sec. Find the diffusion coefficients of electrons and holes.	

SECTION – II

Q.4	Answer the following in brief:		16
	a)	Write expressions for surface and volume bound currents in terms of magnetization.	
	b)	Explain polarizability of a molecule.	
	c)	State the Gauss's law for dielectrics.	
	d)	What are linear dielectrics? Show that $\varepsilon_r = 1+\chi_e$	
	e)	Explain Lorentz force.	
	f)	Calculate the wavelength of an electron under a potential difference of 10kV.	
	g)	Explain why short focal length magnetostatic lenses require short coils.	
	h)	Explain why in metals secondary electron emission decreases at higher energies of incident primary electrons?	

Q.5	a)	Write Maxwell's equations in matter in integral form explaining physical meaning of each of them. Derive the boundary conditions at the interface between two different media.	07
	b)	Consider a monochromatic plane-wave representation of electromagnetic waves propagating in +z direction. Write the wave equations for $\vec{E}$ and $\vec{B}$. Show that the Maxwell's equations impose restrictions on the solution of these equations such that (i) electromagnetic waves are transverse and, (ii) $\vec{E}$ and $\vec{B}$ are in phase and mutually perpendicular.	06
	c)	What is the working principle of optical fibers? Explain the terms (i) critical angle (ii) angle of acceptance and derive the expression for the numerical aperture of optical fiber.	04
		OR	
Q.5	a)	How does polarization current arise in a dielectric? Show that the polarization current satisfies the continuity equation in terms of bound charges. Derive the Ampere's law in terms of the auxiliary field.	07
	b)	Derive and explain the integral as well as differential form of the work-energy theorem of electrodynamics.	06
	c)	Calculate the thickness of silver coating to be done for a microwave experiment to operate at a frequency of 10 GHz. Given: resistivity of silver = 1.59×10^{-9} Ω-m, $\varepsilon \approx \varepsilon_0 = 8.85 \times 10^{-12}$ $m^{-3}kg^{-1}s^4A^2$, $\mu \approx \mu_0 = 4\pi \times 10^{-7}$ m-kg-$s^{-2}A^{-2}$.	04
Q.6	a)	What is meant by a thin lens? Briefly explain a thin electrostatic lens. Provide comparison between thin electrostatic lens and a thin optical lens. Derive the equation for focal length of a thin electrostatic lens and show that for a constant electric field, the lens cannot converge (or diverge) the electron beam.	07
	b)	What is an electron multiplier? With proper schematics explain the working of electron multiplier. Why U shaped electrodes are preferred in electron multiplier tubes? Briefly explain the uses of electron multipliers.	06
	c)	An electron beam is accelerated by a potential difference of 100V in an electron microscope. Can this electron beam be used to image structures of size 0.5 Å? Explain your answer.	04
		OR	
Q.6	a)	Provide an analogy between propagation of light in the boundary between dielectric mediums and motion of electrons in a region where the electric field changes. Explain the similarities and difference in this analogy. Derive Snell's law for motion of electric charges in electric field and compare it with Snell's law for light propagation in dielectric mediums. Explain similarity law.	07
	b)	With schematics compare the propagation of light in regions of refractive index change as well as motion of electrons in the regions of change in electric potential. Derive Snell's law for both cases. Explain is similarity law and the physics behind it.	06
	c)	Angle of incidence of a light beam on a dielectric medium is 45°. If the angle of refraction is 33°, what is the refractive index of the second medium provided the first medium is air? An electron beam is incident at the same angle as the light beam and needs to be refracted (deflected) at the same angle as the refracted light beam. Find the ratio of the electric potentials in the two regions.	04

Slip No.: 1 EXAM. SEAT NO.:

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S.S. of B.E. I (Comp.Sc., Electronics, Textile Processing) Examination

Day: Wednesday Date: 24 Oct Year: 2018 Time: 3.00 to 6.00 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

N. B.: 1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.
3. Boltzmann constant; $k=1.38\times10^{-23}$ J/K, Planck's constant; $h=6.63\times10^{-34}$ Js

SECTION – I

Q.1 Answer the following in brief. 16

a) Define step potential
b) Explain conductors, semiconductors and insulators
c) Give equation for zero point energy
d) Define Fermi level
e) What is the difference between mean collision time and the relaxation time? In which cases are they likely to differ?
f) Explain Meissner effect
g) What are intrinsic and extrinsic semiconductors?
h) Show graphically the variation of conductivity with temperature for an extrinsic semiconductor

Q.2 a) Define barrier potential and write Schroedinger equations and solutions for all the three regions of a barrier potential. 10

b) Find rms speed of O_2 at 30 °C (mass of O_2, $m=5.31\times10^{-26}$ kg) 07

OR

Q.2 a) Compare Maxwell-Bolzmann, Bose-Einstein and Fermi-Dirac statistical methods with suitable examples 10

b) For an ideal gas derive the formula for the average molecular energy. 07

Q.3 Answer the following: 17

a) Derive an expression for conductivity of metals and explain its variation with temperature.
b) A copper wire is 1 m long and has a uniform cross-section of 0.1 mm^2; the resistance of the wire is found to be 0.172 ohm. What is the resistivity of the material?
c) The critical field for niobium is 1×10^5 A/m at 8 K and 2×10^5 A/m at 0 K. Calculate the transition temperature of the element.

OR

Q.3 Answer the following: 17

a) Derive equation for free electrons in an intrinsic semiconductor.
b) Obtain Silsbee's rule for maximum current carried by a super-conducting wire.
c) The electron and hole mobilities in a silicon single crystal at room temp are respectively 0.17 and 0.025 m^2/volt-sec. Find the diffusion coefficients of electrons and holes.

SECTION – II

Q.4 Answer the following in brief: 16

a) Write expressions for surface and volume bound currents in terms of magnetization.
b) Explain the polarizabilities of two molecules. Give its unit.
c) Derive the Gauss's law for dielectrics.
d) What are linear dielectrics? Show that $\varepsilon_r = 1+\chi_e$
e) Explain Lorentz force.

Seat No.: ____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Comp.Sc., Electronics, Textile Processing) Examination

Day: Wednesday Date: 24 Oct Year: 2018 Time: 3.00 to 6.00 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

f) Calculate the wavelength of an electron accelerated through a potential difference of 10kV.

g) Explain why short focal length magnetostatic lenses require short coils.

h) Explain why in metals secondary electron emission decreases at higher energies of incident primary electrons?

Q.5 a) Write Maxwell's equations in matter in integral form explaining physical meaning of each of them. Derive the boundary conditions at the interface between two different media. 07

b) Write the statement of Poynting's theorem and explain its physical significance. Write the energy conservation law in case of electrodynamics in integral form and hence derive its differential form. 06

c) What is the working principle of optical fibers? Explain the terms (i) critical angle (ii) angle of acceptance and derive the expression for the numerical aperture of optical fiber. 04

OR

Q.5 a) How does polarization current arise in a dielectric? Show that the polarization current satisfies the continuity equation in terms of bound charges. Derive the Ampere's law in terms of the auxiliary field. 07

b) Show that linearly polarized electromagnetic radiation is transverse and the electric and magnetic field vectors are always perpendicular to each other as well as direction of propagation. 06

c) Calculate the thickness of silver coating to be done for a microwave experiment to operate at a frequency of 10 GHz.

Given: resistivity of silver = 1.59×10^{-9} Ω-m, $\varepsilon \approx \varepsilon_0 = 8.85 \times 10^{-12}$ $m^{-3}kg^{-1}s^4A^2$, $\mu \approx \mu_0 = \pi \times 10^{-7}$ m-kg-$s^{-2}A^{-2}$. 04

Q.6 a) What is meant by a thin lens? Briefly explain a thin electrostatic lens. Provide comparison between thin electrostatic lens and a thin optical lens. Derive the equation for focal length of a thin electrostatic lens and show that for a constant electric field, the lens cannot converge (or diverge) the electron beam. 07

b) Explain the construction and working of an electron microscope with schematics. Derive an expression for the resolution of an electron microscope. 06

c) An electron beam is accelerated by a potential difference of 100V in an electron microscope. Can this electron beam be used to image structures of size 0.5 Å? Explain your answer. 04

OR

Q.6 a) Provide an analogy between propagation of light in the boundary between dielectric mediums and motion of electrons in a region where the electric field changes. Explain the similarities and difference in this analogy. Derive Snell's law for motion of electric charges in electric field and compare it with Snell's law for light propagation in dielectric mediums. Explain similarity law. 07

b) With schematics compare the propagation of light in regions of refractive index change as well as motion of electrons in the regions of change in electric potential. Derive Snell's law for both cases. Explain is similarity law and the physics behind it. 06

c) Why imaging requires a lens? Which parameters decide the resolution of an imaging system? Explain dark field and bright field imaging with schematics. Which of these imaging schemes provides better resolution and better image contrast and why? 04

— × —

Top No.: 1

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Comp.Sc., Electronics, Textile Processing) Examination

Day: Wednesday Date: 25 April Year: 2018 Time: 11.30 a.m. to 2.30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

N. B.: 1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.
3. Boltzmann constant, $k=1.38\times10^{-23}$ J/K, Planck's constant, $h=6.63\times10^{-34}$ Js

SECTION – I

Q.1 Answer the following in brief. 16

a) Define barrier potential
b) Explain conductors, semiconductors and insulators using energy band
c) What is zero point energy?
d) Define Fermi energy
e) What is the difference between mean collision time and the relaxation time? In which cases are they likely to differ?
f) How can you differentiate between a perfect conductor and a superconductor with the help of Meissner effect?
g) How do you characterize an intrinsic semiconductor at 0 K? Why?
h) Show graphically the variation of conductivity with temperature for an extrinsic semiconductor

Q.2 a) Discuss the case of quantum harmonic oscillator and sketch probability density for various n. Write conclusions. 10

b) Find rms speed of O_2 at 0 °C (mass of O_2, $m=5.31\times10^{-26}$ kg) 07

OR

Q.2 a) Compare Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistical methods with suitable examples 10

b) Outline the Kronig-Penney model 07

Q.3 Answer the following: 17

a) Obtain an expression for conductivity of metals and comment on its variation with temperature
b) A copper wire is 1 m long and has a uniform cross-section of 0.1 mm^2; the resistance of the wire is found to be 0.172 ohm. What is the resistivity of the material?
c) The critical field for niobium is 1×10^5 A/m at 8 K and 2×10^5 A/m at 0 K. Calculate the transition temperature of the element.

OR

Q.3 Answer the following: 17

a) Show that the number of free electrons in an intrinsic semiconductor is given by n_i = constant $\exp(-W_g/2KT)$, where the constant may depend on temperature
b) Write the expression for the critical magnetic field H_c as a function of temperature. Show the phase diagram of H_c Vs T. Obtain Silsbee's rule for maximum current carried by a super-conducting wire.
c) The electron and hole mobilities in a silicon single crystal at room temp are respectively 0.17 and 0.025 m^2/volt-sec. Find the diffusion coefficients of electrons and holes.

Slip No.: 2

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B. E. I (Comp. Sc., Electronics, Textile Processing) Examination

Day: Wednesday Date: 25 April Year: 2018 Time: 11.30 a.m. to 2.30 p.m.

SUBJECT: API11201 – APPLIED PHYSICS-II

SECTION – II

16

Q.4 Answer the following in brief

a) What are bound currents? Write expressions for surface and volume bound currents in terms of magnetization.

b) A CO_2 molecule and a H_2O molecule are kept in a uniform strong electric field. Explain the difference in the polarizabilities of the two molecules for different directions of applied electric field.

c) Derive the Clausius law for dielectrics.

d) Using Poynting vector, show that the radiative energy emitted through the surface of a current carrying wire is the same as energy due to Joule's heating of the conductor.

e) Explain Lorentz force. Find the work done on an electron moving through a magnetic field of 0.1 T with speed of 2×10^{7} m/s at an angle of 30°?

f) Calculate the wavelength of an electron beam accelerated through a potential difference of 10 kV.

g) What is the importance of electric potential (U), its first and second derivatives (U' and U'') in electrostatic lens?

h) Explain why in metals secondary electron emission decreases at higher energies of incident primary electrons?

Q.5 a) Write Maxwell's equations in matter in integral form explaining physical meaning of each of them. Derive the boundary conditions at the interface between two different media. 07

b) Consider a monochromatic plane-wave representation of electromagnetic waves propagating in +z direction. Write the wave equations for $\vec{E}$ and $\vec{B}$. Show that the Maxwell's equations impose restrictions on the solution of these equations such that (i) electromagnetic waves are transverse and, (ii) $\vec{E}$ and $\vec{B}$ are in phase and mutually perpendicular. 06

c) What is the working principle of optical fibers? Explain the terms (i) critical angle (ii) angle of acceptance and derive the expression for the numerical aperture of optical fiber. 04

OR

Q.5 a) How does polarization current arise in a dielectric? Show that the polarization current satisfies the continuity equation in terms of bound charges. Derive the Ampere's law in terms of the auxiliary field. 07

b) Derive and explain the integral as well as differential form of the work-energy theorem of electrodynamics. 06

c) Calculate the thickness of silver coating to be done for a microwave experiment to operate at a frequency of 10 GHz. 04

Given: resistivity of silver = 1.59×10^{-8} Ω-m, $\epsilon = \epsilon_0 = 8.85\times10^{-12}$ $m^{-3}kg^{-1}s^{4}A^{2}$, $\mu = \mu_0 = 4\pi\times10^{-7}$ $mkgs^{-2}A^{-2}$.

Q.6 a) What is meant by a thin lens? Briefly explain a thin electrostatic lens. Provide comparison between thin electrostatic lens and a thin optical lens. Derive the equation for focal length of a thin electrostatic lens and show that for a constant electric field, the lens cannot 07

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B. E. I (Comp. Sc., Electronics, Textile Processing) Examination

Day: Wednesday Date: 25 April Year: 2018 Time: 11:30 a.m. to 2:30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

converge (or diverge) the electron beam.

b) What is an electron multiplier? With proper schematics explain the working of electron multiplier. Why U shaped electrodes are preferred in electron multiplier tubes? Briefly explain the uses of electron multipliers. 06

c) An electron beam enters a region of transverse magnetic field of 0.55 Tesla. This field is used to focus the beam of electrons. If the speed of the electron beam is 1.2×10^7 m/s, calculate the spread of the beam around the focal point. Given that apex angle $2\Psi=21.3°$. If this beam of electrons (same speed and same apex angle) is used in an axial magnetic field having the same strength, calculate the pitch of the helix traced by the electron beam. 04

OR

Q.6 a) Provide an analogy between propagation of light in the boundary between dielectric mediums and motion of electrons in a region where the electric field changes. Explain the similarities and difference in this analogy. Derive Snell's law for motion of electric charges in electric field and compare it with Snell's law for light propagation in dielectric mediums. Explain similarity law. 07

b) With proper schematics show the construction of an axi-symmetric electrostatic lens. Explain the path of electrons in such a lens. Using Gauss law show that it can be used to focus a paraxial beam of electrons very close to the optic axis. 06

c) Angle of incidence of a light beam on a dielectric medium is 45°. If the angle of refraction is 33°, what is the refractive index of the second medium provided the first medium is air? An electron beam is incident at the same angle as the light beam and needs to be refracted (deflected) at the same angle as the refracted light beam. Find the ratio of the electric potentials in the two regions. 04

.....

No.: 1 EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Electronics, Computer Science & Textile Processing) Examination

Day: Friday 21st April Year: 2017 Time: 11:30 a.m. to 2:30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

N. B.: 1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.

SECTION – I

Q.1 Answer the following in brief. 16

a) Write time independent Schrödinger equation and identify each term.
b) Explain conductors, semiconductors and insulators with respect to energy band.
c) For an oscillator (frequency = 10^{13} Hz) calculate zero point energy.
d) Define Fermi energy.
e) Starting from the standard form of Ohms law V = IR, Qualitatively obtained the relationship between current density and electric field.
f) Define mobility and relaxation time?
g) State the Silsbee's rule?
h) Draw the energy band scheme for semiconductor for containing donor atoms; at absolute zero.

Q.2 a) Outline and compare Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistical methods with suitable examples. 10

b) Define barrier potential and write Schrödinger equations and solutions for all the three regions of a barrier potential 07

OR

Q.2 a) Discuss molecular energies of an ideal gas using Maxwell-Boltzmann statistics and derive the formula for the average molecular energy. 10

b) Calculate probability of finding the particle with wave function $\psi = A \cdot x$; between $x = 0.45$ and $x = 0.55$. Also find expectation value of the particle's position between 0 and 1. 07

Q.3 Answer the following: 17

a) Using the interaction between electron with lattice in metal prove that the relaxation time is related to the mean time between collisions. i.e. $\tau = \frac{\tau}{1-\langle \cos\theta \rangle}$

b) A copper wire has a resistivity of 1.8×10^{-8} ohm m at room temperature (300°K). Assuming the copper is very pure, estimate the resistivity at 700°C and percentage change in resistivity from room temperature to 700°C.

c) The Transition temperature of sample with isotopic mass of 204.87 amu is 19.2 K. Find Transition temperature (Tc), when isotopic mass change to 218.87 amu.

OR

Q.3 Answer the following: 17

a) Define diffusion current and drift current, prove that diffusion constant is proportional to mobility in semiconductor.

b) The electron and hole mobilities in a silicon single crystal at room temp are respectively 0.17 and 0.025 m^2/volt-sec. Find the diffusion coefficients of electrons and holes.

c) InSb has an electron mobility of 6 m^2/(volt sec) and a hole mobility of 0.2 m^2/(volt sec). The highest room temperature (300 K) resistivity found to date is 2×10^{-4} ohm m. Assuming the material is intrinsic, determine the intrinsic carrier density (n_i) at room temperature.

(P. T. O.)

Slip No.: 2 EXAM. SEAT NO.:

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Computer Science, Electronics & Textile Processing) Examinati...

Day: Tuesday Date: 26th December Year: 2017 Time: 03:00 p.m. to 06:00 p...

SUBJECT: APH1201 APPLIED PHYSICS-II

SECTION-II

Q.4 Answer the following in brief: 16

a) Maxwell added a term called 'displacement current' on the right hand side of the Ampere's law. What was wrong with the original Ampere's law?

b) What are bound charges and bound currents? How are they formed?

c) Define numerical aperture of an optical fiber and derive its expression.

d) Enlist the advantages of data transmission using fiber optic communication over that using copper wired lines.

e) Is it possible to fabricate a diverging magnetic lens? Justify your answer in brief.

f) Give analogy between refractive index ratio in optical lens and potential ratio in electrostatic lens.

g) Write the equation for force on a charged particle in electromagnetic field. Identify the part responsible for changing the kinetic energy of charged particles.

h) Calculate the lateral resolution of an electron microscope having aperture angle of 8.1° employing an electron beam accelerated through a potential of 100 kV.

Q.5 a) With the help of a proper derivation, show that Poynting theorem is the work-energy theorem of electrodynamics and interpret the vector relations of electric and magnetic fields in the Poynting vector with respect to direction of propagation. 10

b) An electromagnetic wave is traveling in a linear media with electrical conductivity(σ), permittivity(ε) and refractive index(μ) . Write down the expression for the skin depth (d). For the case of a good conductor ($\sigma >> \omega\varepsilon$), what would be d? Calculate d for an EM wave of frequency 10^{10} Hz passing through a conductor made of silver. 07
Given: $\rho = 1.59 \times 10^{-8}\ \Omega$m, $\varepsilon \approx \varepsilon_0 = 8.85 \times 10^{-12}$ F/m.

OR

Q.5 a) Write Maxwell's equations in medium with no charge or current. Derive the wave equation for electromagnetic waves. Obtain the expressions for electric and magnetic field vectors in case of monochromatic plane polarized waves. 10

b) What is polarization current? Discuss its contribution to the derivation of Ampere's law for dielectrics. 07

Q.6 a) What is a thin electrostatic lens? Give comparison between thin electrostatic lens and a thin optical lens. Derive the equation for focal length of a thin electrostatic lens and show that for a constant electric field, the lens can not converge (or diverge) the electron beam. 1

b) An electron beam enters a region of transverse magnetic field of 0.5 Tesla. This field is used to focus the beam of electrons. If the velocity of the electron beam is 5.7×10^7 m/s, calculate the spread of the beam around the focal point. (Given: apex angle 2Ψ=24.8°). If this beam of electrons (same velocity and same apex angle) is used in an axial magnetic field having the same strength, calculate the pitch of the helix traced by the electron beam.

OR

Q.6 a) With proper schematics show the construction of an axi-symmetric electrostatic lens. Using Gauss law show that it can be used to focus a paraxial beam of electrons very close to the optic axis.

b) An electron goes from a point A with electric potential of 20 V to another point B with electric potential of 10 kV. (i) Calculate its speed and wavelength at point B. (ii) Compute the resolution of this electrostatic lens employing this potential configuration if the maximum angle of the lens aperture is 5°.

.....

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Computer Science, Electronics & Textile Processing) Examination

Day: Tuesday Date: 26th December Year: 2017 Time: 03:00 p.m. to 06:00 p.m.

SUBJECT: APH1201: APPLIED PHYSICS-II

N. B.: 1 Answers to Q.1 and Q.4 are compulsory.
2 Answer to the two sections must be written in two separate answer books.
3 Figures to the right indicate marks.

SECTION-I

Q.1 Answer the following in brief. 16

a) Define potential function of a potential step. What is the transmittance and reflectance of electron beam of energy E incident on a step potential V_0 if $E > V_0$ & $E < V_0$; where V_0 is the potential step height.

b) Write the expression of probability current density in one and three dimensions.

c) What is effective mass of electron? Write its expression.

d) Write the Schrödinger equation for the Harmonic oscillator. What is zero point energy of harmonic oscillator? Can it be zero?

e) Differentiate between Bosons, Fermions and classical particles.

f) Define average drift velocity, mobility and relaxation time.

g) Super current in a wire flows only on the surface of the super-conducting wire, why?

h) What is Cooper pair? Can an electron and a proton make a Cooper pair in superconductors? Explain.

Q.2 a) A beam of particles of kinetic energy E is incident on a potential barrier of height V and width L. State the potential function, write the Schrodinger equation with the meaning of constants appeared in the equation. Define reflection and transmission coefficient, hence explain tunnel effect. 10

b) A cubic meter of atomic hydrogen at 273 K and at atmospheric pressure contains about 2.7×10^{25} atoms. Find the number of the atoms in their first excited states at 273 K and at 10,273 K. Write your conclusion. 07

[Given: Ground state energy of hydrogen = −13.6 eV, Boltzmann constant = 8.617×10^{-5} eV/K]

OR

Q.2 a) Discuss the Kronig – Penney model in brief and state the conclusions made from the appropriate graph. 10

b) Compare the three statistical distribution functions which is applied to different system of particles for the following: [1] Category of particles, [2] Properties of particles, [3] Examples of particles, [4] Distribution function and [5] Properties of distribution. [Note: Comparison in a tabular form will be preferred.] 07

Q.3 a) Discuss the carrier densities of electron and holes in n-type semiconductor. Explain how carrier densities are modified by introducing the impurity in an intrinsic semiconductor. 10

b) A metal wire has a resistivity of 2.0×10^{-8} ohm-m at room temperature. For an electric field along the wire of 3.2 volt/cm, compute the average drift velocity of the electrons, assuming there are 6×10^{28} conduction electrons per cubic meter. Also calculate the mobility and relaxation time of electrons. 07

OR

Q.3 a) Discuss the carrier densities of electron and holes in n-type semiconductor. Explain how carrier densities are modified by introducing the impurity in an intrinsic semiconductor. 10

b) Given that the relaxation time of conduction electrons in copper is equal to 2.7×10^{-14} sec, calculate the average increase in the x-component of velocity between two collisions, when an electric field of 1.5 volt/cm is applied in the negative x-direction. Compare this with the velocity of an electron with Fermi energy of 7 eV. 07

(P.T.O.)

Slip No.: 2 EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Electronics, Computer Science & Textile Processing) Examination

Day: Friday 21st April Year: 2017 Time: 11:30 a.m. to 2:30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

SECTION – II

Q.4 Answer the following in brief:

a) Write the equation for Lorentz force. Which term in the Lorentz force equation is responsible for change energy of the particle and why?

b) An electron traveling with a velocity of 2.1×10^{6} m/s suddenly enters a region of electric field 12kV/cm and magnetic field of 0.17T. Calculate its change in kinetic energy.

c) What is the importance of electric potential (U), its first and second derivatives (U' and U'') in electrostatic lens?

d) Plot the change in number of secondary electrons emitted from metal surface as a function of the energy of the incident primary electrons and explain the shape of the plot.

e) Show that magnetic forces do not work, how magnetic forces affect the motion of a particle?

f) Why polarizability tensor is considered for a molecule in some cases?

g) A glass clad fibre is made with core glass of refractive index 1.5 and the cladding is doped to give a fractional index difference of 0.0005. Determine (i) cladding index (ii) critical internal reflection angle (iii) external critical acceptance angle and (iv) numerical aperture

h) Which physical property/quantity χ_e represent in dielectrics? What is its value for vacuum? Why?

Q.5 a) Write the integral form of Maxwell's equations and derive the boundary conditions on the fields $\vec{E}$, $\vec{B}$, $\vec{D}$ and $\vec{H}$ at the boundary of two dielectric media. 07

b) Define skin depth for EM waves propagating in matter. Write down the expression for the skin depth in good conductors (like metals). Calculate the skin depth for copper ($\sigma = 57\times10^{6}$ S/m, $\mu = \mu_0$) at frequencies 50 Hz and 1000 Hz. 04

c) Consider an electromagnetic plane wave propagating in $+x$ direction. If the electric field vectors is $\vec{E} = E_0\cos(kx - \omega t)\hat{j}$, what will be the magnetic field? Calculate the Poynting vector. 03

d) Describe the origin of polarization current ($\vec{J}_p$) due to bound charges in matter. Show that it satisfies the continuity equation. 03

OR

Q.5 a) State and prove the work-energy theorem of electrodynamics. Give the physical significance of Poynting vector. 07

b) Derive the expressions for Maxwell's equations in matter, hence explain the concept of displacement current. 04

c) A potential of 50.0 V is applied to a parallel plate capacitor completely filled with a 2.50 mm piece of mica between the plates. Find the magnitude of: (i) the electric field E between the plates, (ii) the electric displacement D between the plates, and (iii) the polarization P between the plates. The dielectric constant for mica is 5.40. 03

d) With the help of Maxwell's equations for the monochromatic plane waves propagating in vacuum, show that: (i) electromagnetic waves are transverse and, (ii) $\vec{E}$, and $\vec{B}$ are in phase and mutually perpendicular. 03

EXAM. SEAT NO.: _____

Slip No.: 3

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S.S. of B.E. I (Electronics, Computer Science & Textile Processing) Examination

Day: Friday 21st April Year: 2017 Time: 11:30 a.m. to 2:30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

Q.6 a) What is a thin lens? Explain the similarities and differences between thin optical and thin electrostatic lens. Derive an expression for focal length of a thin electrostatic lens. 07

b) What is and electron multiplier? Explain its construction with proper schematics. What is the preferred shape of the electrodes in an electron multiplier? Briefly explain applications of the electron multiplier. 06

c) An electron beam enters a region of transverse magnetic field of 0.4 Tesla. This field is used to focus the beam of electrons. If the velocity of the electron beam is 4.1×10^{8}m/s, calculate the spread of the beam around the focal point. Given that apex angle $2\Psi=22.8°$. If this beam of electrons (same velocity and same apex angle) is used in an axial magnetic field having the same strength, calculate the pitch of the helix raced by the electron beam. 04

OR

Q.6 a) Explain how focusing is achieved in axi-symmetric magneto-static lenses with schematics. Explain which magnetic fields are responsible for the deflection of the electrons and the path of the electron in such a lens. Explain the term "short coil focusing". 07

b) Provide an analogy between propagation of light between regions of two different refractive indices and motion of charge particles between regions of different electric potential differences and explain the role of refractive index ratio and electric potential ratio. Explain similarity law of motion of charged particles. 06

c) Compute the lateral resolution of an electron microscope employing an electron beam accelerated through a potential of 10kV. Aperture angle of the system is 12°. 04

.....

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Electronics & Computer Science) Examination

Day: Monday 17th October Year: 2016 Time: 3:00 p.m. to 6:00 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS – II

N. B.: 1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.

SECTION – I

Q.1 Answer the following in brief.

a) Write the expression of probability current density in one and three dimensions.

b) Define potential function of a potential step. What is the transmittance and reflectance of electron beam of energy E incident on a step potential V_0 if $E > V_0$ & $E < V_0$; where V_0 is the potential step height.

c) Write the Schrodinger equation for the Harmonic oscillator. What is zero point energy of harmonic oscillator? Can it be zero?

d) What is effective mass of electron? Write its expression.

e) Explain in brief, (i) Type-I and Type-II superconductor (ii) Meissner Effect

f) What do you mean by Fermi level? Explain with diagram, how it varies with impurities.

g) Super current in a wire flows only on the surface of the super-conducting wire, why?

h) Define (i) effective mass and (ii) diffusion current

Q.2 a) A beam of particles of kinetic energy E is incident on a potential barrier of height V and width L. State the potential function, write the Schrodinger equation with the meaning of constants appeared in the equation. Define reflection and transmission coefficient, hence explain tunnel effect. 10

b) A cubic meter of atomic hydrogen at 273 K and at atmospheric pressure contains about 2.7×10^{25} atoms. Find the number of these atoms in their first excited states at 273 K and at 10,273 K. Write your conclusion. [Given: Ground state energy of hydrogen = –13.6 eV, Boltzmann constant = 8.61×10^{-5} eV/K] 07

OR

Q.2 a) Discuss molecular energies of an ideal gas using Maxwell-Boltzmann statistics and derive the formula for the average molecular energy. 10

b) What are the three statistics? How do they differ with respect to types of particles, their properties and distribution functions? 07

Q.3 Answer the following:

a) Discuss the carrier densities of electron and holes in n-type semiconductor. Explain how carrier densities are modified by introducing the impurity in an intrinsic semiconductor. 10

b) A metal wire has a resistivity of 2.0×10^{-8} ohm-m at room temperature. For an electric field along the wire of 3.2 volt/m, compute the average drift velocity of the electrons, assuming there are 6×10^{28} conduction electrons per cubic meter. Also calculate the mobility and relaxation time of electrons. 07

OR

Q.3 Answer the following:

a) Discuss the carrier densities of electron and holes in n-type semiconductor. Explain how carrier densities are modified by introducing the impurity in an intrinsic semiconductor. 10

b) A long thin superconducting wire of a metal produces a magnetic field 105×10^{3} Am^{-1} on surface due to the current through it at a certain temperature T. The critical field of the metal is 150×10^{3} Am^{-1} at T= 0 K. The critical temperature T_c of the metal is 9.2 K, what is the value of T? 07

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
S.S. of B.E. I (Electronics & Computer Science) Examination
Day: Monday 17th October Year: 2016 Time: 3:00 p.m. to 6:00 p.m.
SUBJECT: APH1201 – APPLIED PHYSICS – II

SECTION – II

Q.4 Answer the following in brief:

a) What are bound charges and bound currents? How are they formed?
b) Maxwell added a term called 'displacement current' on the right hand side of the Ampere's law. What was wrong with the original Ampere's law?
c) Define numerical aperture of an optical fiber and derive its expression.
d) Enlist the advantages of data transmission using fiber optic communication over that using copper wired lines.
e) What are the differences between angular and linear magnifications of an electrostatic lens?
f) Calculate the lateral resolution of an electron microscope having aperture angle of 7.6° employing an electron beam accelerated through a potential of 100 kV.
g) Write the equation for force on a charged particle in electromagnetic field. Identify the part responsible for changing the kinetic energy of charged particles.
h) What are the differences between angular and linear magnifications of an electrostatic lens? Write the equation for force on a charged particle in electromagnetic field. Identify the part responsible for changing the kinetic energy of charged particles.

Q.5 a) Obtain Maxwell's equations in matter and derive the boundary conditions at the interface between two different media. 10

b) Define Maxwell's stress tensor. Derive the expression for the total force felt by volume charge distribution in terms of the stress tensor. 07

OR

Q.5 a) Write Maxwell's equations in medium with no charge or current. Derive the wave equation for electromagnetic waves. Obtain the expressions for electric and magnetic field vectors in case of monochromatic plane polarized waves. 10

b) An electromagnetic wave is traveling in a linear media with electrical conductivity (σ), permittivity (ε) and refractive index (μ). Write down the expression for the skin depth (d). For the case of a good conductor ($\sigma >> \omega\varepsilon$), what would be d? Calculate d for an EM wave of frequency 10^{10} Hz passing through a conductor made of silver. 07
Given: $\rho = 1.59 \times 10^{-8}\ \Omega m$, $\varepsilon \approx \varepsilon_0 = 8.85 \times 10^{-12}$ F/m.

Q.6 a) What is a thin electrostatic lens? Give comparison between thin electrostatic lens and a thin optical lens. Derive the equation for focal length of a thin electrostatic lens and show that for a constant electric field, the lens cannot converge (or diverge) the electron beam. 10

b) An electron beam enters a region of transverse magnetic field of 0.5 Tesla. This field is used to focus the beam of electrons. If the velocity of the electron beam is 5.7×10^7 m/s, calculate the spread of the beam around the focal point. (Given: apex angle $2\psi = 24.8°$). If this beam of electrons (same velocity and same apex angle) is used in an axial magnetic field having the same strength, calculate the pitch of the helix traced by the electron beam. 07

OR

Q.6 a) With proper schematics show the construction of an axi-symmetric electrostatic lens. Using Gauss law show that it can be used to focus a paraxial beam of electrons very close to the optic axis. 10

b) An electron goes from a point A with electric potential of 20 V to another point B with electric potential of 10 kV. (i) Calculate its speed and wavelength at point B. (ii) Compute the resolution of this electrostatic lens employing this potential configuration if the maximum angle of the lens aperture is 5°. 07

****

No.: 1

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Electronics & Computer Science) Examination

Day: Friday 08th May Year: 2015 Time: 11:30 a.m. to 2:30 p.m.

SUBJECT: API1201 – APPLIED PHYSICS-II

N. B.: 1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.

SECTION – I

Q.1 Answer the following in brief: 16

a) Write time dependent and time independent Schrödinger equations and name all the terms involved.

b) Calculate probability of finding the particle with wave function $\psi = (3)^{1/3}x$ between $x = 0.45$ and $x = 0.55$

c) Write mathematical conditions for a step and a barrier potential

d) Explain conductors, semiconductors and insulators with respect to energy band.

e) What are the main features of the Ohm's law?

f) Define average mobility and relaxation time.

g) Write the expression for the critical magnetic field H_c as a function of temperature.

h) Show graphically the variation of conductivity with temperature for an extrinsic semiconductor.

Q.2 a) Discuss the potential energy function for quantum harmonic oscillator and derive the equation for its energy levels. Show using plots that the probability densities approach the classical values for higher n. 10

b) What are symmetric and anti-symmetric wave functions? Show that fermions obey the Pauli's exclusion principle. Write distribution functions for bosons and fermions. 07

OR

Q.2 a) Discuss molecular energies of an ideal gas using Maxwell-Boltzmann statistics and derive the formula for the average molecular energy. 1

b) What is periodicity of the potential? Discuss Kronig Penney model to explain bands in solids.

Q.3 Answer the following:

a) Obtain an expression for conductivity of metals and comment on its variation with temperature.

b) Comment on the expression: $2\pi \int P(\theta) \sin\theta \, d\theta = 1$. What is the nature of $P(\theta)$ in case of the electron scattering in metals?

c) The resistivity of intrinsic Si at 27 °C is 3000 ohm-m. Assuming electron and hole mobility of respectively 0.19 & 0.035 m^2 volt^{-1} sec^{-1}, calculate the intrinsic carrier density n_i at 27°C.

OR

Q.3 Answer the following:

a) Show that the number of free electrons in an intrinsic semiconductor is given by n_i = constant $\exp(-W_g/2kT)$, where the constant may depend on temperature.

b) If the current passing through a superconducting wire exceeds the value given by Silsbees' rule, the entire wire looses superconductivity. Why?

c) The critical field for niobium is 1×10^5 A/m at 8 K and 2×10^5 A/m at 0 K. Calculate the transition temperature of the element.

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
S. S. of B.E. I (Electronics & Computer Science) Examination
Day: Friday 08th May Year: 2015 Time: 11:30 a.m. to 2:30 p.m.
SUBJECT: APH1201 - APPLIED PHYSICS-II

406
125

SECTION – II

Q.4 Answer the following in brief:

a) A hydrogen atom is placed between to conducting plates separated by 0.5 mm. If the potential difference between the two plates is 500 V, calculate the distance between the positive and negative charge centers.

Given: atomic polarizability of H atom $\frac{\alpha}{4\pi\varepsilon_0} = 0.667\times10^{-10}\ m^3, \varepsilon_0 = 8.85\times10^{-12}\ C^2/N\text{-}m^2$

b) Define: (1) atomic polarizability (2) electric displacement

c) Using Poynting vector, show that the radiative energy emitted through the surface of a current carrying wire is the same as energy due to Joule's heating of the conductor.

d) Differentiate between step index and graded index fiber. Also show the path of light travelling through both of them. Show relevant diagrams.

e) Explain the cause of chromatic aberration in electrostatic lenses.

f) What is short coil focusing in magnetostatic lenses?

g) Calculate the pitch of the helix formed by a neutron entering a region of magnetic field of 0.25T with initial velocity of 3×10^6 m/s.

h) An electron enters a region in space having both electric and magnetic field. What is the force on the electron?

Q.5 a) Show with the help of Maxwell's equations that light is an electromagnetic (EM) wave and its velocity is $1/\sqrt{\mu_0\varepsilon_0}$. Also, prove that the EM radiation is transverse and; the electric field vector, magnetic field vector and propagation vector are mutually perpendicular. 07

b) Write the Maxwell's equations in integral form. Hence, obtain the boundary conditions on the $\vec{E}$, $\vec{B}$, $\vec{D}$ and $\vec{H}$ field vectors. 04

c) What is polarization current? Show that the continuity equation is satisfied in an electrically polarized material. i.e. $\vec{\nabla}\cdot\vec{J}_p = -\frac{\partial\rho_b}{\partial t}$ where $\vec{J}_p$ is the polarization current density and ρ_b is the bound charge density. 03

Find the wavelength and propagation speed in copper for radio waves at 1 MHz. Compare the corresponding values in air or vacuum. The conductivity of copper is 6×10^7 *mho/m*. 07

OR

Q.5 a) How does propagation of electromagnetic waves differ in conducting medium compared to dielectric medium? Obtain the expression for the skin depth with the help of Maxwell's equations in conducting media. 07

b) The space between the plates of a parallel-plate capacitor is filled with two slabs of linear dielectric material. Each slab has thickness a, so the total distance between the plates is $2a$. Slab 1 has a dielectric constant of 2, and slab 2 has a dielectric constant of 1.5. The free charge density on the top plate is σ and on the bottom plate $-\sigma$. Find for each slab, (i) electric displacement ($\vec{D}$), (ii) electric field ($\vec{E}$) and (iii) polarization ($\vec{P}$). 04

c) Based on the physical interpretation of bound charges, derive the expressions for surface and volume bound charge densities (σ_b and ρ_b). 03

d) What are diamagnetic and paramagnetic materials? The magnetic susceptibilities of silver and aluminum are -2.4×10^{-5} and 2.1×10^{-5} respectively. Which of these metals is diamagnetic? Explain your answer in brief. 03

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S.S.of B.E. I (Electronics & Computer Science) Examination

Day: Friday 08th May Year: 2015 Time: 11:30 a.m. to 2:30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-I.

a) Explain the working of a thin electrostatic thin lens with schematics. Derive the expression for the focal length of such a lens and show that without radial field the lens cannot focus. 07

b) What is an electron multiplier? Explain the working of an electron multiplier with proper schematics. What type of material is to be used to have maximum secondary electron yield in the case of electron multipliers and also explain the change in secondary electron yield as a function of energy of primary electrons. 06

c) An electron beam is accelerated by an electric field of 100V and it enters a region of magnetic field at 15°. Compute the amount of magnetic field required so that the electrons follow a helical path of pitch 1.2mm. 04

OR

Q.6 a) Describe in detail the working of magneto-static lenses. How the magnetic field distribution for focusing of electrons is achieved in magneto-static lenses? Write the different magnetic field components encountered by the electron while entering such a lens. Which magnetic field component is responsible for focusing of electrons? How a magnetic-static lens differs from an electro-static lens? 07

b) Provide an analogy between an optical thin lens and an electro-static thin lens. What are the types of aberrations that affect an electro-static lens? Explain their origin and how these aberrations can be reduced. 06

c) An electron microscope is working at a potential difference of 1kV. Compute the lateral resolution of the microscope provided that the numerical aperture of the system is 0.2. What will be the numerical aperture needed for an optical microscope working at 365nm to achieve the same lateral resolution. Is such a numerical aperture possible? 04

— X —

Slip No.: 1

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Electrical Engg.) Examination

Day: Wednesday Date: 25 April Year: 2018 Time: 11.30 a.m. to 2:30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

44-9/70

08

N. B.: 1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.
3. Boltzmann constant, k 1.38×10^{-23} J/K, Planck's constant, h=6.63×10^{-34} Js

SECTION – I

Q.1 Answer the following in brief. **16**

a) Define barrier potential
b) Explain conductors, semiconductors and insulators using energy band
c) What is zero point energy?
d) Define Fermi energy
e) What is the difference between mean collision time and the relaxation time? In which cases are they likely to differ?
f) How can you differentiate between a perfect conductor and a superconductor with the help of Meissner effect?
g) How do you characterize an intrinsic semiconductor at 0 K? Why?
h) Show graphically the variation of conductivity with temperature for an extrinsic semiconductor

Q.2 a) Discuss the case of quantum harmonic oscillator and sketch probability density for various *n*. Write conclusions. **10**

b) Find rms speed of O_2 at 0 °C (mass of O_2, m=5.31×10^{-26} kg) **07**

OR

Q.2 a) Compare Maxwell-Bolzmann, Bose-Einstein and Fermi-Dirac statistical methods with suitable examples **10**

b) Outline the Kronig-Penney model **07**

Q. 3 Answer the following: **17**

a) Obtain an expression for conductivity of metals and comment on its variation with temperature.
b) A copper wire is 1 m long and has a uniform cross-section of 0.1 mm^2; the resistance of the wire is found to be 0.172 ohm. What is the resistivity of the material?
c) The critical field for niobium is 1×10^5 A/m at 8 K and 2×10^5 A/m at 0 K. Calculate the transition temperature of the element.

OR

Q.3 Answer the following: **17**

a) Show that the number of free electrons in an intrinsic semiconductor is given by n_i = constant $\exp(-W_g/2kT)$, where the constant may depend on temperature.
b) Write the expression for the critical magnetic field H_c as a function of temperature. Show the phase diagram of H_c Vs T. Obtain Silsbee's rule for maximum current carried by a super-conducting wire.
c) The electron and hole mobilities in a silicon single crystal at room temp are respectively 0.17 and 0.025 m^2/volt-sec. Find the diffusion coefficients of electrons and holes.

Slip No.: 2

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. Y. of B.E. - I (Electrical Engg.) Examination

Day: Wednesday Date: 25 April Year: 2018 Time: 11:30 a.m. to 2:30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

SECTION – II

Q.4 Answer the following in brief: 14

a) What are bound currents? Write expressions for surface and volume bound currents in terms of magnetization.

b) A CO_2 molecule and a H_2O molecule are kept in a uniform strong electric field. Explain the difference in the polarizabilities of the two molecules for different directions of applied electric field.

c) Derive the Gauss's law for dielectrics.

d) Using Poynting vector, show that the radiative energy emitted through the surface of a current carrying wire is the same as energy due to Joule's heating of the conductor.

e) Explain Lorentz force. Find the work done on an electron moving through a magnetic field of 1T with speed of 2×10^6 m/s at an angle of 30°?

f) Calculate the wavelength of an electron beam accelerated through a potential difference of 10kV.

g) What is the importance of electric potential (U), its first and second derivatives (U' and U'') in electrostatic lens?

h) Explain why in metals secondary electron emission decreases at higher energies of incident primary electrons?

Q.5 a) Write Maxwell's equations in matter in integral form explaining physical meaning of each of them. Derive the boundary conditions at the interface between two different media. 12

b) Consider a monochromatic plane-wave representation of electromagnetic waves propagating in +z direction. Write the wave equations for $\vec{E}$ and $\vec{B}$. Show that the Maxwell's equations impose restrictions on the solution of these equations such that (i) electromagnetic waves are transverse and, (ii) $\vec{E}$ and $\vec{B}$ are in phase and mutually perpendicular. 08

c) A dielectric cube of side L and center at the origin has a radial polarization given by $\vec{P} = a\vec{r}$, where a is a constant and $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. Find the surface and volume bound charge densities. Show that the total bound charge vanishes. 04

OR

Q.5 a) How does polarization current arise in a dielectric? Show that the polarization current satisfies the continuity equation in terms of bound charges. Derive the Ampere's law in terms of the auxiliary field. 12

b) Derive and explain the integral as well as differential form of the work-energy theorem of electrodynamics. 08

c) Calculate the thickness of silver coating to be done for a microwave experiment to operate at a frequency of 10 GHz. 04

Given: resistivity of silver $= 1.59 \times 10^{-9}$ Ω-m, $\varepsilon \approx \varepsilon_0 = 8.85 \times 10^{-12}$ $m^{-3}kg^{-1}s^4A^2$, $\mu = \mu_0 = 4\pi \times 10^{-7}$ m-kg-$s^{-2}A^{-2}$.

EXAM. SEAT NO.: _____

Slip No.: 3

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B.E. I (Electrical Engg.) Examination

Day: Wednesday Date: 25 April Year: 2018 Time: 11:30 a.m. to 2:30 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

Q.6 a) What is meant by a thin lens? Briefly explain a thin electrostatic lens. Provide comparison between thin electrostatic lens and a thin optical lens. Derive the equation for focal length of a thin electrostatic lens and show that for a constant electric field, the lens cannot converge (or diverge) the electron beam. **07**

b) What is an electron multiplier? With proper schematics explain the working of electron multiplier. Why U shaped electrodes are preferred in electron multiplier tubes? Briefly explain the uses of electron multipliers. **06**

c) An electron beam enters a region of transverse magnetic field of 0.55 Tesla. This field is used to focus the beam of electrons. If the speed of the electron beam is 1.2×10^7 m/s, calculate the spread of the beam around the focal point. Given that apex angle $2\Psi=21.3^\circ$. If this beam of electrons (same speed and same apex angle) is used in an axial magnetic field having the same strength, calculate the pitch of the helix traced by the electron beam. **04**

OR

Q.6 a) Provide an analogy between propagation of light in the boundary between dielectric mediums and motion of electrons in a region where the electric field changes. Explain the similarities and difference in this analogy. Derive Snell's law for motion of electric charges in electric field and compare it with Snell's law for light propagation in dielectric mediums. Explain similarity law. **07**

b) With proper schematics show the construction of an axi-symmetric electrostatic lens. Explain the path of electrons in such a lens. Using Gauss law show that it can be used to focus a paraxial beam of electrons very close to the optic axis. **06**

c) Angle of incidence of a light beam on a dielectric medium is 45°. If the angle of refraction is 33°, what is the refractive index of the second medium provided the first medium is air? An electron beam is incident at the same angle as the light beam and needs to be refracted (deflected) at the same angle as the refracted light beam. Find the ratio of the electric potentials in the two regions. **04**

.....

Exam Seat No: 14

UNIVERSITY OF BARODA

Slip No.: 1

7.a
10

EXAM. SEAT NO.: _____

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S S of B E I (Electrical Engg.) Examination

Day: Friday Date: 11 Oct Year: 2019 Time: 3.00 to 6.00 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

N. B.: 1. Answer to the two sections must be written in two separate answer books.
2. Figures to the right indicate marks.
3. Boltzmann constant; $k=1.38\times10^{-23}$ J/K, Planck's constant; $h=6.63\times10^{-34}$ Js

SECTION – I

Q.1	Answer the following in brief.		
	a)	Define barrier potential	16
	b)	Explain conductors and semiconductors using band theory	
	c)	Give equation for zero point energy	
	d)	Define Fermi energy	
	e)	What is the difference between mean collision time and the relaxation time?	
	f)	Explain Meissner effect	
	g)	What are intrinsic and extrinsic semiconductors?	
	h)	Show graphically the variation of conductivity with temperature for an extrinsic semiconductor	
Q.2	a)	Write Schroedinger equations and solutions for all the three regions of a barrier potential.	10
	b)	Find rms speed of O_2 at 30 °C (mass of O_2, $m=5.31\times10^{-26}$ kg)	07
		OR	
Q.2	a)	Compare Maxwell-Bolzmann, Bose-Einstein and Fermi-Dirac statistical methods with suitable examples	10
	b)	For an ideal gas derive the formula for the average molecular energy.	07
Q. 3	Answer the following:		17
	a)	Derive an expression for conductivity of metals and explain its variation with temperature.	
	b)	The critical field for niobium is 1×10^5 A/m at 8 K and 2×10^5 A/m at 0 K. Calculate the transition temperature of the element.	
		OR	
Q.3	Answer the following:		17
	a)	Obtain Silsbee's rule for maximum current carried by a super-conducting wire.	
	b)	The electron and hole mobilities in a silicon single crystal at room temp are respectively 0.17 and 0.025 m^2/volt-sec. Find the diffusion coefficients of electrons and holes.	

SECTION – II

Q.4	Answer the following in brief:		16
	a)	Write expressions for surface and volume bound currents in terms of magnetization.	
	b)	Explain polarizability of a molecule.	
	c)	State the Gauss's law for dielectrics.	
	d)	What are linear dielectrics? Show that $\varepsilon_r = 1+\chi_e$	
	e)	Explain Lorentz force.	
	f)	Calculate the wavelength of an electron under a potential difference of 10kV.	
	g)	Explain why short focal length magnetostatic lenses require short coils.	
	h)	Explain why in metals secondary electron emission decreases at higher energies of incident primary electrons?	

d) What are [illegible]

EXAM. SEAT NO.:

Slip No.: 2

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

S. S. of B E I (Electrical Engg.) Examination

Day: Friday Date: 11 Oct Year: 2019 Time: 3:00 to 6:00 p.m.

SUBJECT: APH1201 – APPLIED PHYSICS-II

87/10

Q.5	a)	Write Maxwell's equations in matter in integral form explaining physical meaning of each of them. Derive the boundary conditions at the interface between two different media.	07
	b)	Consider a monochromatic plane-wave representation of electromagnetic waves propagating in +z direction. Write the wave equations for $\vec{E}$ and $\vec{B}$. Show that the Maxwell's equations impose restrictions on the solution of these equations such that (i) electromagnetic waves are transverse and, (ii) $\vec{E}$ and $\vec{B}$ are in phase and mutually perpendicular.	06
	c)	What is the working principle of optical fibers? Explain the terms (i) critical angle (ii) angle of acceptance and derive the expression for the numerical aperture of optical fiber.	04
		OR	
Q.5	a)	How does polarization current arise in a dielectric? Show that the polarization current satisfies the continuity equation in terms of bound charges. Derive the Ampere's law in terms of the auxiliary field.	07
	b)	Derive and explain the integral as well as differential form of the work-energy theorem of electrodynamics.	06
	c)	Calculate the thickness of silver coating to be done for a microwave experiment to operate at a frequency of 10 GHz. Given: resistivity of silver = 1.59×10^{-9} Ω-m, $\varepsilon \approx \varepsilon_0 = 8.85 \times 10^{-12}$ $m^{-3}kg^{-1}s^4A^2$, $\mu \approx \mu_0 = 4\pi \times 10^{-7}$ m-kg-$s^{-2}A^{-2}$.	04
Q.6	a)	What is meant by a thin lens? Briefly explain a thin electrostatic lens. Provide comparison between thin electrostatic lens and a thin optical lens. Derive the equation for focal length of a thin electrostatic lens and show that for a constant electric field, the lens cannot converge (or diverge) the electron beam.	07
	b)	What is an electron multiplier? With proper schematics explain the working of electron multiplier. Why U shaped electrodes are preferred in electron multiplier tubes? Briefly explain the uses of electron multipliers.	06
	c)	An electron beam is accelerated by a potential difference of 100V in an electron microscope. Can this electron beam be used to image structures of size 0.5 Å? Explain your answer.	04
		OR	
Q.6	a)	Provide an analogy between propagation of light in the boundary between dielectric mediums and motion of electrons in a region where the electric field changes. Explain the similarities and difference in this analogy. Derive Snell's law for motion of electric charges in electric field and compare it with Snell's law for light propagation in dielectric mediums. Explain similarity law.	07
	b)	With schematics compare the propagation of light in regions of refractive index change as well as motion of electrons in the regions of change in electric potential. Derive Snell's law for both cases. Explain is similarity law and the physics behind it.	06
	c)	Angle of incidence of a light beam on a dielectric medium is 45°. If the angle of refraction is 33°, what is the refractive index of the second medium provided the first medium is air? An electron beam is incident at the same angle as the light beam and needs to be refracted (deflected) at the same angle as the refracted light beam. Find the ratio of the electric potentials in the two regions.	04