

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 Hours

WINTER SEMESTER, 2017-2018

FULL MARKS: 150

Phy 4141: Physics I

Programmable calculators are not allowed. Do not write anything on the question paper.
There are 8 (eight) questions. Answer any 6 (six) of them.
Figures in the right margin indicate marks.

- a) State Gauss's law in electrostatics. Define electric flux and flux density. Write down Gauss's law for magnetism, for gravitation, and for an incompressible fluid. 7
- b) A particle of mass m and charge q is placed at rest in a uniform electric field E and released. Describe the motion of the electron. Show that the kinetic energy attained by the electron after moving a distance y is given by $K=qEy$, where the symbols have their usual meaning. 10
- c) Compare the motion of the electron with that of a falling body under the action of gravity. The electric field between the plates of a cathode-ray oscilloscope is 1.2×10^4 nt/coul. What deflection will an electron experience if it enters at right angles to the field with a kinetic energy of 2.0 keV ($1\text{eV} = 1.6 \times 10^{-19}$ joule)? The deflecting assembly is 1.5 cm long. 8
- a) Discuss Ohm's law. Define resistivity and current density. What do you mean by temperature coefficient of resistivity? 7
- b) In a metallic conductor the electrons drift opposite to the applied external electric field E . Show that the drift velocity of the electrons in the conductor is given by $v_d = j/ne$, where the symbols have their usual meaning. 10
- c) Show that the power P per unit volume transformed into Joule heat in a resistor is given by $P = j^2\rho$ or $P = E^2/\rho$, where the symbols have their usual meaning. 8
- a) Name and distinguish ferromagnet, ferrimagnet and antiferromagnetic materials. 7
- b) What is Hall effect? Define Hall field E_H and Hall voltage V_H . How would you measure these quantities? Show that the Hall field experienced by the conduction electron is given by $E_H = j/ne B$, where the symbols have their usual meaning. 10
- c) A copper strip 2.0 cm wide and 1.0 mm thick is placed in a magnetic field with $B = 1.5$ webers/m². If a current of 200 amp is set up in the strip, what Hall potential difference would appear across the strip? 8
- a) Define Capacitance of a capacitor. What is a dielectric material and why is it used in a capacitor? Discuss the mechanism of charge polarization in a dielectric material. 7
- b) What are free charges and induced charges? Show that the induced surface charge q' is always less in magnitude than the free charge q and that $q' = 0$ if no dielectric material is present in the capacitor. 10
- c) A parallel plate capacitor has plates with area A and separation d . A battery charges the plates to a potential difference V_0 . The battery is then disconnected, and a dielectric slab of thickness d is introduced between the plates. Calculate the stored energy both before and after the slab is introduced and account for any difference. 8

5. a) Discuss interference of light. Describe Young's experiment in a quantitative way assuming that the incident light consists of a single wavelength.
- b) In a Young's double slit arrangement the two slits are illuminated with light from a mercury vapor lamp so filtered that only the strong green line ($\lambda = 5400 \text{ \AA}$) is effective. The slits are 2.10 mm apart, and the screen on which the interference patterns appears is 20 cm away. Calculate
- The angular position of the first minimum
 - The angular position of the tenth maximum
 - The linear distance on screen between adjacent maxima.
- c) Discuss the various uses of MgF_2 ($n=1.38$) as an anti-reflecting glass coating for different optical devices.
6. a) Discuss the phenomenon of diffraction of light. State and explain Huygen's principle.
- b) A plane wave falling at normal incidence on a long narrow slit of width a . Using the optical diagrams show the conditions at the central maximum of diffraction and at the first minimum of the diffraction.
- c) A slit of width a is illuminated by white light. For what value of a will the first minimum for red light ($\lambda = 6000 \text{ \AA}$) fall at $\theta=30^\circ$?
7. a) Define polarization of light. Discuss with the help of a diagram the mechanism of polarization of light using polarizing sheets.
- b) Discuss polarization by double refraction. Describe how a beam of unpolarized light falling on a calcite crystal is split into two beams which are polarized at right angles to each other? What are o-ray and e-ray?
- c) Two polarizing sheets have their polarizing directions parallel so that the intensity I_m of the transmitted light is a maximum. Through what angle must either sheet be turned if the intensity is to drop by one-half?
8. a) Discuss Einstein's general theory of relativity. Discuss how Einstein related gravity to the structure of space and time? What do you mean by the term "warping of space-time around a body of matter"?
- b) Define relativistic mass and relativistic momentum. Derive Einstein's Mass-Energy relation.
- c) Solar energy reaches the earth at the rate of about 1.4 kW per square meter of surface perpendicular to the direction of the sun. By how much does the mass of the sun decrease per second owing to this energy loss? The mean radius of the earth's orbit is $1.5 \times 10^{11} \text{ m}$.