GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY
Faculty of Engineering
Department of Electrical, Electronic and Telecommunication Engineering

BSc Engineering Degree
Semester 5 Examination – May 2023
(Intake 38 – EE/ET)

ET3132 – PHOTONICS AND OPTOELECTRONICS

Time allowed: 2 hours | 10th May 2023

ADDITIONAL MATERIAL PROVIDED

Universal Constants

Plank constant (h)	$6.63 \times 10^{-34}\ J.s$
Charge of an electron (e)	$1.6021 \times 10^{-19}\ C$
Electron mass(m)	$9.11 \times 10^{-31}\ kg$
Speed of light in free space (c)	$3.00 \times 10^{8}\ m.s^{-1}$

INSTRUCTIONS TO CANDIDATES

This paper contains 4 questions on 5 pages.

Answer **all five** questions.

This is a closed book examination.

This examination accounts for 70% of the module assessment. A total maximum mark obtainable is 100. The marks assigned for each question and parts thereof are indicated in square brackets.

If you have any doubt as to the interpretation of the wordings of a question, make your own decision, but clearly state it on the script.

Assume reasonable values for any data not given in or provided with the question paper, clearly make such assumptions made in the script.

All examinations are conducted under the rules and regulations of the KDU.

This Page is Intentionally Left Blank

1) A Single-electron orbit around a stationary nucleus of charge $+Ze$, where Z is a constant and e is the magnitude of electronic charge.

a. Derive an equation for the energy of an electron in n^{th} state of an atom having atomic number Z. [07]

b. Prove that energy required to excite an electron from nth to $n+1$th Bohr orbits is higher than the Energy Required to excite an electron from $n+1$th to $n+2$th Bohr orbits (Correspondance Principle). [10]

c. It requires 50 eV of photon energy to excite the electron from the second Bohr orbit to the third Bohr orbit. Estimate,

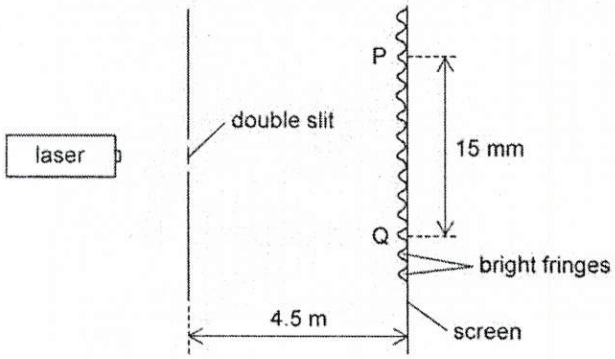
i. The wavelength of the photon. [03]

ii. An atomic number of the nucleus. [05]

2) Explain Newton's double slit experiment in physical optics with a suitable diagram. [05]

a. Prove that the distance between the m^{th} dark fringe and bright central fringe on the screen is $y_m = \left(m - \frac{1}{2}\right)\lambda\frac{D}{d}$ and Hence $\Delta y_m = \lambda\frac{D}{d}$ [10]

b. As shown in the diagram below, a laser is placed in front of a double-slit.

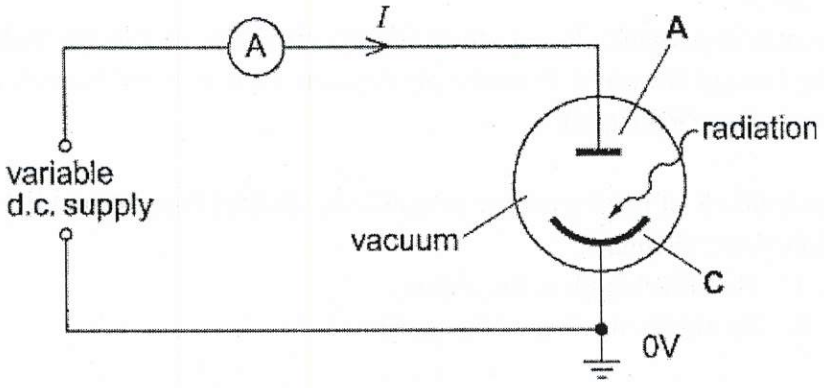


The laser emits light of frequency 750 THz. The separation of the maxima P and Q observed on the screen is 15 mm. The distance between the double slit and the screen is 4.5 m.

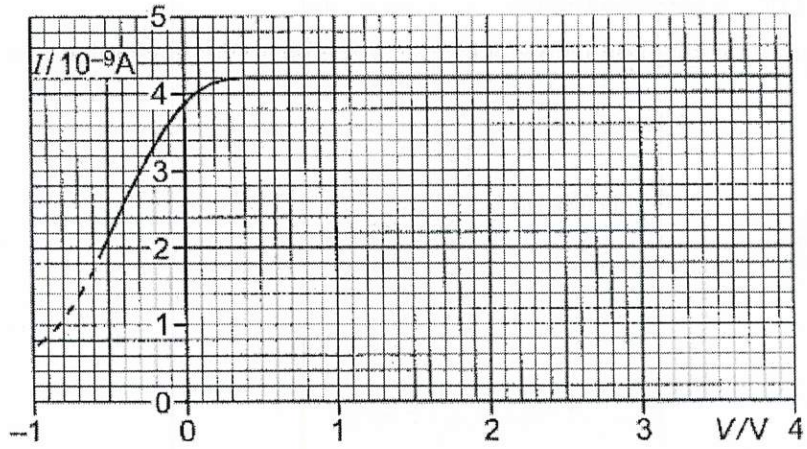
i. Calculate the wavelength of light [02]

ii. Calculate the separation of the slit. [08]

3) The photocell consists of a metal plate C that is to electromagnetic radiation. The photoelectrons emitted travel toward electrode A. A sensitive ammeter measures the current in the circuit.



The plate C is illuminated with ultraviolet radiation of constant intensity and of wavelength $2.5 \times 10^{-7} m$. The figure shows how the photoelectric current I in the circuit varies with the potential difference V between A and C.



a. Estimate the number of electrons reaching the electrode A when the potential difference is $2\,V$. [08]

b. The metal plate C has work function energy $2.2\,eV$. Calculate the maximum kinetic energy of the emitted photoelectron from this plate. [07]

c. State how the maximum energy of the photoelectrons emitted from plate C depends on the intensity of the incident radiation. [05]

d. State and explain how the photoelectric current depends on the intensity of the radiation. [05]

4)

a. Discuss the fabrication process of photonic crystal fiber and its advantages in communication compared to conventional fiber optics. [10]

b. Briefly discuss the scribe and break and scribe and tension methods of fiber optic cleaving. [04]

c. Discuss Mechanical Splicing and Fusion Splicing. [03]

d. Discuss one of the cleave defects. [03]

e. Discuss how Bragg grating is used to measure physical quantities [05]

End of the paper