

**U.G. 4th Semester Examination - 2022**

**PHYSICS**

**[PROGRAMME]**

**Skill Enhancement Course (SEC)**

**Course Code : PHY-G-SEC-T-02(A-G)**

Full Marks : 40

Time : 2 Hours

*The figures in the right-hand margin indicate marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

**Answer all the questions from Selected Option.**

**OPTION–A**

**PHY-G-SEC-T-02A**

**(Physics Workshop Skill)**

**GROUP–A**

1. Answer any **five** questions:  $2 \times 5 = 10$
- a) What are the uses of a Digital Multimeter?
  - b) Find the mechanical advantage of a Class 2 lever.
  - c) Define Horsepower. How it is related to watt?
  - d) What is the mechanical advantage of a pulley to lift a mass of 15 kg using pulley?

- e) Write the requirements of good pattern materials.
- f) What are the functions of coating on electrode?
- g) What are the differences between alloy and composites?
- h) Define Vernier Constant of a Slide Calliper.

**GROUP–B**

2. Answer any **two** questions:  $5 \times 2 = 10$
- a) Write short notes on Continuous Casting and Resistance welding. What do you understand by metal forming?  $2+2+1$
  - b) Distinguish between Avalanche and Zener Breakdown. Explain the I-V characteristics of a Zener diode.  $1.5+1.5+2$
  - c) What do you understand by drilling? Explain the different types of drilling mechanism.  $1+4$
  - d) What is Sextant? What is its principle? Explain the theory to measure the height of a building using sextant.  $1+1+3$

**GROUP-C**

3. Answer any **two** questions:  $10 \times 2 = 20$

a) i) Write down the configuration of basic machine tools (with schematic diagram) and their uses.

ii) Write down some applications of laser beam welding.  $8+2$

b) i) What are the hazards involved in soldering of electrical circuit?

ii) Explain the operation of a transistor as a switch with proper circuit diagram.

iii) Explain the difference between mechanical and hydraulic braking system.  $3+4+3$

c) i) What is a Generator?

ii) Explain the construction and working principle of a power generator.

iii) What are the differences of AC and DC generators?  $1+7+2$

d) i) Explain the construction of a Slide Calliper with proper diagram. How will you measure the volume of a cylindrical beaker using slide calliper?

ii) A see-saw is 30 ft long with a fulcrum in the middle of the board. If a 70 pound child sits 5 ft. from the fulcrum, what is the lowest weight that will lift the child?

$3+3+4$

**OPTION–B**

**PHY-G-SEC-T-02B**

**(Computational Physics Skills)**

1. Answer any **five** questions (symbols have their usual meanings):  $2 \times 5 = 10$

- a) What do you mean by “flow chart” related to computer programming?
- b) Write down the syntax for “IF” conditional statement used in FORTRAN.
- c) What is the syntax to input “fractional numbers” in FORTRAN?
- d) How do you open a file in a FORTRAN program?
- e) Write the LaTeX script to write

$$x^2 + y^2 = a^2.$$

- f) What is the LaTeX script to write “ ${}_{92}^{238}U$ ”?
- g) How does a dimensional array is declared in FORTRAN?
- h) Write the FORMAT syntax to print the number up to four decimal places in FORTRAN.

2. Answer any **two** questions (symbols have their usual meanings):  $5 \times 2 = 10$

a) Use GNUPLOT to plot the following functions:

$$f_1(x) = \frac{\sin^2 x}{x^2} \text{ and } f_2(x) = x^2 e^{-3x} \text{ over the}$$

range  $-10$  to  $+10$ . Set the x-label, y-label and the title of the plots.

b) Write a FORTRAN program to find the factorial of any given number.

c) Write a LaTeX script to write

$$\delta_n(x) = \frac{\sin nx}{\pi x} = \frac{1}{2\pi} \int_{-n}^n e^{ixt} dt.$$

3. Answer any **two** questions (symbols have their usual meanings):  $10 \times 2 = 20$

a) Write down an algorithm and FORTRAN program to write the prime numbers from 1 to 50. How does the CALL statement act?

$$8+2$$

b) Write a program to create a data file for

$$f(x) = \sqrt{1 - \frac{x^2}{4}}$$

over the range  $-10$  to  $10$ . Now use the GNU PLOT to plot the curve from the data file.

7+3

- c) Write down the LaTeX script to print the following equations: 7+3

$$\nabla\psi(\rho, \varphi, z) = \hat{\rho}\frac{\partial\psi}{\partial\rho} + \hat{\varphi}\frac{1}{\rho}\frac{\partial\psi}{\partial\varphi} + \hat{z}\frac{\partial\psi}{\partial z}$$

$$\frac{\partial F_{\lambda\mu}}{\partial x_{\mu}} = j_{\lambda} .$$

### OPTION-C

#### PHY-G-SEC-T-02C

#### (Renewable Energy and Energy Harvesting)

1. Answer any **five** questions:  $2 \times 5 = 10$
- What are the Conventional and Non-conventional energy sources?
  - What is solar pond? Where first solar pond was established in India?
  - Differentiate between primary and secondary energy sources.
  - What are the main components of tidal power plant?
  - What is meant by photovoltaic effect? Where photovoltaic energy is used?
  - Define Geothermal energy. What are geothermal resources?
  - Define ocean thermal energy conversion (OTEC).
  - What is biochemical conversion? Name two types of biomass.

2. Answer any **two** questions:  $5 \times 2 = 10$

- a) Write need for use of renewable energy resources.  $5$
- b) What do you mean by fossil fuels? Write the environmental impacts of burning them.  $1+4$
- c) What is a Solar cell? Briefly explain how it works. Draw I-V characteristic of a Solar cell.  $1+3+1$
- d) Briefly explain (qualitatively) piezoelectric effect by simple molecular model. How piezoelectric energy harvested from human motion?  $3+2$

3. Answer any **two** questions:  $10 \times 2 = 20$

- a)
  - i) Explain action of Solar Cooker, Flat plate collector, Solar Green House.
  - ii) Write down advantage and disadvantage of solar energy.  $(2+2+2)+4$
- b)
  - i) Write down basic principle of wind energy conversion.
  - ii) Write down advantages and disadvantages of wind power energy.

iii) Derive the expression for wind power.  $3+4+3$

- c) What is hydro energy? Discuss the impact of hydro power sources on the environment in detail.  $2+8$
- d)
  - i) Write application of piezoelectric energy harvesting.
  - ii) Write working principle of linear generator.  $5+5$

**OPTION-D**

**PHY-G-SEC-T-02D**

**(Electrical Circuits and Network Skills)**

**GROUP-A**

1. Answer any **five** questions:  $2 \times 5 = 10$
- a) What are the losses in a DC generator?
  - b) Explain the effects of temperature on resistance.
  - c) Show that in case of AC, the potential drop across a capacitor lags the current by  $90^\circ$ .
  - d) What do you mean by the term 'Impedance', 'Reactance' and 'Power factor' of an AC circuit?
  - e) Calculate the *r.m.s* value of the current given by  $i = +\cos(\omega t + \theta)$ .
  - f) What is passive network and active network?
  - g) It is found that the resistance of a coil of wire increases from 40 ohm at  $15^\circ\text{C}$  to 50 ohm at  $60^\circ\text{C}$ . Calculate the resistance temperature coefficient at  $0^\circ\text{C}$  of the conductor material.
  - h) State Kirchhoff's current law and explain.

**GROUP-B**

2. Answer any **two** questions:  $5 \times 2 = 10$
- a) i) Calculate the equivalent resistance when the resistance are connected in parallel and series. Describe the working principle of a transformer.
  - ii) What is the time constant of a growth LR (charging) circuit?  $3+2$
  - b) i) What are two phase and three phase ac generators?
  - ii) Show that the quantity 'CR' (product of capacitor and resistor) has the dimension of time.  $3+2$
  - c) Show that the power of an AC circuit is  $I_{rms} \times V_{rms} \times \cos\theta$ , where  $\cos\theta$  is power factor.  $5$
  - d) Calculate the *rms* value, *average* value and *form factor* of a half-wave rectified alternative current.  $2+2+1$

**GROUP-C**

3. Answer any **two** questions:  $10 \times 2 = 20$

- a) i) What is a transformer?
- ii) In an ideal transformer, show that the ratio of output voltage to the input voltage is equal to the ratio of the number of secondary turns to the primary turns.
- iii) Write the expression of efficiency of a transformer.  $2+6+2$
- b) i)  $\rho_1$  and  $\rho_2$  are the resistivities of the materials of two wires of the same dimensions. What will be the equivalent resistivity of the series combination of the two wires?
- ii) A metallic wire is stretched to increase its length by 20%. What will be the percentage change of its resistance?
- iii) If a shunt of  $1 \Omega$  is connected to a galvanometer of resistance  $99 \Omega$ , what fraction of the main current will flow through the galvanometer?  $4+4+2$

- c) i) An ac source of frequency 50Hz is applied to series LR circuit with  $L=10\text{mH}$  and  $R = 2 \Omega$ . Calculate the power factor. What capacitance placed in the circuit will make the power factor unity?
- ii) In an ac circuit the complex impedance is  $Z=1+2j$  and complex voltage is  $-4+7j$  V. Find the complex current in the circuit.
- iii) A step-up ideal transformer has primary to secondary turns ratio as 2:25. If the primary voltage is 220V and the transformer supplies 1A current to an external load, find the output power.  $4+2+4$
- d) i) Draw a full wave rectifier circuit.
- ii) Explain the operation of the circuit and plot output waveforms.
- iii) Find the efficiency of this circuit.  $1+2+2+5$

**OPTION–E**

**PHY-G-SEC-T-02E  
(Radiation Safety)**

**GROUP–A**

1. Answer any **five** of the following questions:

2×5=10

- a) If the nuclear radius of  ${}^{12}_6\text{C}$  nucleus is  $2.7 \times 10^{-15}$  m then find the density of the nucleus.
- b) What are Auger electrons?
- c) Why the minimum wavelength ( $\lambda_{\min}$ ) of the X-rays produced at a particular accelerating potential, is the same for two targets of different material?
- d) What is pair production?
- e) What is KERMA?
- f) Define Annual Limit of Intake (ALI)?
- g) What is meant by Derived Air Concentration (DAC)?
- h) What is Cherenkov radiation?

**GROUP–B**

2. Answer any **two** of the following questions:

5×2=10

- a) i) Ordinary chlorine is a mixture of  ${}^{35}_{17}\text{Cl}$  and  ${}^{37}_{17}\text{Cl}$  isotopes and has atomic mass of 35.46 amu. What percentage of each isotope is present in ordinary chlorine?  
ii) What is bremsstrahlung? 3+2
- b) What happens to the atomic number and mass number of a nucleus when it
  - i) emits an alpha particle
  - ii) emits an electron
  - iii) emits a positron
  - iv) captures an electron
  - v) emits  $\gamma$  radiation 5
- c) i) What are the chief sources of radiation?  
ii) What is meant by exposure, absorbed dose and equivalent dose? 2+3
- d) i) The binding energies of  ${}^{56}_{26}\text{Fe}$  and  ${}^{64}_{30}\text{Zn}$  nuclei are 493 and 559 MeV respectively. Explain which one is more stable nuclide.

- ii) The masses of hydrogen atom ( ${}^1_1H$ ) and neutron are 1.007825 and 1.008665 amu respectively. If the atomic mass of the neon isotope ( ${}^{20}_{10}Ne$ ) is 19.992 amu then find binding energy per nucleon of the neon isotope. 2+3

### GROUP-C

3. Answer any **two** of the following questions:

$$10 \times 2 = 20$$

- a) i) What is Compton effect? Find the expression of change in wavelength of a photon in Compton scattering.
- ii) Define energy straggling and range straggling.
- iii) The maximum wavelength for photoelectric emission in copper is 278 nm. Find the maximum energy of the photoelectrons when the surface of copper is illuminated with light of frequency  $1.5 \times 10^{15}$  Hz. (1+4)+2+3
- b) i) Define decay constant and half life of a radionuclide. Find the relation between them.
- ii) If the half life of radon for alpha decay is 3.82 days then how long does it take for 60 percent of a sample of radon to decay?
- iii) In nuclear fission or fusion large amount of energy is released – what is the source of this energy? (1+3)+3+3

- c) i) Why is the radiation safety important?  
How can we protect ourselves from the radiation hazards?
- ii) What is Accelerator driven Sub-critical system (ADS)? How is it used for waste management? (3+3)+(2+2)
- d) i) What is the basic working principle of radiation detectors? Describe the operation of a Geiger-Muller Counter.
- ii) Describe some major applications of nuclear techniques in medical sciences (2+4)+4

**OPTION-F**

**PHY-G-SEC-T-02F**

**(Basic Instrumentation Skills)**

**GROUP-A**

1. Answer any **five** questions:  $2 \times 5 = 10$
- a) Write down the significance of digital multimeter.
- b) What is the difference between ac and dc voltage.
- c) Distinguish between digital and analog instruments.
- d) What is continuity on a multimeter?
- e) Write down the types of errors in measurement.
- f) What do you mean by Impedance Bridge?
- g) Write down the advantages of electronic voltmeters.
- h) Write any two uses of CRO.

**GROUP-B**

2. Answer any **two** from the following questions:  $5 \times 2 = 10$
- a) Discuss the working principle and block

diagram of digital storage oscilloscope.

- b) Write down the steps for measuring ac current and resistance of a wire by a conventional multimeter.
- c) Discuss the working principle of a frequency counter.
- d) Explain the following terms applied to digital display: i) Resolution, ii) Sensitivity.

**GROUP-C**

3. Answer any **two** from the following questions:

10×2=20

- a) With a block diagram, explain the working principle of RLC bridge. What are the working principles of function and pulse generator?  
5+5
- b) Discuss about the construction of a CRT. What is the significance of ADC in DVM? 5+5
- c) Write short notes on:
  - i) Digital meter
  - ii) Q-meter. 5+5
- d) How time base is obtained in CRO? What must be done to obtain a steady oscillogram? Why fluorescent screen is used in CRT? 3+4+3

**OPTION-G**

**PHY-G-SEC-T-02G**

**(Applied Optics)**

**GROUP-A**

- 1. Answer any **five** questions: 2×5=10
  - a) What do you mean by spatial frequency filtering?
  - b) What do you mean by graded index and step index optical fibre?
  - c) What do you mean by transmission and reflection type holograms?
  - d) Give one example of solid-state laser and one gas-laser.
  - e) Write down the full forms of the following: LASER, FTS.
  - f) Explain the following terms in case of a laser system: optical pumping, population inversion.
  - g) What do you mean by splice loss in optical fibre?
  - h) Write two laser pumping techniques.

**GROUP-B**

2. Answer any **two** questions:  $5 \times 2 = 10$
- a) Write down the full form of LDR. Draw the I-V characteristics of a LED. What are the major advantages of LED bulbs compared to fluorescent bulbs?  $1+2+2=5$
  - b) With the help of a suitable diagram explain the action of a semiconductor laser. 5
  - c) What are the major advantages and disadvantages of optical fibre compared to other modes of communication? 5
  - d) Write a short note on application of NMR Spectroscopy in forensic science. 5

**GROUP-C**

3. Answer any **two** questions:  $10 \times 2 = 20$
- a) What is Fibre Bragg Grating? Explain briefly the basic principle of holography. Write down the names of different types of holograms. Write down the application of holography in microscopy.  $2+3+2+3=10$
  - b) What do you mean by coherence time and coherence length? Discuss the concept of spatial frequency filtering. Show that a thin

lens can be used as a Fourier Transformer. Describe how a transmission hologram is made.  $2+2+3+3=10$

- c) What are Einstein's A and B coefficients? Write down the relation among them. Establish the relations between A and B coefficients. What is a heterostructure semiconductor laser?  $2+1+5+2=10$
- d) What do you mean by acceptance angle and numerical aperture in an optical fibre? With the help of suitable diagrams derive the expressions for acceptance angle and numerical aperture of an optical fibre.  $2+2+6=10$

-----