

U.G. 6th Semester Examination-2024**PHYSICS****[PROGRAMME]****Skill Enhancement Course (SEC)****Course Code : PHY-G-SEC-T-04(A-I)**

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-04A****(Electrical Circuits & Network Skills)****GROUP-A**

1. Answer any five questions: $2 \times 5 = 10$
- A cubical network consists of 12 resistances of one Ohm each. Calculate the equivalent resistance between any two points along its body diagonal.
 - State Thevenin's theorem.
 - What do you mean by power factor of an AC circuit?

[Turn Over]

- d) Write the features of three-phase alternating current source.
- e) What do you mean by impedance of an electrical circuit?
- f) Why circuit breakers are used in electrical wiring?
- g) Explain the working principle of a relay.
- h) What are the causes of energy loss across the cables and conductors?

GROUP-B

2. Answer any **two** questions: 5×2=10

- a) With proper schematics explain the working principles of a DC motor. How can we control the speed of such motor? 4+1
- b) What are the sources of AC electricity and DC electricity? Three resistances are connected in series across a battery of 6V. The first resistance has a value of $1\ \Omega$, second has a voltage drop of 2 V and the third has a power dissipation of 3 W. Calculate the value of the current in the circuit and resistances. 2+3
- c) Explain the operation of a transformers. What are the sources of energy losses in a transformer? 3+2

- d) How a Junction diode works in forward and reverse bias? Show its characteristics curve.

4+1

GROUP-C

3. Answer any two questions: 10×2=20

a) What do you mean by star and delta connection? Mention some differences between them. What are real, imaginary and complex power in an AC circuits? 4+3+3

b) State and prove maximum power transfer theorem in an AC circuit. A 50 Hz sinusoidal voltage $V = 311.13\sin(\omega t)$ is applied across a series R-L circuit. The values of the resistance and the inductance are 3Ω and 12.73 mH respectively. Compute the r.m.s. value of the current in the circuit and its phase angle with respect to the applied voltage. Write down the expression for the instantaneous current in the circuit. Compute the r.m.s. value and the phase of the voltages appearing across the resistance and the inductance. 4+6

c) Explain the operation of a full-wave rectifier. A R-C series circuit is charged with a DC voltage V . Show the variation of transient current in the circuit and the transient voltage across the capacitor. If the applied voltage be an AC, find the phase angle between the current and the voltage across capacitor. 4+4+2

d) Describe the uses of a multimeter. What are the principal characteristics of a surge protector? What do you mean by ground fault? Write some possible facts that causes ground fault. What do you mean by phase reversal? How the losses across the cables of an electrical wiring can be reduced?

2+2+1+2+1+2

OPTION-B

PHY-G-SEC-T-04B

(Basic Instrumentation Skills)

GROUP-A

1. Answer any **five** questions : 2×5=10
- a) Define absolute error and relative error and percentage error.
 - b) What is multimeter and what are the things you can measure?
 - c) Why is the CRT called heart of the CRO?
 - d) Write down the advantage and disadvantage of digital voltmeter over analog voltmeter.
 - e) What do you mean by distortion? Explain the harmonic distortion.
 - f) What is a Shunt? What is the purpose of use of it?
 - g) An ac voltage $v(t) = 24.5 \sin(90t - \pi/4)$ is applied to the electrical circuit. Write down the amplitude, frequency and phase of this voltage source with proper units.
 - h) What is an electron gun? Write its application.

GROUP-B

2. Answer any **two** questions : 5×2=10
- a) Explain the principle of voltage measurement with block diagram. 5
 - b) How do you measure the dc voltage, ac current and resistance with multimeter. 5

- c) Write down the working principle of digital meters. What are main characteristics of digital voltmeter? 2+3
- d) A dc voltmeter is giving a reading 25.8 volts while the true value is 25.85 volts. Calculate all the errors (absolute, relative and percentage). What do you think which error need to calculate in a experiment? 4+1

GROUP-C

3. Answer any **two** questions : 10×2=20
- a) What is C.R.O.? Draw the diagram of C.R.O. and explain its all components. 2+8
- b) What do you mean by *loading effect*? Derive the general equation of balance for an ac bridge. Why is it preferable in bridge circuits, that the equations of balance should be independent of frequency? 2+7+1
- c) What are the requirements of pulse generator? What is duty cycle? What are the basic difference between pulse generator and square wave generator? 6+2+2
- d) What is *shunt*? What are the requirement of *shunt*? What are the precautions need to take when using an ammeter for measurement? How can you extend the range of an ammeter? 2+2+3+3

OPTION-C
PHY-G-SEC-T-04C
(Radiation Safety)
GROUP-A

1. Answer any **five** of the following questions: $2 \times 5 = 10$
- a) Do isotopes of an element have the same physical properties?
 - b) Determine the mass of a single Aluminium ($^{13}_{27}\text{Al}$) atom.
 - c) Give two examples of man-made sources of radiations.
 - d) What are Auger electrons?
 - e) What happens to the atomic nucleus $^{14}_6\text{C}$ when it undergoes successively β and γ decay?
 - f) What is nuclear fission?
 - g) What is KERMA?
 - h) What is cherenkov radiation?

GROUP-B

2. Answer any **two** of the following questions: $5 \times 2 = 10$
- a) i) Consider that both $^{14}_8\text{O}$ and $^{19}_8\text{O}$ undergo β -decay. Which would you expect to emit a positron and which an electron? Give an explanation.
 - ii) The atomic masses of ^3_1H , ^3_2He and ^4_2He are respectively 3.016050, 3.016029 and 4.002603 amu. How much energy is needed to remove one neutron from the nucleus of

${}^4_2\text{He}$? What will be the corresponding energy to remove one proton? Are the energies same? Give a reason to support your answer.

• 2+3=5

- b) i) State the factors on which maximum energy of a photoelectron depends.
- ii) The maximum wavelength for photoelectric emission in tungsten is 230 nm. What wavelength of light must be used in order for electrons of maximum energy of 1.5 eV to be ejected? 2+3=5
- c) i) What is bremsstrahlung?
- ii) Explain the incidents fluorescence and thermoluminescence. 2+3=5
- d) i) Describe the mechanism through which nuclear radiation affects the living cells.
- ii) What do you mean by absorbed dose, equivalent dose and effective dose? 3+2=5

GROUP-C

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

10×2=20

- a) i) What is Compton Effect?
- ii) Define activity, decay constant, half life and mean life of a radionuclide. Find the relation between decay constant and half life.

- iii) The activity of a radionuclide decreases to 20% of its original value in 15 days. Find its half life. How long will it take for 80% of the original sample to decay? $2+(2+3)+3=10$
- b) i) What is meant by the stopping power of a medium? Write down the Bethe-Bloch formula for stopping power explaining each term.
- ii) What do you mean by the range of a charged particle?
- iii) Describe two major applications of nuclear techniques in each of the following purpose:
A) medical sciences, B) industry.
 $(2+2)+2+(2+2)=10$
- c) i) What do you mean by the radiation hazard? What is meant by the internal and external radiation hazard? Describe three methods by which external radiation hazard is controlled.
- ii) What is meant by Annual Limit of Intake (ALI) and Derived Air Concentration (DAC)?
 $(2+2+3)+3=10$
- d) i) Which class of solid state radiation detector is suitable for measuring a person's accumulated radiation dose? How does the detector function?
- ii) Describe the operation of a Geiger-Muller counter. $(1+4)+5=10$

OPTION-D
PHY-G-SEC-T-04D
(Physics Workshop Skill)

GROUP-A

1. Answer any **five** questions: 2×5=10
- a) What is bipolar junction transistor?
 - b) Draw a diagram to show switching action of a transistor.
 - c) What are the active and passive electronic components?
 - d) What is Vernier Calliper?
 - e) Write a short note on oxy-fuel welding.
 - f) How can a galvanometer be converted into an ammeter? Explain.
 - g) Write down the procedure to measure voltage using a Multimeter.
 - h) Define inductor.

GROUP-B

2. Answer any **two** questions: 5×2=10
- a) What is the process for conversation of SI to CGS?
Give suitable examples. 5
 - b) Define Capacitor. Explain its working principle. 5
 - c) Write down different types of diodes. Explain the working principle of diodes. 5

- d) Write down advantages, disadvantages and applications of casting process. 5

GROUP-C

3. Answer any **two** questions: 10×2=20
- a) What is the principle of Sextant? Discuss the procedure of measuring height of accessible objects by Sextant. 10
- b) Classify welding processes and discuss them with their advantages and disadvantages. 10
- c) What is soldering? Write about different types of tools used during soldering process. Differentiate between up milling and down milling. 2+4+4
- d) What are the different types of gears? Explain briefly any one of them using suitable diagram. What is a braking system? Note down different types of brakes. Give advantages and disadvantages of disc brakes. 2+3+1+1+3

OPTION-E
PHY-G-SEC-T-04E
(Technical Drawing)

GROUP-A

1. Answer any **five** questions: 2×5=10
- a) Discuss the steps to inscribe a circle in a given triangle.
 - b) What do you mean by lettering?
 - c) What do you mean by RF? Explain with examples.
 - d) A vernier calliper has a main scale with the smallest division of 0.5 mm. The vernier scale has 20 divisions that correspond to 19 divisions on the main scale. Determine the vernier constant of the vernier scale.
 - e) What do you mean by the screw pitch of an instrument?
 - f) A distance of 500 km on the Earth is shown as 1 cm on the map. Find out the R.F.
 - g) Write down the full forms: RF, CAD, HP, VP.
 - h) Write down the names of two drafting instruments in technical drawing.

GROUP-B

2. Answer any two questions : 5×2=10

- a) What do you mean by orthographic projection? Draw the orthographic projections of the following points: Point A is 20 mm. above H.P. and 50 mm. in front of V.P., Point B is 30 mm. below H.P. and 40 mm in front of V.P., Point C is in H.P and 30 mm behind VP. 2+3=5
- b) Draw the involute of a semicircle of radius 5 cm. 5
- c) The distance between Kolkata and Behrampur is 200 km. In a railway map it is represented by a line 2 cm long. Find its R.F. Draw a diagonal scale to show single km and maximum 500km. Indicate on it following distances. (i) 50km (ii)100km (iii) 200km (iv) 400km. 5
- d) What are the different types of lettering used in engineering drawings? Write down the cartesian equations of Circle, Ellipse, and Parabola. Write down the expression for the eccentricities of each of them. 2+(1½+1½)=5

GROUP-C

3. Answer any **two** questions : 10×2=20
- a) To draw a parabola with the distance of the focus from the directrix at 50mm. What is CAD? Write down four advantages of CAD compared to other drafting methods. 5+5=10
- b) Draw a straight line of length 8 cm. Divide the line into six equal parts. Why is consistent and clear lettering important in engineering drawings? Describe the method of proper care and handling of drafting instruments. 6+2+2=10
- c) What is Computer-Aided design (CAD) and how does it differ from traditional drafting methods? How are basic 2D and 3D drawings created using AutoCAD? What are the differences between isometric and oblique parallel projections, and how are they used? 3+3+4=10
- d) What are the basic principles of orthographic projection used in engineering drawing? A cylindrical hole with a diameter of 20 mm is drilled through the center of a rectangular block with dimensions 40 mm × 30 mm × 20 mm. Draw the front view of the object showing the interpenetration of the cylinder and the block. 5+5=10

OPTION-F

PHY-G-SEC-T-04F

(Computational Physics Skills)

GROUP-A

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

- a) What is the difference between algorithm and computer programming?
- b) Draw the flow chart symbol for "INPUT", "OUTPUT" and "Decision Making".
- c) Give some examples of Linux editors. What are their uses?
- d) What does the function "REAL(x)" do?
- e) Write down the LaTeX script to write the equation

$$u(\nu, T) = \frac{8\pi\nu^2}{c^3} \frac{h\nu}{e^{h\nu/kT} - 1}$$

- f) Write down the LaTeX script to insert a figure in a text.
- g) Explain the syntax of "IF ELSE ENDIF" statement.
- h) How do you define a dynamical array in FORTRAN?

GROUP-B

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

- a) Write down a FORTRAN programme to find out the time of flight of a projectile thrown vertically. Initial velocity of the projectile will be given as an input.
- b) Write down a programme to find out "root mean square" out of a given set of numbers.
- c) Write down a programme to find out the following sum:

$$S = 1 + \frac{x^2}{2} + \frac{x^2}{3} + \frac{x^4}{4} + \dots + \frac{x^{10}}{10};$$

where x is a variable input.

- d) Write a LaTeX script to print the following text:
"Using $p(E, x) = \pm\sqrt{2mE - m^2\omega^2x^2}$ and from the symmetry considerations, we can write the action as

$$\oint p dx = 2 \int_{-a}^a \sqrt{2mE - m^2\omega^2x^2} dx = 4m\omega \int_0^a \sqrt{a^2 - x^2} dx.$$

GROUP-C

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

- a)
 - i) Write down the basic formulation required to solve a first order differential equation by any numerical method.
 - ii) Write down the corresponding algorithm to solve a first order differential equation.
 - iii) Write a FORTRAN programme to solve the following first order differential equation

$$\frac{dy}{dx} = -0.2y$$

Provided the initial condition, at $x=0.0$, $y=550$. Find the value of y at $x=8.5$.

2+3+5

- b) Write a FORTRAN program to calculate $\cos x$ as the sum of a series, use a subroutine which evaluates the factorial of any integer number.

10

- c) i) Write a FORTRAN programme to calculate the multiplication of two different $n \times n$ square matrices.

- ii) Write a FORTRAN programme to find the trace of a square matrix.

7+3

- d) Write down the LaTeX script to print the following text: \hat{p} is given in the position representation by,

$$\hat{p} = -i\hbar\vec{\nabla}.$$

Its Cartesian components are

$$\hat{p}_x = -i\hbar\frac{\partial}{\partial x}, \quad \hat{p}_y = -i\hbar\frac{\partial}{\partial y}, \quad \hat{p}_z = -i\hbar\frac{\partial}{\partial z}.$$

We can write the Hamiltonian operator

$\hat{H} = \frac{\hat{p}^2}{2m} + \hat{V}$ in the position representation as follows:

$$\hat{H} = -\frac{\hbar^2}{2m}\nabla^2 + \hat{V}(\vec{r}) = -\frac{\hbar^2}{2m}\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right) + \hat{V}(x, y, z).$$

10

OPTION-G
PHY-G-SEC-T-04G
(Weather Forecasting)

GROUP-A

1. Answer any **five** questions: $2 \times 5 = 10$
- a) What are the main tools used for weather forecasting?
 - b) What are Van Allen Belts?
 - c) What is Global warming potential?
 - d) What is catabetic wind?
 - e) Define Easterly Jet Stream.
 - f) What is solar constant?
 - g) How you do the mapping of wind speed?
 - h) What is Global warming potential?

GROUP-B

2. Answer any **two** questions: $5 \times 2 = 10$
- a) Why are higher altitudes colder than lower altitudes?
 - b) Explain the temperature distribution on the Earth.

- c) Explain the Electron density profile of ionosphere. How you do the mapping of wind speed? 3+2
- d) What is air parcel? Calculate the virtual temperature of air at 1000 milibar level-at 300K temperature (Vapour pressure 13.7 milibar). 2+3

GROUP-C

3. Answer any **two** questions: 10×2=20
- a) What are the factors that control the weather? What is meant by weather forecasting? What is the importance of studying the weather systems of other planets? 3+3+4
- b) Discuss the climatological significance of SST.
- c) What is DALR? Compute the relation between DALR and SALR.
- d) Explain different types of weather conditions. what is the difference between weather and climate?

OPTION-H
PHY-G-SEC-T-04H
(Applied Optics)

GROUP-A

1. Answer any **five** questions: $2 \times 5 = 10$
- a) Classify LASER as per gain medium. Give one example for each of them.
 - b) What do you mean by the visibility of fringes in an interferometer?
 - c) Define the term spatial frequency filtering.
 - d) What is holography and how is it different from photography?
 - e) If following two SHMs, $\sin(2\pi x)$ and $\sin(3\pi x)$ combine. Determine the resultant frequency.
 - f) How is holography different from photography?
 - g) With the help of a suitable example, explain the Fourier transformation.
 - h) Write down the full forms of the following terms: LED, and LDR.

GROUP-B

2. Answer any **two** questions : $5 \times 2 = 10$
- a) With the help of a suitable diagram, explain the action of a Solid-state laser. 5

OPTION-H
PHY-G-SEC-T-04H
(Applied Optics)

GROUP-A

1. Answer any **five** questions: $2 \times 5 = 10$
- a) Classify LASER as per gain medium. Give one example for each of them.
 - b) What do you mean by the visibility of fringes in an interferometer?
 - c) Define the term spatial frequency filtering.
 - d) What is holography and how is it different from photography?
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 - f) How is holography different from photography?
 - g) With the help of a suitable example, explain the Fourier transformation.
 - h) Write down the full forms of the following terms: LED, and LDR.

GROUP-B

2. Answer any **two** questions : $5 \times 2 = 10$
- a) With the help of a suitable diagram, explain the action of a Solid-state laser. 5

- b) Write down the full form of FTS. With the help of suitable circuit diagrams, explain the working principle of an IR sensor. Write down one use of an IR sensor. $1+3+1=5$
- c) What do you mean by loss in optical fibre communication? Explain the following in optical fibre communication– splice loss, absorption loss, and scattering loss. $2+3=5$
- d) Classify different types of optical fibre. Why is optical fibre so important in communication? $2+3=5$

GROUP-C

3. Answer any **two** questions : $10 \times 2 = 20$
- a) Explain the method of determining the angle of polarization of a LASER light using a polarizer and analyzer in the laboratory. Write a short note on Fibre Bragg Grating. $5+5=10$
- b) Explain the terms optical pumping and population inversion in a laser system. With the help of a suitable diagram, explain how population inversion is achieved in a two-level laser system. Define Einstein's A and B coefficients; establish the relations between them. $2+2+6=10$

- c) With the help of a suitable diagram, explain the different components of an optical fibre. What do you mean by the acceptance angle and numerical aperture of an optical fibre? Derive the expression for the numerical aperture of an optical fibre. Find the numerical aperture of a step-index fibre when the refractive index of the core is 1.65 and that of the material used for cladding is 1.55. $3+3+4=10$
- d) Explain briefly the recording process and reconstruction of images from holograms. Write down the application of holography in interferometry. $3+3+4=10$

OPTION-I

PHY-G-SEC-T-04I

(Renewable Energy & Energy Harvesting)

GROUP-A

1. Answer any **five** questions: $2 \times 5 = 10$
- a) Define solar constant and declination angle.
 - b) What is fossil fuel? Write down the two limitations of fossil fuel.
 - c) Write down the working principle of wind turbine.
 - d) What are the main applications of solar pond?
 - e) Mention four examples of non-renewable energy resources.
 - f) Define Osmotic pressure and Ocean Biomass.
 - g) What is meant by photovoltaic effect?

GROUP-B

2. Answer any **two** questions: $5 \times 2 = 10$
- a) The sun is the ultimate source of energy. – Explain. 5
 - b) What are the methods of direct energy conservation? Describe in brief. What are the advantages and limitations of renewable energy sources? 3+2

- c) Briefly explain (qualitatively) piezoelectric effect by simple molecular model. How piezoelectric energy harvested from human motion? 3+2
- d) Define Ocean Thermal Energy Conversion (OTEC). Explain by one method how does ocean thermal energy generate electricity. 2+3

GROUP-C

3. Answer any **two** questions: 10×2=20
- a) Write down the environmental impacts of hydropower sources. Describe briefly how hydroelectric power is generated. Write down the main advantages of hydropower. 3+4+3
- b) Explain action of Solar Cooker, Flat Plate Collector, Solar Green House. Write the advantages and disadvantages of solar energy. 2+2+2+4
- c) Describe the precautions to establish nuclear power plant and mention the advantages of nuclear energy. 6+4
- d) Write short notes on:
- I) Basic principle of Linear Generator.
- II) Biomass. 5+5