D 12309 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Radiation Physics

RPHIC 06—INTERACTION OF RADIATION WITH MATTER

(2019 Admissions)

Time : Three Hours Maximum : 70 Marks

Section A

Answer any **six** *questions.*
Each question carries 3 *marks.*

1. What does the term 'pair production' in radiation physics mean ? Explain the minimum condition to take place pair production.
2. What are linear and mass absorption co-efficients of gamma rays ?
3. What are the possible relaxation processes of an atom after photo electric effect ?
4. Briefly explain the four categories of indirectly ionising photons.
5. Compare the energy loss during Bremsstrahlung and collision.
6. What are Cerenkov radiations ? Why Cerenkov radiation is not observed in air ?
7. What does the term 'straggling' mean in particle interaction with matter ?
8. How are neutrons classified according their energy ?
9. Briefly explain the modes of neutron interactions with matter.

(6 × 3 = 18 marks)

Section B

Answer **all** *questions.*
Each question carries 14 *marks.*

10. a) Discuss photon interaction processes with matter, comparing each aspect and parameters of interaction including energy.

Or

b) Explain the energy loss mechanisms of high energy electrons in matter.

11. a) Even if neutrons are neutral, they interact many ways with matter. Discuss possible modes of interactions of neutron with matter.

Or

b) Obtain Bethe Bloch formula to describe the mean energy loss per distance travelled of charged particles in matter.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each question carries 6 *marks.*

12. When do we apply Klein-Nishina theory for scattering of photons with atoms ? Write the expression for the differential scattering cross section ?

13. Explain the mechanisms of energy loss of electrons in matter by emitting radiations.

14. Estimate the fraction of 1.0 MeV gamma ray photons that will be transmitted through a lead shield of thickness 5 cm. (Absorption co-efficient, $\mu = 0.795\ cm^{-1}$). What is the half thickness for these photons in lead ?

15. Calculate the average thermal neutron capture cross section for LiF. Lithium has two stable isotopes ^{6}Li (7.5%) and ^{7}Li (92.5%) with thermal neutron capture cross sections of $\sigma_{thermal}$ = 39mb and 45 mb, respectively. Fluorine is monoisotopic, ^{19}F, with $\sigma_{thermal}$ = 9.6mb.

16. Derive the expression for the maximum energy transfer in a single collision for an energetic particle interacting with atomic electrons in a substance ?

17. Calculate the maximum fractional frequency shift for an incident photon of wavelength 1°A scattering off a proton initially at rest ?

(4 × 6 = 24 marks)

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FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Radiation Physics

RPHIC 05—BASICS OF ELECTRODYNAMICS

(2019 Admissions)

Time : Three Hours Maximum : 70 Marks

Section A

Answer any **six** *questions.*
Each question carries 3 *marks.*

1. Using Maxwell's equations, derive the free space wave equation.
2. Discuss Coulomb gauge and Lorentz gauge and discuss their advantages and disadvantages.
3. Derive the differential form of Poynting vector. Compare it with the continuity equation.
4. Discuss the scalar and vector potentials using Maxwell's equations.
5. Obtain the : (a) propagation constant ; (b) phase velocity ; and (c) characteristic impedance of a distortionless transmission line.
6. Give equation for power radiated by a moving point charge.
7. List and explain different types of wave guides.
8. Give a brief account of cavity resonators.
9. In what ways do the retardation time and the velocity of propagation depend on the constitutive parameters of the medium ?

(6 × 3 = 18 marks)

Section B

Answer **all** *questions.*
Each question carries 14 *marks.*

10. a) Derive the expressions for the transverse components of electric and magnetic fields in a waveguide of arbitrary shape. Using those equations find the relation for the cut off frequency in the case of TM mode.

Or

b) Express the Maxwell's equations for time varying fields in differential and integral forms in free space.

Turn over

11. a) Express the total electromagnetic force on charge in a volume by using the Maxwell's stress tensor.

Or

b) Discuss the radiation of energy and power by an electric dipole.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each question carries 6 *marks.*

12. Obtain the equation for power radiated by a moving point charge.

13. Derive the Jefimenko's equations from retarded potential equations. Discuss the advantages of those equations.

14. For a rectangular waveguide of 5 cm × 2.5 cm, find the cutoff frequency for the dominant mode. Also find phase velocity and group velocity at 3.5 GHz.

15. An open wire transmission line has the following parameters : R = 37 Ω/km ; L = 0.6 mH/km ; G = 1 μS/km and C = 0.04 μF/km. Calculate the characteristic impedance, attenuation constant in Np/km and the phase constant in deg/km, at a frequency of 1 kHz.

16. Derive Abraham Lorentz formula for radiation reaction force.

17. Reformulate Maxwell's equations in phasor notations.

(4 × 6 = 24 marks)

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FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Radiation Physics

RPH IC 04—INTRODUCTORY NUCLEAR PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 70 Marks

Section A

Answer any **six** *questions.*
Each question carries 3 *marks.*

1. Write nuclear reaction equation for α -decay of $^{226}_{88}Ra$ and $^{242}_{94}Pu$.
2. Explain nuclear fission on the basis of the potential energy curve of the liquid drop model.
3. What are stripping reactions ?
4. What is critical ignition temperature in nuclear fusion ?
5. Explain the rotational and vibrational models.
6. What are magic numbers ? What is their significance ?
7. Explain Fermi age equation.
8. What are the main features of nuclear forces ?
9. What is isospin ? Explain its importance.

(6 × 3 = 18 marks)

Section B

Answer **all** *questions.*
Each question carries 14 *marks.*

10. a) Elucidate the Bohr-Wheeler theory of nuclear fission.

Or

b) Explain the partial wave analysis of lower energy n-p scattering and obtain the scattering cross section.

11. a) Explain the liquid drop model of nuclei. How fission mechanism is explained using liquid drop model ?

Or

d) Discuss Fermi age theory. Apply this theory for a nuclear core with spherical geometry.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each question carries 6 *marks.*

12. Calculate the total cross section for n-p scattering at neutron energy 2MeV(lab).

Given a_t = 5.38F, a_s = –23.7F, r_{ot} = 1.70F and r_{os} = 240F. The total cross section is given by $\sigma = \frac{3}{4}\sigma_t + \frac{1}{4}\sigma_s$.

13. On the basis of shell model predict, the ground state spin and parity of the following nuclei :

(i) ^{12}C. (ii) ^{17}O.

(iii) ^{40}Ca. (iv) ^{11}B.

14. Calculate the fission rate for ^{235}U required to produce 2watt and the amount of energy that is released in the complete fissioning of ½kg of ^{235}U.

15. A cubical nuclear reactor has neutron multiplication factor 2.8 and diffusion length 30cm.Caculate the Buckling factor and hence the critical volume of the core.

16. Show that critical constant can be derived as a four factor formula for a nuclear reactor of infinite dimension.

17. Using the liquid drop model, find the expression for the most stable isobar for a given odd A. Find the stable atom with A = 77.

(4 × 6 = 24 marks)

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FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Radiation Physics

RPH 1C 03—BASIC ELECTRONICS

(2019 Admissions)

Time : Three Hours Maximum : 70 Marks

Section A

Answer any **six** *questions.*
Each question carries 3 *marks.*

1. Write a short note on MOSFET.
2. Define amplification factor of linear small signal equitant circuit for FET.
3. Explain Barkhausen Criterion.
4. Explain first order high pass butter worth filter.
5. What is the significance of figure of merit of oscillator circuit ?
6. Describe the function of comparators.
7. Describe the structure of binary address for a memory system having a capacity of 1024 bits.
8. Explain asynchronous counter.
9. Briefly explain how does Schmitt trigger work ?

(6 × 3 = 18 marks)

Section B

Answer **all** *questions.*
Each question carrlcs 14 *marks.*

10. a) Draw and explain the working of a transistor amplifier. What is the significance of *h* parameter ?

Or

b) Explain the working of LED and laser diode with schematic diagrams. Compare the merits and demerits.

Turn over

11 a) How are Oscillator classified ? Explain working of Phase shift oscillator with neat diagram.

Or

b) Describe the functions of different types of registers in microprocessor.

(2 × 14 = 28 marks)

Section C

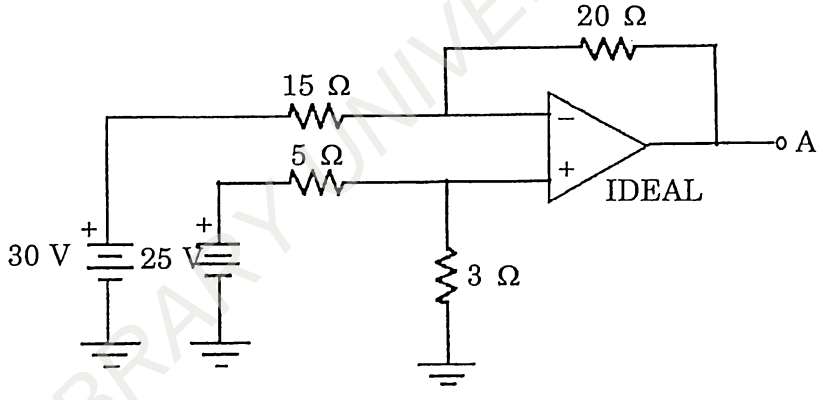
Answer any **four** *questions.*
Each question carries 6 *marks.*

12. Define trans conductance and drain resistance of an FET ?

13. List some of the applications of electronic counters.

14. Calculate the reflectivity of GaAs semiconductor laser $(\bar{n} = 3.6)$.

15. For the difference amplifier circuit shown, determine the output voltage at terminal A.



16. Draw a neat diagram of 4 bit D/A convertor.

17. Differentiate between microprocessor and microcontroller.

(4 × 6 = 24 marks)

D 12305 (Pages : 2) Name.....

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FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Radiation Physics

RPH 1C 02—CLASSICAL MECHANICS

(2019 Admissions)

Time : Three Hours Maximum : 70 Marks

Section A

Answer any **six** *questions.*
Each question carries 3 *marks.*

1. How many independent co-ordinates are required to specify the motion of a rigid body ? Explain.
2. What are ignorable co-ordinates ? Show that the generalized momentum corresponding to a cyclic co-ordinate is conserved.
3. Differentiate holonomic and non-holonomic constraints. Give an example for each.
4. Obtain the expression for equation of motion of a simple pendulum using Lagrange's equation.
5. Find out whether the transformation $P = q$ and $Q = -p$ is canonical or not.
6. What is the physical significance of the Hamiltonian function ?
7. Write any three characteristics of Poisson's bracket.
8. How the values of eccentricity determine the shape of the orbit in a central force problem ?
9. Obtain the relation between Hamilton's Principal Function S and the Lagrangian of a system.

(6 × 3 = 18 marks)

Section B

Answer **all** *questions.*
Each question carries 14 *marks.*

10. (a) Using D'Alembert principle derive the Lagrange's equations of motion.

Or

(b) Deduce Kepler's first law. Show that in the case of elliptical orbit, the total energy depends only on major axis.

Turn over

11. (a) What are canonical transformations ? Derive the expressions for the generating functions of canonical transformation of a system.

Or

(b) Derive the Hamilton Jacobi equation. Solve the one dimensional harmonic oscillator problem by Hamilton Jacobi method.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each question carries 6 *marks.*

12. State Hamilton's principle. Deduce Newton's second law of motion from Hamilton's principle.

13. Obtain the equation of motion of an Atwood's machine by using Lagrange's equation.

14. Obtain the Hamiltonian function of the system having a Lagrangian $L = \frac{1}{2} m_1 \dot{q}_1^2 + \frac{1}{2} m_2 \dot{q}_2^2 - K q_1^2$.

Also determine aconserved quantity of the system using this Lagrangian.

15. For what values of α and β do the equations $Q = q\,\alpha \cos \beta\, p$ and $P = q\,\alpha \sin \beta p$ represent a canonical transformation ? What is the form of the generating function F_3 for this case ?

16. State and prove the fundamental Poisson's bracket.

17. Find the Poisson's bracket of $\left[\overline{L_y}, \overline{L_z}\right]$ where $\overline{L_y}$ and $\overline{L_z}$ are angular momentum components.

(4 × 6 = 24 marks)

D 12304 **(Pages : 3)** **Name.....**

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FIRST SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Radiation Physics

RPH 1C 01—MATHEMATICAL METHODS IN PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 70 Marks

Section A

Answer any **six** *questions.*
Each question carries 3 *marks.*

1. Obtain the expression for the Divergence Operator in terms of spherical polar Co-ordinates ?

2. Explain Unitary Matrices ? Show that the matrix $\begin{bmatrix} \alpha + i\gamma & -\beta + i\delta \\ \beta + i\delta & \alpha - i\gamma \end{bmatrix}$ is unitary if $\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = 1$.

3. Show that any tensor having either two contravariant or covariant indices can be expressed as a sum of two parts one symmetric and the other is skew symmetric ?

4. If A and B are two unitary matrices show that AB is a unitary matrix ?

5. Write a short note on Hermitian Operator specifying its properties.

6. Derive the recurrence relation $\Gamma(n+1) = n\Gamma(n)$.

7. Obtain the $xJ_n' = xJ_n - xJ_{n+1}$.

8. Explain any three properties of the Fourier Transform.

9. State Rodrigue's Formula and hence evaluate the values of $P_0(x)$ and $P_1(x)$.

(6 × 3 = 18 marks)

Turn over

Section B

Answer **all** *questions.*
Each question carries 14 *marks.*

10. a) Solve the Three Dimensional Laplace equation in Spherical polar co-ordinate using variable separable method ?

Or

b) Solve the Legendre differential equation $\left(1-x^2\right)\frac{d^2y}{dx^2}-2x\frac{dy}{dx}+n\left(n+1\right)y=0$ and hence prove that $\int \mathrm{P}_n dx=\frac{1}{(2n+1)}\left[\mathrm{P}_{n+1}-\mathrm{P}_{n-1}\right]+\mathrm{C}$.

11. a) Deduce the general expression for the Gradient, Divergent and Curl operators in curvilinear co-ordinates ? Using the above expression derive the expression for the Laplacian operator in spherical polar co-ordinates.

Or

b) (i) Define Laplace transform. Obtain Laplace transform of (i) cosh kt ; and (ii) cos kt.

(ii) Prove the convolution theorem of Laplace Transform.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each question carries 6 *marks.*

12. Let λ be an eigen value of a matrix A, then prove that :

(i) $\lambda+k$ is an eigen value of $\mathrm{A}+k\mathrm{I}$; and

(ii) $k\lambda$ is an eigen value of kA.

13. Prove that $\mathrm{J}_2'=\left(1-\frac{4}{x^2}\right)\mathrm{J}_1\left(x\right)+\frac{2}{x}\mathrm{J}_0\left(x\right)$ where $\mathrm{J}_n\left(x\right)$ is the Bessel's function of first kind .

14. Show that $\lceil n \lceil 1-n = \frac{\pi}{\sin n}\left(0<n<1\right)$.

15. Find the Laplace transform of $f(t)$ defined as $f(t)=\begin{cases}\frac{t}{k}, & \text{when } 0<t<k\\ 1, & \text{when } t>k\end{cases}$.

16. Prove that $\int_{-1}^{1} P_n(x)\left(1-2xt+t^2\right)^{-1/2}\,dx=\frac{2t^n}{2n+1}$.

17. Applying the method of separation of variables techniques, find the solution to Partial Differential Equation $3u_x+2u_y=0$ where $u_x=\frac{\partial u}{\partial x}, u_y=\frac{\partial u}{\partial y}$.

(4 × 6 = 24 marks)