D 11698 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 07—INTRODUCTION TO NANOSCIENCE TECHNOLOGY

(2020 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

8 *Short questions, each answerable within* 7.5 *minutes*
Answer **all** *questions. Each question carries weightage* 1.

1. Discuss about the lotus effect in nanotechnology.
2. What are the unique features in nanoscale when compared to bulk materials ?
3. What is meant by "locked moment magnetism" ?
4. How does fluctuation induced changes in structure of nanoparticles result in the formation of liquid like droplet of atoms ?
5. Write a note on the reactivity of nanoparticles.
6. What is meant by the density of quantum states ?
7. How can we classify a quantum device based on the relation between its dimensionality and de-Broglie wavelength ?
8. What are the effects of size of a nanomaterial on its mechanical properties ?

(8 × 1 = 8 weightage)

Turn over

D 11698 (Pages : 2) Name.....

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THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 07—INTRODUCTION TO NANOSCIENCE TECHNOLOGY

(2020 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

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Section A

8 *Short questions, each answerable within* 7.5 *minutes*
Answer **all** *questions. Each question carries weightage* 1.

1. Discuss about the lotus effect in nanotechnology.
2. What are the unique features in nanoscale when compared to bulk materials ?
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8. What are the effects of size of a nanomaterial on its mechanical properties ?

(8 × 1 = 8 weightage)

Turn over

Section B

4 Essay questions, each answerable within 30 minutes
Answer any **two** *questions. Each question carries weightage 5.*

9. Discuss any three bottom up methods for the synthesis of nanomaterials.
10. Discuss about any *two* methods used for the synthesis of solid disordered nanostructures.
11. Explain briefly the quantum confinement in semiconductors. Hence explain the concepts of (i) Potential step ; (ii) Potential barrier ; and (iii) Quantum well.
12. What are Excitons ? How are they classified based on the formation mechanism ?

(2 × 5 = 10 weightage)

Section C

7 Problem questions, each answerable within 15 minutes
Answer any **four** *questions, Each question carries weightage 3.*

13. Describe the nanoimprint lithographic (NIL) technique with the help of a neat schematic diagram.
14. Discuss briefly about any *one* method to study the electronic structure of nanoparticles.
15. Describe basic principles of electrospinning and its applications in the production of nanofibers.
16. Consider a spherical gold nanoparticle of radium 4nm. Calculate the total number of gold atoms available inside the nanoparticles. Given that gold has a fcc lattice with lattice parameter 0.408nm.
17. Compare the density of states of 0D, 1D, 2D and 3D nanostructures.
18. Describe the quantum mechanical tunneling effect.
19. Explain how the physical properties of the materials significantly depend on their size when reduced to nanodimension.

(4 × 3 = 12 weightage)

D 11697 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 06—ELEMENTARY ASTROPHYSICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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Section A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. Why Altazimuth system is not suitable for making permanent star charts ?
2. Illustrate the Aspect of the Sky at the equator of earth.
3. Define colour index of a star. It is invariant with respect to distance of star. Comment.
4. Give the radiative equilibrium condition in stellar interior.
5. Define Chandrasekhar mass limit for white Dwarfs.
6. Define Resolving power and focal ratio of a telescope.
7. What are two different types of X-ray binaries ? Give any *two* differences between them.
8. What is the role of water cell in measurement of infrared spectrum of a star ? Giveits limitation.

(8 × 1 = 8 weightage)

Turn over

Section B

Answer any **two** *questions.*
Each question carries 5 *weightage.*

9. Illustrate the Local Equatorial system and Universal Equatorial system to give the location of star.
10. Discuss Saha's equation of thermal ionization.
11. Illustrate the energy generation in stars.
12. Describe the sources of Ultraviolet Astronomy and its importance.

(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

13. The Parallax of a star is 0".785. Find its distance in in parsecs and in light years.
14. Find the luminosity of the star which has an absolute bolometric magnitude of+1.42. Given that the luminosity of sun is $3.84 \times 10^{26}\ Js^{-1}$ and the absolute bolometric magnitude of sun is +4. 72.
15. Discuss Harvard system of spectral classification.
16. Draw the path on the H-R diagram of sun as it contracts to main sequence and illustrate.
17. Describe the formation of Black Hole. What is event Horizon ?
18. Draw schematic diagrams of Astograph and Schmidt Telescope and describe them.
19. Describe gamma ray Spectroscopy. Give any *three* sources of the Gamma rays from space.

(4 × 3 = 12 weightage)

D 11696 (Pages : 3) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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Section A

Answer **all** *questions.*
Each question carries weightage 1.

1. What are the basic functions of the working fluid in an oil rotary pump ?
2. Give an idea about the fundamental principle of the working of getter ion pump.
3. Explain the function of the quartz crystal in a thickness monitor for thin films.
4. What is the mechanism of the sputter ion deposition technique for thin film fabrication ?
5. Explain why the successive accelerating tubes in a linear accelerator have progressively increasing lengths.
6. What are the special advantages of ion implantation technique ?
7. Back angles are preferred in the RBS technique for materials analysis. Why ?
8. What is a unit cell ? What is its shape and parameters ?

(8 × 1 = 8 weightage)

Section B

Answer any **two** *questions.*
Each question carries weightage 5.

9. (a) With the help of a neat diagram discuss the working principle and working of a turbo molecular pump.

   (b) Explain the concept of pumping speed.

10. (a) Describe the glow discharge technique for thin film fabrication.

    (b) Write a note on multi layer optical filters and their uses.

11. (a) What is PIXE ? Explain the general set up for trace element analysis via this technique, providing a neat sketch of the same.

    (b) Discuss the application of the PIXE techniques for human hair samples.

12. (a) State and explain Bragg's law of X-ray diffraction.

    (b) Describe the instrumentation for single crystal diffraction studies.

(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions.*
Each question carries weightage 3.

13. A vacuum chamber in the form of a sphere with radius of 25 cm is pumped by a diffusion pump, starting from an inlet pressure 1×10^{-3} Torr to an ultimate pressure of 8×10^{-7} Torr. If the effective pumping speed of 150 litres/sec, calculate the pump down time.

14. A vacuum evaporation unit is used to coat a thin aluminium film on a substrate kept a distance of 15 cm from the heating boat 1 gram of the metal is taken in the boat and is evaporated completely. Find the thickness of the thin film obtained, in microns (ρ = 2.7 g/cm^3). The film thickness is measured in an interferometer using light of wavelength 589 nm. Obtain the fringe shift given μ = 1.5.

15. The r.f. field in a cyclotron used for accelerating alpha particles is 15 MHz. The Dees have a radius of 0.6 m. Obtain the strength of the magnetic field and the maximum energy attained by the ions.

16. The thermal column of a nuclear reactor provides a neutron flux of 10^{12} n/cm^2/sec. A sample containing ^{10}B is subjected to NAA using the (n, r) reaction in this column. What is the radio active isotope produced ? The radio activity produced has a half life of 30 minutes. Gamma counting is started 15 minutes after irradiation is over. 1,000 gammas are detected for 2 minutes by means of a HPGe detector of efficiency 2%, kept subtending a solid angle of 2×10^{-3} sr at the sample centre. Calculate the mass of the isotope in the sample, assuming $\sigma = 100$ mb.

17. An experiment is carried out to determine the particle size of a powder sample using X-ray diffraction. The FWHM of the diffraction peak at 31.8° is obtained as 0.5 degrees, when Cu kα radiation of energy 8.04 keV is used. Calculate the particle size.

18. A linear accelerator operating at r.f. frequency of *f* kHz and *rf* field amplitude of V k Volts is used to accelerate ions of charge *ne* and mass *m* with an initial energy of E0 keV. Derive expressions for the length of the n^{th} drift tube and the exit energy of the ions after *n* drift tubes.

19. The reaction X (a, b) Y with a *q*-value Q is used for analysis of a sample containing the isotope X by detecting the outgoing particles *b* at an angle 0 to the incident beam direction. Using the principles of conservation of energy and momentum, deduce an expression relevant to the qualitative analysis of the sample for X.

(4 × 3 = 12 weightage)

D 11695 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 04—DIGITAL SIGNAL PROCESSING

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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Section A

Answer all **eight** *questions.*
Each answerable in 7.5 minutes.
Each carries a weightage of 1.

1. Distinguish between continous time Even and Odd signals.
2. For a three bit D/A convertor with a range of 0-3.3 volts what would be the highest output voltage ?
3. How is the correlation of discreet time signals quantified ?
4. Distinguish between Static and Dynamic discrete time systems. Give an example.
5. Explain scaling property of the z-transform.
6. What is the stability criterion for a linear time invariant system ?
7. Describe two properties of frequency selective filters.
8. Define system function of a LTI system.

(8 × 1 = 8 weightage)

Turn over

Section B

Answer any **two** *questions from among the* 4 *essay questions.*
Each answerable in 30 *minutes.*
Each carries a weightage of 5.

9. Explain Linear Time Invariant Systems and their causality property. Describe the different types of interconnections of LTI systems.

10. Explain the following properties of z-transform with suitable example (1) Linearity ; (2) Time reversal ; and (3) Correlation.

11. Explain how frequency analysis of Discrete time signals is implemented.

12. What is the purpose of Discreet Fourier Transform ? Explain the properties of Periodicity, linearity and circular convolution.

(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions from among the* 7 *problems.*
Each answerable in 15 *minutes.*
Each carries a weightage of 3.

13. A 5-bit D/A converter produces $V_{OUT} = 0.2$ V for a digital input of 0001. Find the value of output voltage for an input of 11111.

14. Determine the fourier transform of the discrete time series represented by $x(n) = \left(\frac{1}{4}\right)^n u(n+2)$.

15. Determine the output response $y(n)$ if $h(n) = \{1, 1, 1\}$ and $x(n) = \{1, 2, 3, 1\}$ by using linear convolution.

16. Determine the poles and zeros for the signal

    $x(n) = a^n$ for $0 \le n \le N-1$
    $x(n) = 0$ otherwise.

17. Compute the DFT of a sequence $(-1)^n$ for $N = 4$.

18. Find the inverse z-transform of $X(z) = \frac{z^2 + z}{(z-1)(z-3)}$ with ROC $|Z| > 3$.

19. Evaluate the step response for the LTI system represented by the impulse response

    (1) $h(n) = \delta(n) - \delta(n-1)$; and

    (2) $h(n) = u(n)$.

(4 × 3 = 12 weightage)

D 11695 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 04—DIGITAL SIGNAL PROCESSING

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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Section A

Answer all **eight** *questions.*
Each answerable in 7.5 minutes.
Each carries a weightage of 1.

1. Distinguish between continous time Even and Odd signals.
2. For a three bit D/A convertor with a range of 0-3.3 volts what would be the highest output voltage ?
3. How is the correlation of discreet time signals quantified ?
4. Distinguish between Static and Dynamic discrete time systems. Give an example.
5. Explain scaling property of the z-transform.
6. What is the stability criterion for a linear time invariant system ?
7. Describe two properties of frequency selective filters.
8. Define system function of a LTI system.

(8 × 1 = 8 weightage)

Turn over

Section B

Answer any **two** *questions from among the* 4 *essay questions.*
Each answerable in 30 *minutes.*
Each carries a weightage of 5.

9. Explain Linear Time Invariant Systems and their causality property. Describe the different types of interconnections of LTI systems.

10. Explain the following properties of z-transform with suitable example (1) Linearity ; (2) Time reversal ; and (3) Correlation.

11. Explain how frequency analysis of Discrete time signals is implemented.

12. What is the purpose of Discreet Fourier Transform ? Explain the properties of Periodicity, linearity and circular convolution.

(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions from among the* 7 *problems.*
Each answerable in 15 *minutes.*
Each carries a weightage of 3.

13. A 5-bit D/A converter produces $V_{OUT} = 0.2$ V for a digital input of 0001. Find the value of output voltage for an input of 11111.

14. Determine the fourier transform of the discrete time series represented by $x(n) = \left(\frac{1}{4}\right)^n u(n+2)$.

15. Determine the output response $y(n)$ if $h(n) = \{1, 1, 1\}$ and $x(n) = \{1, 2, 3, 1\}$ by using linear convolution.

16. Determine the poles and zeros for the signal

    $x(n) = a^n$ for $0 \le n \le N-1$
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17. Compute the DFT of a sequence $(-1)^n$ for $N = 4$.

18. Find the inverse z-transform of $X(z) = \frac{z^2 + z}{(z-1)(z-3)}$ with ROC $|Z| > 3$.

19. Evaluate the step response for the LTI system represented by the impulse response

    (1) $h(n) = \delta(n) - \delta(n-1)$; and

    (2) $h(n) = u(n)$.

(4 × 3 = 12 weightage)

D 11694 (Pages : 3) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 03—RADIATION PHYSICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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Section A

8 *Short questions answerable within 7½ minutes.*

Answer **all** *questions, each carry weightage* 1.

1. What is a neutrino ?
2. What you mean by stopping power with respect to radiations ?
3. Distinguish between elastic and inelastic scattering.
4. What is a thermoluminescent dosimeter (TLD) ?
5. What is meant by chromosomal aberrations ?
6. Explain the radioactive waste disposal.
7. Distinguish between ionizing and nonionizing radiation.
8. Write the properties of gamma ray.

(8 × 1= 8 weightage)

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions, each carry weightage 5.*

9. (a) What is mean by interaction mechanism of gamma rays ?

   (b) Writes notes on :

   (i) Pair production.

   (ii) Compton scattering.

   (iii) Photo electric absorption.

10. Discuss the construction and action of a cyclotron. Point out its limitations.

11. (a) Explain how the radiation affect the genetics.

    (b) Discuss the applications of radiations in cancer therapy.

12. (a) Distinguish between primary and secondary radiations.

    (b) Writes notes on :

    (i) Beta shielding.

    (ii) Gamma shielding.

    (iii) Neutron shielding.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.
Answer any **four** *questions, each carry Weightage 3.*

13. X-rays of wavelength 0.7080 Å are scattered from a carbon block through an angle of 90° and are analyzed with a calcite crystal, the interplanar distance of whose reflectingplanes is 3.13 Å. Determine the angular separation, in the first order, between the modified and the unmodified rays.

14. Write notes on basic factors for radiation protection.

15. Explain the basic concept of cell biology.

16. Calculate the velocity and the mass of a β-particle with a K.E. of 0.5 MeV. If a beam of such particles enters a uniform magnetic field, find the flux density required to cause them totraverse a circular arc of radius 0.1 m.

17. In a linear accelerator, proton accelerated thrice by a potential of 40 kV leaves a tube and enters an accelerating space of length 30 cm. before entering the next tube. Calculate the frequency of the r. f. voltage and the length of the tube entered by the proton.

18. Describe the Radiation survey meter for area monitoring.

19. The entrance skin exposure from a chest radiography is typically 25 mR. What are the corresponding dose in centi-gray and the dose equivalent in millisieverts (mSv) ?

(4 × 3 = 12 weightage)

D 11692 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 01—PLASMA PHYSICS

(2020 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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Section A

8 Short questions, each answerable within 7.5 minutes
Answer **all** *questions. Each question carries weightage* 1.

1. Explain the concept of Debye Shielding.
2. What do we mean by 'Solid state plasma' ?
3. Explain the term the 'Larmor radius'
4. The phase velocity of a wave in a plasma often exceeds the velocity of light c. Does this violate theory of relativity ? Explain.
5. What are the characteristics of magnetic hydrodynamic equilibriums ?
6. Write and explain the physical meaning of Vlasov equation ?
7. What is magnetic confinement ?
8. Briefly explain the mechanism of plasma heating.

(8 × 1 = 8 weightage)

Turn over

Section B

4 Essay questions, each answerable within 30 minutes
Answer any **two** *questions. Each question carries weightage 5.*

9. Explain electron plasma waves with the support of necessary theory.

10. (a) List three quantitative criteria for a plasma and explain each in a few lines.

    (b) Describe the following phenomena.

    (i) Electron plasma waves.

    (ii) Weibel instability.

    (iii) Landau damping in plasma oscillations.

11. Describe any *three* applications in Plasma Physics ?

12. Explain the magnetic confinement of plasma with special emphasis on Torus, Mirrors and Pinches.

(2 × 5 = 10 weightage)

Section C

7 Problem questions, each answerable within 15 minutes
Answer any **four** *questions, Each question carries weightage 3.*

13. Determine the Debye Length (λ_D) and number of particles in Debye sphere (N_D) for a glow discharge with particles $n = 10^{16}$ per m^3 and $KT_e = 4eV$.

14. An ion engine has a 2T magnetic field, and a hydrogen plasma is to be shot out at an E × B velocity of 10^7m/s. How much internal electric field must be present in the plasma ?

15. Show that the mean free path λ_{ei} for electron-ion collisions is proportional to T_e^2.

16. A 20 keV deuteron in a large mirror fusion device has a pitch angle $\theta = 45$ at the midplane, where B = 1 T. Compute its Larmor radius

17. Show that the frequency of plasma oscillations is proportional to the root of plasma density.

18. Obtain the expression for the energy density in the electric field of plasma medium.

19. Calculate mean free path of certain ions for elastic collisions in a weakly ionized plasma at temperature 27 °C and pressure 1000 Pa. Assume that the cross section of collision $\sigma = 10^{-14}$ cm^2.

(4 × 3 = 12 weightage)

D 11691 (Pages : 3) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3E 01—PLASMA PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 30 Weightage

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Section A

8 Short questions, each answerable within 7½ minutes.
Answer **all** *questions, each carries weightage* 1.

1. What is meant by 'drift instability' ?
2. Give the conditions for plasma.
3. Derive the dispersion relation for electron-plasma waves (Bohm-Gross waves) ?
4. Explain the origin and significances of diamagnetic drift.
5. Define the term β ? Explain why it is not possible for a magnetically confined plasma to have $\beta > 1$.
6. Explain the characteristics of flute instability.
7. Write down the Fokker-Planck equation. Explain each term.
8. Explain the lawson criterion?

(8 × 1 = 8 weightage)

Section B

4 Essay questions, each answerable within 30 minutes.
Answer any **two** *questions, each carries weightage 5.*

9. Derive an expression for the curvature drift of a particle in a non-uniform magnetic field.

10. What are Alfven waves ? Obtain the dispersion relation for Alfven waves.

11. Derive the dispersion relation for a two-stream instability 'cold plasma' ? Also, calculate the maximum growth rate ?

12. Derive an expression for Landau damping rate for plasma oscillations.

(2 × 5 = 10 weightage)

Section C

7 Problem questions, each answerable within 15 minutes.
Answer any **four** *questions, each carries weightage 3.*

13. (a) The plasma ions are compressed to a density of $10^{30}/m^3$ at a temperature of 2×10^8 K. Compute the values of N_D and λ_D ?

    (b) Compute the larmor radius for a 11 keV electron in the earth's magnetic feld of strength 2.98×10^{-5} T ?

14. The Earth's magnetic field falls off as $1/r^3$ and is 3×10^{-5} T at the equator. Compute the ion and electron ΔB drift velocities, for an isotropic population of 1 eV protons and 10 keV electrons, each with density $n = 10^{12}\ m^{-3}$ at $r = 2.5$ radii in the equatorial plane ?

15. A cylindrically symmetric plasma column in a uniform B field has, $n(r) = n_0 e^{-r^2/r_0^2}$ and

$$n_i = n_e = n_0 e^{e\phi / KT} e$$

Find the diamagnetic current density J_D as a function of radius ?

16. In a potassium Q-machine plasma, a fraction 'm' of the electrons can be replaced by negative Cl ions. The plasma then has n_0 K^+ ions, mn_0 Cl^- ions, and $(1-m)\ n_0$ electrons per m^3. Find the critical value of n_0 which will cut off a 0.3 cm. wavelength microwave beam if $m = 0.4$.

17. Let two cold, counter-streaming ion fluids have densities n_0 and velocities $+v_0\,\hat{y}$ and $-v_0\,\hat{y}$ in a magnetic field $B_0\,\hat{z}$ and a cold neutralizing electron fluid. The field B_0 is strong enough to confine electrons but not strong enough to affect ion orbits. Calculate the dispersion ω (k) and growth rate Y (k) of the unstable waves.

18. Ion waves with λ = 5 cm. are excited in a singly ionized argon plasma with $n_e = 10^{12}$ m^{-3}, T_e = 1 eV, T_i = 0.2 eV ; and the Landau damping rate is measured. A hydrogen impurity of density $n_H = \beta\, n_e$ is then introduced. Calculate the value of β to enhance the damping rate by two ?

19. An *z*-pinch thermodynamic plasma in a column of radius 0.05 cm. is in equilibrium with the number density 2.03×10^{28} per centimeter. A current of 105.9 kA is needed to confine the plasma at a temperature of 200 K. Calculate the magnetic field at the surface of plasma ? Also, verify the Bennett-pinch condition ?

(4 × 3 = 12 weightage)

D 11690 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3C 11—SOLID STATE PHYSICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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Section A

8 Short questions answerable within 7.5 minutes.
Answer **all** *questions, each question carries weightage* 1.

1. What are symmetry operations ? Name the symmetry elements of a crystal.
2. What are the different types of bonding in the crystal and mention its characteristics ?
3. The one-dimensional monoatomic lattice acts as a low-pass filter. Explain.
4. What is Wiedemann -Franz law ?
5. What is Hall effect ? Give the expression for Hall co-efficient as predicted by free electron theory.
6. Explain the origin of the diamagnetism.
7. Distinguish between pyroelectric and piezoelectric materials.
8. What is the importance of high temperature superconductors ? Give one example with transition temperature.

(8 × 1 = 8 weightage)

Turn over

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions, each carry weightage 5.*

9. What are the short comings of Einstein's theory of lattice specific heat ? Explain Debeye's theory of lattice specific heat.

10. Discuss with necessary theory the Kronig-Penny model and show how energy bands are formed in solids.

11. Distinguish between ferromagnetism and anti-ferromagnetisms. Describe the Neel model of anti-ferromagnetism.

12. Explain Meisner effect. Describe London equations and discuss how do they help in explaining superconducting state.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.
(Answer any **four** *questions, each carry weightage 3.*

13. Silicon crystallizes in the diamond cubic structure. The radius of silicon atom is 0.1176 nm. The atomic weight and density of silicon are 28.09 and 2.3×10^3 kg/m^3. Give me the number of atoms present in a unit cell.

14. If Einstein's temperature of a material is 157 K, find the value of C_v for the material at 100 K in cal/mol/K using Einstein's formula. Also calculate Einstein's frequency.

15. Find the relaxation time and mean free path of conduction electron in copper. For copper density of the free electron 8.5×10^{28}/m^3, resistivity 1.69×10^{-8} ohm-m and average velocity of electron 1.154×10^5 m/s.

16. Helium gas contains 2.7×10^{25} atoms/m^3 and dielectric constant of He atom NTD is 1. 0000684. Calculate the electric polarizability of He atom.

17. A paramagnetic material has 1028 atoms/m^3 . Its susceptibility at 350 K is 2.8×10^{-4}. Calculate susceptibility at 300 K.

18. A superconducting tin has a critical temperature of 3.7 K at zero magnetic field and a critical field of 0.0306 T at 0K. What is the critical field at 2K ?

19. A beam of X-rays of wavelength 0.842Å is incident on a crystal at a glancing angle of 8° 35' when the first order Bragg reflection occurs. Calculate the glancing angle of the third order reflection.

(4 × 3 = 12 weightage)

D 11689 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3C 10—NUCLEAR AND PARTICLE PHYSICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

Answer **all** *questions.*
Each question carries weightage 1.

1. Give the theory of force between a proton and neutron in deuterium for the ground state.
2. What is the basic assumption of a single particle shell model ?
3. What is the concept of fission to explain the stability of nucleus ?
4. What are allowed and forbidden beta decay ?
5. What is the kinetic energy of alpha particles in terms of Q value ?
6. What was the necessity of introducing color quantum number ?
7. Write a note on semiconductor detectors.
8. Explain about the four fundamental forces in nature.

(8 × 1 = 8 weightage)

Section B

Answer any **two** *questions.*
Each question carries weightage 5.

9. Explain the term mass and binding energy of a nucleus. Give two method for determining the mass and binding energy of nucleus.

10. Explain the quark model for hadrons. What are the experimental evidences for confined quark.

11. Give a brief description of Nuclear Model Explain the single particle shell model with one of its application.

12. Explain the theory of alpha particle emission. Also discuss the angular momentum and parity selection rule for alpha decay.

(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions.*
Each question carries weightage 3.

13. From the known masses of ^{15}O and ^{15}N, compute the difference in binding energy. Assuming this difference to arise from the difference in coulomb energy, Compute the nuclear radius of ^{15}O and ^{15}N. (Mass of proton = 1.00727647 a.m.u., Mass of neutron = 1.0086654 a.m.u., Mass of ^{15}O = 15.0030654 a.m.u. Mass of ^{15}N = 15.004890a.m.u)

14. Show that the mixing of S and D states accounts for the magnetic moment of the deuteron.

15. Discuss about the classical electromagnetic radiation.

16. Discuss the theory of controlled fission reactions.

17. Explain what are single channel and multichannel analyser.

18. Illustrate with an example the conservation laws obeyed in elementary particle reaction.

19. Distinguish between Leptons and Hadrons.

(4 × 3 = 12 weightage)

D 11688 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHY 3C 09—QUANTUM MECHANICS—II

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. What is the difference between the Zeeman correction to energy in weak magnetic field and in strong magnetic field ?
2. Explain why non degenerate time independent perturbation theory cannot be applied to degenerate cases.
3. Describe the principle of Variational method.
4. Describe the connection formulae for WKB approximation.
5. What is meant by Dyson's series ?
6. What is optical theorem ? What does it imply ?
7. What are the properties of Dirac matrices ?
8. What is Weyl equation ? Give its significance.

(8 × 1 = 8 weightage)

Turn over

Section B

Answer any **two** *questions.*
Each question carries 5 *weightage.*

9. Discuss time independent degenerate perturbation theory and apply the same to explain the fine structure of the Hydrogen atom due to the relativistic correction.

10. Describe the method of WKB approximation. Apply it to find the wave function and energy inside a potential well with two vertical walls.

11. Deduce the expression for transition probability for induced emission for an atom placed in an electromagnetic field.

12. Discuss the method of partial waves with respect to the scattering by central potential. Find the total scattering cross section.

(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

13. Find the wave function and energy levels of anharmonic oscillator.

14. Using Variational principle find the ground state energy of one dimensional harmonic oscillator.

15. Apply Time dependent perturbation theory to find the absorption energy from the field in the case of Harmonic perturbation.

16. For scattering by square well potential show that the scattering cross section is independent of energy and scattering angle.

17. Derive the Klein Gordon equation. Find the corresponding probability density.

18. Show that the total angular momentum is a constant of motion for Dirac particles.

19. Using time independent perturbation theory find the first order correction to the energy of $n = 2$ state of hydrogen atom in the presence of electric field.

(4 × 3 = 12 weightage)

D 11383 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2021

(CUCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2017 to 2018 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions.*
Each question carries weightage 1.

1. What is a Cyclotron ?
2. What is gate valve ?
3. Give the conversion between milli bar and Torr.
4. What do you mean by a Unit Cell.
5. How can you define a thin film.
6. What is Seebeck effect.
7. Write the cyclotron condition for the angular frequency.
8. What do you mean by non-destructive technique.
9. What are the advantages of Turbo molecular pump.
10. What is meant by backing pump ?
11. What do you mean by cold trap ?
12. Draw the variation of Rutherford scattering cross section vs scattering angle.

(12 × 1 = 12 weightage)

Section B

Answer any **two** *questions.*
Each question carries weightage 6.

13. With the help of diagrams explain method of measuring vacuum using cold cathode ionization gauge and hot cathode ionization gauge.

14. What are the advantages and disadvantages of electron beam evaporation technique ? , with the help of a diagram explain the electron beam physical vapour deposition process.

15. What is differential scattering cross section?, Obtain an expression for the total cross section.

16. Explain the principle of linear accelerator. Describe briefly the construction and working of linear radio frequency accelerators.

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*
Each question carries weightage 3.

17. Determine the pump down time for a chamber of 1.5 m diameter and 0.6 m height pumped by a rotary pump with a speed of 2000 litres per minute to attain a pressure of 10^{-1} Torr ?

18. Derive an expression for frequency changes in a quartz crystal thickness monitor set up.

19. A proton accelerator consists of 200 drift tubes. The rf electric field has a frequency of 500 MHz. The average potential when the protons cross the accelerating gap is 1.5×10^3 kV. If the protons are injected into the machine at 2 MeV energy, calculate the final energy and the length of the last drift tube.

20. An X Ray beam of wavelength 0.71×10^{-10} m is diffracted by a cubic KCl crystal of density 1.99×10^3 kgm^{-3}. Calculate the interplanars pacing for (200) planes and the glancing angle for the second order reflection from these planes. The molecular weight of KC1 is 74.6 amu and Avogadro's number is 6.023×10^{26} kg^{-1} $mole^{-1}$.

21. Derive expression connecting impact parameter and angle of scattering in Rutherford scattering process.

22. Obtain the energy equation of outgoing particle in a typical nuclear reaction as a quadratic expression in square root of E_b.

(4 × 3 = 12 weightage)

D 11382 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2021

(CUCSS)

Physics

PHY 3E 04—DIGITAL SIGNAL PROCESSING

(2017 to 2018 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer all **twelve** *questions.*
Each answerable in 5 *minutes.*
Each question carries a weightage of 1.

1. Explain the principle of a Comb filter.
2. What are different types of signal representation ?
3. Explain the architecture of a LTI system.
4. Define circular convolution.
5. Explain scaling property of the z-transform.
6. Define the frequency response of a discreet time system.
7. Explain cross energy density spectrum.
8. Define then-point DFT of a sequence $x(n)$.
9. Explain the need of a sampling and hold circuit in an A/D convertor.
10. What is the purpose of inverse z-transforms ?
11. Explain the meaning of the poles and zeros in terms of a transfer function :

$$H(z) = \frac{Y(z)}{X(z)}.$$

12. Define a FFT algorithm.

(12 × 1 = 12 weightage)

Turn over

Section B

Answer any **two** *questions from among the* 4 *essay questions.*
Each answerable in 30 *minutes.*
Each question carries a weightage of 6.

13. Explain properties of the Discreet Fourier How are discreet time systems classified ? Explain impulse response and convolution sum operation on a discreet time system.

14. Explain the following properties of DFT : (1) Periodicity ; (2) Time reversal ; (3) Time reversal ; (4) Circular time shifting ; and (5) Circular correlation ; and (6) Circular Convolution.

15. Explain different types of operations performed on discrete time signals.

16. Explain properties of the Discreet Fourier transform with an example.

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions from among the* 6 *problem.*
Each answerable in 15 *minutes.*
Each question carries a weightage of 3.

17. Compute the convolution of the sequence : $u(n) * u(n-3)$.

18. Find the Fourier transform of : (1) $x(n) = u(n)$; and (2) $x(n) = u(n-k)$.

19. Compute the Nyqust sampling frequency and Nyqust interval for the signal

$x(t) = \cos(400\pi t) \cdot \cos(200\pi t)$.

20. For the given impulse response determine if the system is causal and stable $h(n) = e^{2n}\, u(n-1)$.

21. Obtain frequency response of discreet time system with impulse function $h(n) = b^n\, u(n)$ for $|b| < 1$.

22. Represent the following finite duration sequence as a sum of weighted impulse sequence. Given $x(n) = \{2, \underset{\uparrow}{4}, -1, -2\}$.

(4 × 3 = 12 weightage)

D 11380 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2021

(CUCSS)

Physics

PHY 3C 11—SOLID STATE PHYSICS

(2017 to 2018 Admissions)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. Define lattice, basis and crystal structure.
2. What is atomic form factor and geometrical structure factor ?
3. Explain metallic bonding. What is the nature of bonds in NaCl and diamond ?
4. What is meant by optical mode of wave propagation in a linear diatomic crystal ?
5. Explain how does the classical free electron theory leads to the Ohm's law.
6. Show that the hall co-efficient is independent of the applied magnetic field and is inversely proportional to the current density and electronic charge.
7. What are intrinsic semiconductors ? Explain band gap in semiconductors.
8. Explain the dielectric polarization of a solid.
9. Distinguish between antiferro and ferromagnetic materials.
10. Write a note on the atomic theory of magnetism.
11. Explain the concept of cooper pairs in superconductors.
12. What is Meissner effect ? Explain the perfect diamagnetism in superconductors.

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries 6 *weightage.*

13. What are Brillouin zones ? Determine the reciprocal lattice vectors which define the Brillouin zones of bcc and fcc lattices.

14. Obtain the dispersion relation for elastic waves in a linear monoatomic chain with nearest neighbour interaction and show that the group velocity vanishes at the zone boundaries. Discuss the dispersion behavior at low and high frequencies.

15. Distinguish between diamagnetism, paramagnetism and ferromagnetism. Discuss the Langevin and quantum theory of diamagnetism.

16. Give the basis of London theory. Derive the London equations and explain the term coherence length.

(2 × 6 = 12 weightage)

Part C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

17. A substance with fcc lattice has density 6250 kg/m^3 and molecular weight 60.2. Calculate the lattice constant.

18. The Debye temperature of diamond is 2000 K. Calculate the mean velocity of sound in diamond, given the density and atomic mass of diamond as 3500 kgm^{-3} and 12 amu respectively.

19. Find the Bragg angle for the lowest angle lines on powder photograph of an fcc crystal whose lattice parameter is 6 A° and the wavelength used is 1.54 A°.

20. A uniform silver wire has a resistivity of 1.54×10^{-8} Ωm. at room temperature. For an electric field along the wire of 1 volt/cm, compute the average drift velocity of the electrons assuming that there are 5.8×10^{28} conduction electrons /m^3. Also calculate mobility and the relaxation time of the electron.

21. A paramagnetic salt contains 10^{28} ions/m^3 with magnetic moment of one Bohr magneton. Calculate the paramagnetic susceptibility and magnetization produced in a uniform magnetic field of 10^6 A/m, at room temperature.

22. The penetration depths of lead are 396 A° and 1730 A° at 3K and 7.1K respectively. Calculate the critical temperature for lead.

(4 × 3 = 12 weightage)

D 11379 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2021

(CUCSS)

Physics

PHY 3C 10—NUCLEAR AND PARTICLE PHYSICS

(2017 to 2018 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

12 *short questions, each answerable within* 5 *minutes.*
Answer **all** *questions. Each question carries weightage* 1.

1. Explain hard core repulsion.
2. Give the leptonic and nuonic lepton numbers of any *four* leptons.
3. Write a note on quantum number 'colour'.
4. What is the spatial dependence of density of nucleons and nuclear potential ?
5. What is a Muon ?
6. When we have zero and non-zero value of quadrapole moment ?
7. What are magic numbers ?
8. What is Tensor potential ?
9. Why rotational model is called 'adiabatic' ?
10. Write down two applications of GM counter.
11. What is a Surface barrier detectors.
12. Explain the use of single channel analyser.

(12 × 1 = 12 weightage)

Section B

4 Essay questions, each answerable within 30 minutes.
Answer any **two** *questions. Each question carries weightage 6.*

13. With examples, write a note on (1) Baryon number ; and (2) Lepton number.

14. With necessary figure explain the eight fold way model.

15. With necessary figure, explain nuclear B.E.

16. Explain single channel and multichannel analysers.

(2 × 6 = 12 weightage)

Section C

6 problem questions, each answerable within 15 minutes.
Answer any **four** *questions. Each question carries weightage 3.*

17. Give the quantum numbers A, Q and I_3 of mesons according to Sakata model.

18. Compute the total binding energy per nucleon for a) $_{7}Li$ b) $_{20}Ne$.

19. Calculate the electric quadra pole moment of a uniformly charged ellipsoid of semi-major axis a and semi-minor axis b.

20. What is the minimum photon energy and frequency necessary to dissociate $_{2}H$? ; B.E.= 2.224589 MeV.

21. Give the expected shell model spin and parity for ground state of 1) $_{7}Li$ 2) $_{11}Be$ 3) $_{15}C$.

22. The dissociation energy of H_2 is 430.53 KJ/mol. If H_2 is exposed to radiant energy of wavelength 253.7nm, what % of radiant energy will be converted into K.E ?

(4 × 3 = 12 weightage)

D 11378 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2021

(CUCSS)

Physics

PHY 3C 09—QUANTUM MECHANICS—II

(2017 to 2018 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions.*
Each question carries weightage 1.

1. The WKB is valid for systems in which the potential is slowly varying. Why ?
2. Discuss the quantum condition of Wilson Sommerfeld.
3. Explain quadratic stark effect.
4. Explain briefly the variation method for excited state.
5. Briefly explain the variation method.
6. Discuss Fermi's Golden rule.
7. Discuss dipole approximation.
8. Discuss the Weyl equation for neutrino.
9. Explain how Klein Gordan equation leads to positive and negative probability density values.
10. Write a short note on Hamiltonian density.
11. Differentiate between Creation and Annihilation operators.
12. What are negative energy states ? What is a hole ?

(12 × 1 = 12 weightage)

Section B

Answer any **two** *questions.*
Each question carries weightage 6.

13. Discuss the first order time independent perturbation theory for non-degenerate stationary state. Obtain the corrected eigen value and eigen function.

14. What are transition probabilities ? Outline the way in which absorption and emission of radiation is explained in quantum mechanics, explain how the selection rules follow naturally.

15. Derive the Dirac equation for a free particle. Find out the Dirac matrices. Obtain the Dirac equation in covariant form.

16. Explain Second quantization. How second quantization does leads to Bose Einstein statistics ?

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*
Each question carries weightage 3.

17. Work out the splitting of the $^1P \rightarrow {}^1S$ transition of an atom placed in a magnetic field B along the z-axis.

18. Estimate the ground state energy of a one dimensional harmonic oscillator of mass m and angular frequency ω using a Gaussian trial function.

19. Determine the ground state energy eigen value of helium atom by variation method.

20. A system in an unperturbed state n is suddenly subjected to a constant perturbation $H^1(r)$ which exists during time $0 \rightarrow t$. Find the probability for transition from state n to k.

21. Prove that the operator $c\alpha$, where α stand for Dirac matrix , can be interpreted as velocity operator.

22. Write a note on principle of canonical quantization of fields.

(4 × 3 = 12 weightage)

D 11231 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Physics

PHY 3E 05—ELEMENTARY ASTROPHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer **all** *questions.*
Each question carries 2 *marks.*

1. Write a note on Pogson scale.
2. Define Absolute magnitude.
3. What is Luminosity ?
4. What is MK classification ?
5. What is par second ?
6. Differentiate between Photographic and Photovisual magnitude.
7. What are the two types of telescopes.
8. Explain angular magnification.
9. What is a coma ?
10. Write a note on Schmidt telescope.
11. Mention examples for high resolution Spectrographs.
12. Briefly write a note on X-ray astronomy.

(12 × 2 = 24 marks)

Section B

Answer any **two** *questions.*
Each question carries 14 *marks.*

13. State and explain Saha's equation of thermal ionization.
14. Explain HR diagram. Compare it with CM diagram.
15. Explain the characteristics of Spectrographs.
16. What is a celestial sphere ? Explain with figure local and universal equatorial systems.

(2 × 14 = 28 marks)

Turn over

Section C

Answer any **four** *questions.*
Each question carries 7 marks.

17. Calculate the Schwarzschild radius of a star whose mass is equal to 10^{15} times the mass of sun.

18. Find the age of the universe at $z = 6$, assuming an expansion R α $t^{2/3}$ and a current age $t_0 = 13.7$ G.yr.

19. If one observes a nearby galaxy at a distance of 1 Mpc (= 10^6 parsecs) what is the apparent magnitude of sun-like stars in that galaxy.

20. The brightest stars are around 105 times brighter than the sun. If the apparent magnitude of these bright stars in some galaxy is 22.5, how far away is the galaxy.

21. Faint brown-dwarf stars have absolute magnitudes of around 17.5. How many times fainter than the sun are these stars ?

22. Hipparcus measures a parallax of a star of 0.01 arc sec. Its apparent magnitude is 8.0. Ignoring bolometric corrections, what is the absolute bolometric magnitude of the star ?

(4 × 7 = 28 marks)

D 11229 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Physics

PHY 3C 14—SOLID-STATE PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer **all** *questions.*
Each question carries 2 *marks.*

1. What are space lattices ?
2. Define Brillouin zones.
3. What is a hydrogen bond ?
4. What is a covalent bonding ?
5. What is the value of chemical potential of phonons ?
6. Define Hall effect.
7. What are Bloch functions ?
8. What is effective mass ?
9. What is piezo electricity ?
10. Define ferroelectricity.
11. What is isotope effect in superconductor ?
12. What is flux quantization ?

(12 × 2 = 24 marks)

Section B

Answer any **two** *questions.*
Each question carries 14 *marks.*

13. State and prove Debye's law for the specific heat of a non-metallic solid.
14. Obtain the Clausius-Mossotti relation for dielectric constant and electronic polarizability.
15. Obtain an expression for the product of electron concentration in conduction band and hole concentration in valence bond in a semiconductor.
16. Obtain Curies law using Langevins theory of paramagnetism.

(2 × 14 = 28 marks)

Turn over

Section C

Answer any **four** *questions.*
Each question carries 7 marks.

17. Debye temperature of diamond structure is 1850 K. Calculate the molar specific heat at 20 K.

18. From Bragg's law in reciprocal lattice space :

$$2\vec{K} \cdot \vec{G} + G^2 = 0.$$

Obtain $2d \sin \theta = n\lambda$.

19. Find the Fermi velocity of electrons if the number density is $2.52 \times 10^{28}/m.^3$

20. Show that effective mass of an electron in an energy band is :

$$m^* = \frac{h^2}{\frac{d^2E}{dk^2}}.$$

21. Starting from Curie's law for paramagnetism, obtain Curie-Weiss law for ferromagnetism.

22. The mobilities of electrons and holes are 0.36 square meter /Vs and 0.17 square meter /Vs. respectively for Ge whose intrinsic concentration is $2 \times 10^{19}/m.^3$ Calculate conductivity and resistivity.

$(4 \times 7 = 28$ marks)

D 11228 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Physics

PHY 3C 13—NUCLEAR AND PARTICLE PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer **all** *questions.*
Each question carries 2 *marks.*

1. Define Q value of nuclear reaction.
2. What are the advantages of studying neutron-proton scattering experiments ?
3. What is Fermi-Kurie plot ?
4. Discuss the selection rules for gamma emission.
5. What are the drawbacks of liquid drop model ?
6. Discuss Carbon-Nitrogen cycle.
7. Distinguish between direct and resonance reactions.
8. Briefly explain Yukawa's theory.
9. What are the basic forces in nature ?
10. Discuss the properties of nuclear force.
11. Briefly explain single channel analysers.
12. What are the important conservation laws obeyed in particle interaction ?

(12 × 2 = 24 marks)

Section B

Answer any **two** *questions.*
Each question carries 14 *marks.*

13. Give the principle of scintillation counter and compare its action with that of GM counter.
14. Explain the partial wave analysis of low energy *n-p* scattering and obtain scattering cross-section.
15. Discuss the eight fold way and illustrate it in the case of Baryon and Meson octets.

16. (a) Distinguish between charge independence and charge symmetry of nuclear forces.

    (b) Deduce an expression connecting the depth and range of nuclear potential in terms of binding energy of deuteron.

(2 × 14 = 28 marks)

Section C

Answer any **four** *questions.*
Each question carries 7 marks.

17. The radii of oxygen and lead nuclei are found to be 3 fm and 7 fm respectively. Their masses are 2.7×10^{-26} kg. and 3.4×10^{-25} kg. respectively. Calculate their densities.

18. Calculate the binding energies of following isobars and their binding energies per nucleon : (a) $_{10}Ne^{20}$ (19.992436 amu) ; (b) $_{35}Br^{79}$ (78.918336 amu).

19. Predict the characteristics of $_8O^{15}$, $_8O^{16}$ and $_8O^{17}$ on the basis of shell model.

20. The radius of central wire of a propotional counter is 0.1 mm. and the radius of the cylindrical tube is 2 cm. Calculate the electric field developed at the surface of the wire, when the potential difference of 1500 volts is applied between the two.

21. The total cross-section of nickel for 1 MeV neutrons is 3.5 barns. What is the fractional attenuation of a beam of such neutrons on passing through a sheet of nickel 0.01 cm. thickness ? Given that density of Ni is 8.9 gm/cc.

22. Which of the following reactions are allowed and forbidden under the conservation of strangeness, conservation of baryon number and conservation of charge ?

    (i) $p + p \rightarrow K^+ + \Sigma^+$; (ii) $p + n \rightarrow \Lambda^\circ + \Sigma^+$; (iii) $\pi^- + p \rightarrow \Sigma^0 + \eta^0$.

(4 × 7 = 28 marks)

D 11227 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2021

(CCSS)

Physics

PHY 3C 12—QUANTUM MECHANICS—II

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A (Short Questions)

Answer **all** *questions.*
Each question carries 2 *marks.*

1. Distinguish between Harmonic and Anharmonic oscillators.
2. Why do we say the Schrodinger equation is nonrelativistic whereas Klein-Gordon equation and Dirac equation are relativistic ?
3. How was the existence of negative energy electrons explained by Dirac ?
4. Obtain the validity condition for Born approximation.
5. Explain Bell's theorem.
6. Discuss the properties of Dirac matrices.
7. Outline the principle of dipole approximation.
8. Explain any two situations that can be treated with perturbation theory.
9. Distinguish between Constant perturbation and Harmonic perturbation in time dependent perturbation theory.
10. What are virtual or metastable states in WKB approximation ?
11. Define probability density and current density.
12. What is Zeeman effect ?

(12 × 2 = 24 marks)

Section B (Essay Questions)

Answer any **two** *questions.*
Each question carries 14 *marks.*

13. Discuss the WKB method and obtain the correction formulae. Obtain the validity of this method.
14. Using semi-classical treatment, discuss the adsorption and emission of radiation.

Turn over

15. Derive Klein Gordon equation. Show that KG equation obeys the equation of continuity. What was the interpretational problem connected with KG equation ?

16. Discuss the second quantization of electromagnetic field.

(2 × 14 = 28 marks)

Section C (Problems)

Answer any **four** *questions.*
Each question carries 7 marks.

17. Discuss Hidden variables.

18. Show that Dirac's Hamiltonian for a free particle commutes with the operators σ. P where p is the momentum operator and σ is the Pauli spin operator in the space of four component spinors.

19. A hydrogen atom in the ground state is placed in an electric field ε along the z-axis. Evaluate the first order correction to the energy.

20. Discuss Lagrangian density.

21. A particle of mass m is moving in a one-dimensional box defined by the potential $V = 0, 0 \le x \le a$ and $V = \infty$ otherwise. Estimate the ground state energy using the trial function $\psi(x) = Ax(a - x), 0 \le x \le a$.

22. What are Einstein's A and B coefficients ? State the relation between two.

(4 × 7 = 28 marks)