D 91530 (Pages : 2) Name.......................................

Reg. No..................................

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

M.Sc. 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 down the significance of colour index.
2. Define Luminosity.
3. Write a note on Pogson scale.
4. Explain Astigmatism.
5. What are white dwarfs ?
6. Mention examples for high resolution Spectrographs.
7. Briefly write a note on X-ray astronomy.
8. What are molecular cloud ?
9. What is meant by magnitude ?
10. Differentiate between reflecting and refracting telescopes.
11. What is celestial equator ?
12. What is Altazimuth system ?

($12 \times 2 = 24$ marks)

Turn over

Section B

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

13. Briefly explain classification of stars, apparent and absolute magnitudes, colour index and its significance.

14. With figure explain telescope aberrations.

15. Explain radio telescopes.

16. Explain local and universal equatorial systems.

(2 × 14 = 28 marks)

Section C

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

17. Derive distance modulus. Calculate the absolute magnitude of a star at distance 2pc. Apparent magnitude is 0.14.

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

19. Compare aspect of sky at North pole of earth and at the equator.

20. If parallax can be measured with an accuracy of 0.01 par second, and the mean density of stars in the Solar neighborhood is 0.1 pc-3, how many stars can have their distances measured via parallax ?

21. Star A has $m = +2.3$ and star B has $m = +3.6$. What is the ratio of the brightness ?

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

(4 × 7 = 28 marks)

D 91529 (Pages : 2) Name.......................................

Reg. No.................................

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

M.Sc. Physics

PHY 3E 04—EXPERIMENTAL TECHNIQUES

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

12 *Short questions answerable within* 5 *minutes.*
Answer **all** *questions.*
Each question carries 2 *marks.*

1. Discuss the functions of oil in a rotary vacuum pump.
2. Define pumping speed and throughput of a vacuum pump.
3. What are O rings and gaskets ?
4. Give the principle of thin film preparation by the sputtering technique.
5. What are multi-layer optical filters ?
6. Give the principle of Van de Graff accelerator.
7. What are the advantages of RF acceleration over electrostatic acceleration ?
8. List the main nuclear techniques useful for materials analysis.
9. Explain why thin targets are preferred in any nuclear technique for elemental analysis.
10. Discuss the principle of PIXE.
11. Discuss lattice planes and Bragg's law.
12. Briefly explain powder diffraction.

(12 × 2 = 24 marks)

Turn over

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions.*
Each question carries 14 marks.

13. With the help of a diagram, explain the various parts and working of an oil diffusion pump. Compare with a Tubo molecular pump ?

14. Give the principle of the technique of thermal evaporation for thin film preparation. What are the different methods used in this technique ? With the help of a neat diagram, describe the experimental set up of laser evaporation technique.

15. Differentiate cyclotron and synchrotron accelerator. With necessary theory explain the principle and working of cyclotron. Give any *two* applications and its limitations.

16. Describe with the help of a diagram, the principle and experimental setup for elemental analysis using neutron activation technique. Discuss applications of NAA technique.

(2 × 14 = 28 marks)

Section C

6 problems answerable within 15 minutes.
Answer any **four** *questions.*
Each question carries 7 marks.

17. A narrow beam of alpha-particles with kinetic energy 1 MeV and intensity 10^{10} particles per second falls on a gold foil (A = 197) of thickness of 1μm. Find the number of alpha-particles scattered by the foil in 20 minutes through 40° – 50°.

18. For an electron and a proton moving along circles in a uniform magnetic field B = 10 kG, determine the orbital periods and radii if the kinetic energy of the particles is 10 MeV. Also, find the kinetic energies if the orbital radius is 10 cm.

19. Write down and explain the formula for the Rutherford scattering.

20. Derive Scherrer formula to estimate the particle size of very small crystals from the measured width of their diffraction curves.

21. In a proton synchrotron, both the frequency of the accelerating electric filed and the magnetic field vary with time. Derive a relation between these two quantities, allowing the particles to traverse along a fixed orbit of radius *r* as they are accelerated.

22. Calculate the breadth B (in degrees of 2θ), due to die small crystal effect alone, of the powder pattern lines of particles of diameter 1000, 750, 500 and 250 Å. Assume $\theta = 45°$ and $\lambda = 1.5$ Å. For particles 250 Å in diameter, calculate the breadth B for $\theta = 10, 45$ and $80°$.

(4 × 7 = 28 marks)

D 91528 (Pages : 2) Name.....................................

Reg. No.................................

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

M.Sc. 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 Madelung interaction ?
2. Define Briliouine zones.
3. What is Debyes theory of specific heat ?
4. What is Ohms law ?
5. What are phonons ?
6. Define Hall effect.
7. What is local electric field ?
8. What is effective mass ?
9. What is piezo electricity ? Give 2 applications.
10. Define ferrimagnetism.
11. What is energy gap in superconductor ?
12. What are high temperature superconductors ?

(12 × 2 = 24 marks)

Section B

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

13. Obtain Debye's law for specific heat capacity of a solid at low temperature.
14. Using Kronig-Penney model obtain the wave equation of electron in a periodic potential.
15. Obtain an expression for the product of electron concentration in conduction band and hole concentration in valence band.
16. Explain Langevin theory of diamagnetism and obtain an expression for susceptibility.

(2 × 14 = 28 marks)

Turn over

Section C

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

17. Calculate the glancing angle on the plane (110) of a cube of side 2.81 AU corresponding to second order diffraction for X rays of wavelength 0.71 AU

18. The Fermi energy of Lithium is 4.72 eV. Find the number density of electrons.

19. The Debye frequency for a solid is 9.8×10^{10}Hz. Find Debye temperature.

20. The polarisability of Neon gas is 0.35×10^{-40}Fm^2. If there are 2.7×10^{25} atoms/ cubic meter determine the dielectric constant.

21. 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.

22. Estimate the para magnetic susceptibility of a substance which has 5×10^{28} atoms/cubic meter placed in a magnetic field of 1 Tesla at 300K.

(4 × 7 = 28 marks)

D 91527 (Pages : 2) Name.......................................

Reg. No...................................

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

M.Sc. 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 binding energy of the nucleus.
2. What are the characteristics of nuclear force ?
3. Give the selection rules related to nuclear decay ?
4. Explain parity violation in beta decay.
5. Give an account of electric quadrupole moment.
6. What are the characteristics of fusion process ?
7. Nuclear forces are charge independent. Comment.
8. What is time reversal operation ? State CPT theorem.
9. Which are the basic forces in nature ?
10. Discuss the fusion process occurring in sun.
11. Briefly explain single channel analysers.
12. Explain conservation of isospin.

(12 × 2 = 24 marks)

Turn over

Section B

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

13. Discuss in detail the working principle of GM counter with the help of a neat diagram.

14. Explain the partial wave analysis of low energy n-p scattering and obtain scattering cross-section.

15. Describe the Quark model of particle physics and explain the quark model of baryons.

16. Find the energy released during beta decay and also explain the Fermi's theory of beta decay.

(2 × 14 = 28 marks)

Section C

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

17. A nucleus with A = 235 splits into two nuclei whose mass numbers are in the ratio 2 : 1. Find the radii of new nuclei.

18. Calculate the binding energies of following isobars and their binding energies per nucleon : a) ${}_{20}Ca^{40}$ (39.96259 amu) b) ${}_{26}Fe^{56}$ (55.934939 amu)

19. Find the energy required in joules to break ${}^{12}C$ into 3 alpha-particles. The atomic mass of ${}^{12}C$ = 12 amu.

20. The radius of central wire of a proportional 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) $\pi^+ + p \rightarrow \pi^0 + \Lambda^0$.

    ii) $\pi^+ + n \rightarrow K^0 + K^+$.

(4 × 7 = 28 marks)

D 91526 (Pages : 2) Name.......................................

Reg. No..................................

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

M.Sc. Physics

PHY 3C 12—QUANTUM MECHANICS—II

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Part A

12 *Short questions answerable within 5 minutes.*
Answer **all** *questions.*
Each question carries 2 marks.

1. Explain briefly the variation principle.
2. Explain Fermi's golden rule.
3. What is dipole approximation
4. List the WKB connection formulae and explain them.
5. What is Hamiltonian density.
6. Distinguish between stimulated and spontaneous emissions.
7. The dimension of Dirac matrices has to be even. Why ?
8. What is EPR paradox.
9. Why does hydrogen atom in the ground state not show a first order stark effect?
10. Why is every charged particle accompanied by an antiparticle in relativistic quantum field theory?
11. What is second quantization ?
12. Obtain Weyl's equation for a neutrino.

(12 × 2 = 24 marks)

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions.*
Each question carries 14 marks.

13. A hydrogen atom is placed in a perturbing magnetic field. Find the first order correction to energy of ground state.

14. Discuss the free particle solution of Dirac equation.

15. (a) What is Born approximation ? Obtain an expression for the scattering amplitude.

    (b) Explain Bell's theorem.

16. Discuss the classical field theory of electrodynamics and gauge symmetry.

(2 × 14 = 28 marks)

Section C

6 problems answerable within 15 minutes.
Answer any **four** *questions.*
Each question carries 7 marks.

17. Evaluate the first and second order correction to the energy of the $n = 1$ state of an oscillator of mass m and angular frequency ω subjected to a potential $V(x) = \frac{1}{2} m\omega^2 x^2 + bx, \ll \frac{1}{2} m\omega^2 x^2$.

18. Optimize the trial function exp $(-\alpha r)$ and evaluate the ground state energy of the hydrogen atom.

19. Find the condition under which stimulated emission equals spontaneous emission. If the temperature of the source is 500 K, at what wavelength will both the emissions be equal ? Comment on the result.

20. For a Dirac particle moving in a central potential, show that the orbital angular momentum is not a constant of motion.

21. Discuss Experimental test of Bell's Inequality.

22. Discuss the principles of canonical quantization of fields.

(4 × 7 = 28 marks)

D 91523 (Pages : 2) Name.......................................

Reg. No..................................

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

M.Sc. Physics

PHY 3C 14—SOLID STATE PHYSICS

(2017 Admissions)

Time : Three Hours Maximum : 80 Marks

Part A

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

1. Show analytically that a five-fold rotation axis does not exist in a crystal lattice.
2. Briefly explain the structure of NaCl crystal.
3. How does the Debye model of specific heat is different from that of Einstein model.
4. Explain Hall effect. Obtain an expression for Hall co-efficient.
5. What are the sources of electrical resistance in materials ? Explain why and how the resistivity varies with temperature and composition.
6. Briefly explainWiedeman-Franz law of thermal conductivity.
7. Write down the relation between macroscopic dielectric constant and microscopic polarizabilities of materials. Explain.
8. Which are the different types of polarization in solids ? Explain each.
9. Write a short note on Bloch wall in a crystal.
10. Explain Miessner effect in superconductivity ?
11. Distinguish between type I and type II superconductors. Give examples for each.
12. Explain quantum mechanical tunneling in super conductors. On this basis, explain dc Josephson effect.

(12 × 2 = 24 marks)

Part B

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

13. Derive an expression for calculating lattice energy in ionic crystals.

14. Derive the dispersion relation in the case of vibration of monatomic gas. Using the above relation, explain the formation of Brillouin zone.

15. Derive an expression for intrinsic concentration of charge carriers in a semi conductor.

16. Derive Clausius-Mossotti relation for the dielectric constant of an insulator. Discuss the variation of dielectric constant with temperature.

($2 \times 14 = 28$ marks)

Part C

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

17. If the atomic radius for Pb = 0.175 nm, find the volume of its unit cell. Assume Pb has fcc structure.

18. If the velocity of sound in a solid is of the order 10^3 m/s.

    (i) What is the frequency of sound wave of wavelength $\lambda = 20$ Å for a monatomic system.

    (ii) What is the frequency of acoustic waves in a diatomic system containing two identical atoms (M = m) per unit cell of inter atomic spacing 2.2 Å.

19. The Hall co-efficient (R_H) of a semiconductor is 3.22×10^{-4} m^3 C^{-1}. Its resistivity is 8.50×10^{-3} Ω-m. Calculate the mobility and carrier concentration of the carriers.

20. A solid elemental dielectric with 3×10^{28} atoms/m^3 shows an electronic polarizability of 10^{-40}F-m^2. Assuming the internal electric field to be Lorentz field, calculate the dielectric constant of the material.

21. What is the Debye frequency for copper, if it has the Debye temperature of 315 K.

22. Calculate the value of London penetration depth at OK for Pb whose density is 11.3 kg/m^3 and the atomic weight is 207.19. Its T_c is 7.22 K.

($4 \times 7 = 28$ marks)

D 91522–A (Pages : 2) Name....................................

Reg. No................................

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

M.Sc. Physics

PHY 3C 13—NUCLEAR AND PARTICLE PHYSICS

(2017 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. Give an estimate of density of nuclei . What information does it provide about the nature of nuclear binding force ?
2. Define multi pole moments of nuclei. How are they related to the spin of nucleons ?
3. What are the major characteristics of nuclear force ?
4. Explain Schmidt lines.
5. Explain selection rules for beta decay.
6. How is angular correlation studies helpful in the determination of polarization of nuclei.
7. Distinguish between ionization chamber and GM counter in their working.
8. Explain the working of semiconductor detector.
9. What are the different types of fission reactors ?
10. What is internal conversion ?
11. Name the leptons . What are their properties ?
12. Explain SU (n) symmetry of particles.

($12 \times 2 = 24$ marks)

Section B

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

13. Derive the various energy terms of semi empirical mass formula. Explain how the semi empirical mass formula can be applied to find out the most stable isobar in beta decay.
14. Explain, how collective model of nucleus explains the low energy excited states of nuclei, citing suitable examples.

15. Explain the construction , working and advantages of scintillation detectors.

16. Give an account of the classification of particles and their interactions.

(2 × 14 = 28 marks)

Section C

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

17. Use extreme single particle shell model to predict the ground state spins, parities and magnetic dipole moments of the following nuclei $^{27}_{13}Al, ^{33}_{16}S$.

18. Examine the possibilities of isomeric transitions between nuclei $^{7}_{4}Be \wedge ^{7}_{3}Li$.

19. Calculate the range of nuclear force if the rest mass of virtual pion emitted in a nucleon-nucleon interaction is 270 m_e.

20. What is Gamow factor ? Express it in terms of wave number (k).

21. A GM counter produces 4×10^8 ions per discharge. If it responds to an incident radiation 12 times per second what is the average ion current through the counter.

22. Analyse the following decays and reaction according to quark content :

    (a) $K^+ \rightarrow \pi^+ + \pi^0$.

    (b) $\Omega^- \rightarrow \Lambda^0 + K^-$.

    (c) $\pi^+ + p \rightarrow p + p + \acute{n}$.

(4 × 7 = 28 marks)

D 91522 (Pages : 2) Name.......................................

Reg. No..................................

THIRD SEMESTER P.G. DEGREE EXAMINATION, NOVEMBER 2020

(CCSS)

M.Sc. Physics

PHY 3C 12—QUANTUM MECHANICS—II

(2017 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. What is golden fermi rule ? Explain.
2. Write down applications of stationary perturbation theory.
3. Write down applications of Variational method.
4. Define transmission coefficient of a potential barrier.
5. Explain the process of tunneling.
6. What is Harmonic perturbation ?
7. What is adiabatic approximation ?
8. Why WKB approximation yields exact answer to the one dimensional potential well problem ?
9. Explain a) Pair production ; and b) Pair annihilation.
10. What is helicity operator ?
11. Why we need to treat degenerate states separately in time independent perturbation theory ?
12. Explain hole theory.

($12 \times 2 = 24$ marks)

Section B

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

13. Explain variational method to find the ground state energy upper bound of a problem.

    Explain it with a known example (for an exactly solvable problem).

Turn over

14. Discuss the time independent perturbation theory for degenerate and non-degenerate cases.

15. Obtain the Klein-Gordan equation and discuss the equation of continuity from it.

16. Discuss about sudden and adiabatic approximations in time dependent perturbation theory.

(2 × 14 = 28 marks)

Section C

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

17. Using variational method, find the ground state energy of a particle in a one dimensional Harmonic oscillator, $V(x) = \frac{1}{2} m\omega^2 x^2$. (Use Gaussian trial wave function, $\Psi = A e^{(-bx^2)}$).

18. Find the first order energy correction to the first excited state ($n = 2$) of a particle in a one dimensional infinite well potential from 0 to L, when it is perturbed by a repulsive Dirac delta potential $V(x) = \alpha\,\delta\left(x - \frac{L}{2}\right)$.

19. Find the probability current density of the Klein-Gordan equation.

20. Prove the anti-commutation of Dirac matrices.

21. Find the energy Eigen values of a particle in a potential $V(x) = ax,\ 0 < x < \infty$ and $V(x) = \infty$, elsewhere, using WKB approximation.

22. A particle which is initially $(t = 0)$ in the ground state of an infinite, one dimensional potential box with walls at $x = 0$ and $x = a$, is subjected for $0 \le t \le \infty$ to a perturbation $V(t) = x^2 e^{-\frac{t}{\tau}}$. Calculate to first order the probability of finding the particle in its first excited state for $t \ge 0$.

(4 × 7 = 28 marks)

D 91059 **(Pages : 2)** **Name.....................................**

Reg. No..................................

THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE (REGULAR) EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY 3E 06—ELEMENTARY ASTROPHYSICS

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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

Section A

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

1. What is a constellation ? How many constellations are there in sky ? Name any *two* star catalogues.
2. What is Stellar parallax and annual parallax of a star ? Give the relevant diagram.
3. Define Bolometric magnitudes of a star. What is Bolometric correction with respect to a star ?
4. What are the classes of stars recognized by Harvard Classification ?
5. Give the differences between Population I and Population II stars.
6. What are pulsars ?
7. What are the advantages and disadvantages of photomultiplier when compared to photographic plate ?
8. Why observations of uv wavelengths are important ?

(8 × 1 = 8 weightage)

Turn over

Section B

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

9. Describe Altazimuth system and the Local Equatorial system with diagrams to determine the location of star.

10. Explain Energy transport in Stellar interior.

11. Describe Radio telescopes with respect to general design and aerials used in radio astronomy.

12. Describe the X ray sources in the sky and the X ray techniques to detect them.

(2 × 5 = 10 weightage)

Section C

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

13. Illustrate the Aspect of the sky at the equator with a neat diagram.

14. Find the luminosity of the star which has an absolute bolometric magnitude of + 1.08. Given that the luminosity of sun is 3.84×10^{26} Js^{-1} and the absolute bolometric magnitude of sun is + 4. 72.

15. Using Shaha's ionization formula, discuss the luminosity effect on stellar spectra.

16. Draw the H- R diagram of Evolutionary tracks of pre-main sequence stars of different masses. Explain.

17. What are black holes ? How are they detected ?

18. Give a schematic diagram of Astograph and Schmidt Telescope and describe.

19. Describe the discrete sources of Galactic gamma ray radiations.

(4 × 3 = 12 weightage)

D 91058 **(Pages : 3)** Name.......................................

Reg. No.....................................

THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE [REGULAR] EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Syllabus year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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

Section A

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

1. What is a liquid nitrogen trap ? How does it work ?
2. Explain the phenomenon of oil back streaming in a diffusion pump. How can this be prevented ?
3. Give the basic principle of the technique of using ion sputtering process for thin film fabrication.
4. Briefly describe thermo electric power and its measurement.
5. How high voltages are developed on the terminal of a Van de Graaff accelerator without sparking ?
6. Explain the basis for using the Nuclear Reaction Analysis technique for materials analysis.
7. Explain the high sensitivity and multi-elemental nature of the PIXE method of trace element analysis.
8. State and explain the Scherrer equation in X-ray diffraction.

(8 × 1 = 8 weightage)

Section B

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

9. (a) What is the role of the cryo surface in a vaccum pump ?

   (b) Describe in detail with the help of a neat diagram, the structure and working of a cryo pump.

Turn over

10. (a) Explain using a neat diagram the principle and details of the optical interferometer method of thickness measurement of thin films.

(b) Write a note on electrical conductivity measurement of thin films.

11. (a) What is the basic principle behind the operation of a Cyclotron, with supporting diagram.

(b) Give the details of the components of the accelerator and its working.

12. (a) Outline the basic theory of materials analysis by the NAA technique.

(b) Describe the instrumentation and procedure for the above, giving the necessary diagram.

($2 \times 5 = 10$ weightage)

Section C

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

13. For a vacuum pump with an effective pumping speed of 1000 litres/s at a pressure of 10^{-3} Torr, calculate the throughput. Also, draw the variation of the pumping speed *vs.* pressure for a rotary pump.

14. A quartz crystal monitor having an initial thickness of 0.2 mm and density 2.3 g/cm^3 is used in a thin film fabrication unit. For a given aluminium thin film deposit the reduction in crystal frequency is found to be 2 kHz. Calculate the initial crystal frequency and the thickness. Given ρ for aluminium = 2.7 g/cm^3 and the crystal frequency constant N = 1.537×10^5Hz – cm.

15. A proton linear accelerator has 40 drift tubes of gradually increasing lengths. The r.f. voltage amplitude used is 400 kV and frequency is set to 200 MHz. Calculate the length of the 25th drift tube and the exit energy of the protons, given that the ion source injects 80 keV protons into the first drift tube.

16. A sample containing traces of silicon impurity is to be analyzed using the RBS technique with 8 Mev alpha particles. The silicon detector is kept at an angle of 150°. Calculate the energies of the two scattered alpha peaks corresponding to the two isotopes of Si with masses 28 and 30. What should be the minimum resolution of the detector in order that these two peaks are just resolved ?

17. Potassium with atomic mass 39 has a b.c.c. structure with a lattice parameter a = 0.52 nm. Estimate its density based on the crystal structure. When μo $k\alpha$ radiation (17.926 keV) is used for X-ray diffraction measurement of the K crystal sample, obtain the angle at which a strong peak corresponding to reflections from the [111] planes will be observed.

18. Derive an expression for the energy of ions of mass M and charge state q after the stripper foil, accelerated through a tandem van de Graaff accelerator of terminal potential V Mega volts. Thus , obtain the energy and velocity of 5^{+} ^{32}S ions delivered by the accelerator of V = 12. Calculate also the number of such ions delivered per second if the beam current is 20 namps.

19. Considering each phase of the entire procedure for trace analysis by the PIXE technique using a proton accelerator, give a step by step derivation of the expression for the number of X-rays detected by the Si (Li) detector per second in terms of the mass m of the particular element investigated and the beam current I and other relevant parameters.

(4 × 3 = 12 weightage)

D 91057 (Pages : 2) Name.......................................

Reg. No..................................

THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE (REGULAR) EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY 3E 04—DIGITAL SIGNAL PROCESSING

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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

Section A

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

1. Distinguish between Energy and Power signals
2. Distinguish between continuous time Even and Odd signals.
3. Describe the cascade interconnection between LTI systems.
4. Explain Convolution sum in linear systems.
5. Enlist five properties of ROC.
6. What purpose is the Notch filter used for ?
7. Differentiate between DFT and FFT.
8. Explain the relationship of Fourier transform to the Z transform.

(8 × 1 = 8 weightage)

Section B

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

9. Explain concepts used in analog to digital conversion.

10. Classify discrete time systems into various categories.

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

12. Explain the theory and procedure of designing FIR filter using windows. What are the desirable characteristics of the windows ?

(2 × 5 = 10 weightage)

Section C

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

13. Determine if the given discrete time signal is a power or energy signal ?

    $x(n) = e^{2n}\, u(n).$

14. Find the Find the z-transform and ROC for the sequence $x(n) = na_n u(n)$.

15. Find the inverse z-transform of $X(z) = \dfrac{z}{(z-2)(z-3)}$ for $1 < |z| < 2$.

16. A 10-bit DAC has a step size of 10 mV. Determine the full-scale output voltage and the percentage resolution.

17. Find the DFT of a sequence $x(n) = \{1, 1, 0, 0\}$.

18. Determine the frequency response of FIR filter defined by :

    $y(n) = 0.25\, x(n) + x(n-1) + 0.25\, x(n-2).$

19. Find whether the following systems are static or dynamic :

    1. $y(n) = x(n)\, x(n-1)$;
    2. $y(n) = x^2(n) + x(n)$.

(4 × 3 = 12 weightage)

D 91056 (Pages : 2) Name.......................................

Reg. No..................................

THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE (REGULAR) EXAMINATION NOVEMBER 2020

(CBCSS)

Physics

PHY 3E 03—RADIATION PHYSICS

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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

Section A

(8 Short questions answerable within 7.5 minutes)

Answer **all** *questions.*

Each question carries a weightage of 1.

1. Define activity of a radioactive sample. Define the unit of curie
2. What is a nuclear reactor ?
3. Describe the origin of gamma rays. What are nuclear isomers ?
4. Distinguish between clinical and calorimetric devices.
5. What is mean by deterministic effect of radiation ?
6. Explain Radiological Spills
7. What is as low as reasonably achievable (ALARA) ?
8. Define kinetic energy released per unit mass (KERMA).

(8 × 1 = 8 weightage)

Section B

(4 essay questions answerable within 30 minutes).

Answer any **two** *questions.*

Each question carries a weightage of 5.

9. What are the health effects of exposure to ionizing radiation ?

Turn over

10. (a) What is a neutron ? Mention its general properties.

(b) Explain the following terms :

(i) Fast neutron interaction.

(ii) Slowing down and moderation of neutrons.

11. Discuss different types of radiation sources.

12. What is meant by radiation protection and explain the basic factors for radiation protection ?

($2 \times 5 = 10$ weightage)

Section C

(7problems answerable within 15 minutes).

Answer any **four** *questions.*

Each question carries a weightage of 3.

13. Deuterons in a cyclotron describe a circle of radius 0.32 m just before emerging from the dees. The frequency of the applied e.m.f. is 10 MHz. Find the flux density of the magnetic field and the velocity of deuterons emerging out of the cyclotron. Mass of deuterium = 3.32×10^{-27} kg ; $e = 1.6 \times 10^{-19}$C.

14. Write notes on nuclear waste disposal.

15. Explain mutation and chromosomal aberrations and discuss the applications of radiations in cancer therapy.

16. Explain the different type dosimeters.

17. X-ray of wavelength 0.1 nm are scattered from a carbon block. Find the wavelength of the scattered beam in the direction making an angle of 90° with the incident beam.

18. Writes notes on :

(i) Beta shielding ;

(ii) Gamma shielding ;

(iii) Neutron shielding.

19. Calculate the time required for 10% of a sample of thorium to disintegrate. Assume the half-life of thorium to be 1.4×10^{10} years.

($4 \times 3 = 12$ weightage)

D 91054 (Pages : 2) Name.......................................

Reg. No...................................

THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE (REGULAR) EXAMINATION NOVEMBER 2020

(CBCSS)

Physics

PHY 3E 01—PLASMA PHYSICS

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each Section / Part.*
2. *The minimum number of questions to be attended from the Section / Part shall remain same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to 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. Give the validity conditions for plasma.
2. Prove that 'magnetic flux through a Larmor orbit is constant'.
3. Distinguish between 'phase velocity' and 'group velocity' ?
4. The magnetosonic waves are often called 'fast hydromagnetic waves'. Justify.
5. Explain the physical mechanism of the Weibel instability.
6. Give the reason for the filamentary structure of the gas in the Crab nebula.
7. What is meant by 'Ion Landau damping' ? Give its dispersion relation.
8. Explain Bremsstrahlung radiation and ignition temperature.

(8 × 1 = 8 weightage)

Section B

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

9. Explain the drift of a gyrating particle in a non-uniform electric field, and a uniform magnetic field. Outline the physical significance of 'finite-Larmor-radius effect'.
10. Derive the dispersion relation for electrostatic ion waves propagating at right angles to the magnetic field B_0 ?

Turn over

11. What are 'instabilities' in plasma. Obtain an expression for the growth rate of plasmas under gravitational instability ?

12. What are the technical difficulties to realize fusion reactors ? Explain how to achieve laser fusion in fusion reactors.

(2 × 5 = 10 weightage)

Section C

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

13. A distant galaxy contains a cloud of protons and antiprotons, each with a density of, $n = 10^{16} m^{-3}$ and temperature 100K . What is the Debye length and the number of particles in a Debye sphere ?

14. An unneutralized electron beam has density $n = 10^{15}\ m^{-3}$ and radius $a = 0.1$ cm and flows along a 2-T magnetic field. If B is in the +z direction and E is the electrostatic field due to the beam's charge, calculate the magnitude and direction of the (E × B) drift at $r = a$.

15. An isothermal plasma is confined between the planes $x = +k$ and $x = -k$, in a magnetic field $B = B_0\hat{z}$ The density distribution is,

$$n = n_0\left(1 - x^2/k^2\right).$$

Derive an expression for the electron diamagnetic drift velocity as a function of x ?

16. For electromagnetic waves, show that the index of refraction is equal to the square root of the appropriate plasma dielectric constant.

17. In a D-D reactor, the magnetic field be limited to 32 T by the strength of materials. Find the maximum plasma density if electromagnetic instability limits $\beta = 1$ and $KT_e = KT_i = 24$ keV ? Also calculate the amount of field energy dissipated as heat during the annihilation of magnetic field ?

18. The concentration of impurity atoms in a singly ionised xenon plasma state is a times that of electron concentration. Assuming the excitation of ion waves of $\lambda = 6$ cm, determine the value of a which will enhance the rate of landau damping by 2 ? ($n_e = 10^{18}\ m^{-3}$, $T_e = 3$ eV, $T_i = 1$ eV and $M_{xenon} = 131$)

19. An z-pinch thermodynamic plasma contains 3×10^{25} number of ions per centimeter, in a column of diameter 1 cm. If Bennet-pinch condition is satisfied by the plasma, calculate the current needed to confine the plasma at a temperature of 120 K, and thereby the magnetic field at the surface of plasma column ?

(4 × 3 = 12 weightage)

D 91053 (Pages : 2) Name..................................

Reg. No..................................

THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE (REGULAR) EXAMINATION NOVEMBER 2020

(CBCSS)

Physics

PHY 3C 11—SOLID STATE PHYSICS

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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

Section A

Eight *Short questions answerable within* 7½ *minutes.*
Answer **all** *questions, each carry weightage* 1.

1. Explain the concept of Miller Indices and mention important features of Miller Indices.
2. Discuss the crystal structure of NaCl.
3. What are the basic assumptions on which the Debye theory is based ?
4. What are the limitations of free electron model in explaining Hall coefficient of metals ?
5. Distinguish between direct and indirect bandgap semiconductors. Give examples.
6. Briefly explain the concept of magnons in ferromagnetic materials.
7. What is superconductivity ? Discuss the type I and type II superconductors.
8. What is isotopic effect in superconductivity ?

(8 × 1 = 8 weightage)

Section B

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

9. Discuss the vibrations of a linear diatomic lattice. Obtain the dispersion relation and differentiate between the optical and acoustical branches.

Turn over

10. Explain how bands are formed in solids. Discuss the essential features of the behavior of electrons in a periodic potential using Kroning-Penny model.

11. Discuss Landau theory of ferroelectric phase transitions.

12. Discuss DC and AC Josephson effect and explain their importance.

(2 × 5 = 10 weightage)

Section C

Seven *problems answerable within* 15 *minutes.*

Answer any **four** *questions, each carry weightage* 3.

13. Find the inter-planar spacing for (321) plane in a simple cubic lattice with lattice constant 4.2×10^{-8} cm.

14. Compute the cut-off frequency for a linear monoatomic lattice of interatomic distance 3×10^{-10} m, if the velocity of sound is 3×10^{3} m/s.

15. Calculate the Fermi energy at absolute zero of sodium metal if its atomic radius 1.86 Å.

16. A solid dielectric has electronic polarizability of 10^{-40} Fm^2. If the internal electric field be a Lorentz field. Find the dielectric constant of the material [Given density = 3×10^{28} atoms/m^3.]

17. Copper has an FCC structure and the atomic radius is 0.1278 nm. Calculate the inter planar spacing for (111)-planes.

18. Find the order of magnitude of the exchange integral of a ferromagnet having curie temperature 727° C. What is the internal field ? [Given $\mu_B = 9.3 \times 10^{-21}$ ergs/gauss].

19. For a superconductor the critical field at 0 K is 6.39×10^{4} A/m and the critical temperature for zero magenetic field is 7.18 K. What is the critical field for the material at 4 K ?

(4 × 3 = 12 weightage)

D 91052 (Pages : 2) Name.....................................

Reg. No..................................

THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE (REGULAR) EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY 3C 10—NUCLEAR AND PARTICLE PHYSICS

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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

Section A

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

1. Show that the D state probability in Deuteron is roughly 4%.
2. What are magic numbers ? Why there are no magic numbers that are odd.
3. What is neutron and proton separation energy ?
4. What you meant by sub criticality and supercriticality condition in a fission reactor ?
5. Briefly explain the multipole moments.
6. Write the semi empirical mass formula. Briefly explain each term in semi empirical mass formula.
7. Parity is conserved in all strong or electromagnetic interactions, but is violated in week interactions. Justify the statement.
8. What are single channel and multichannel analyser ?

(8 × 1 = 8 weightage)

Turn over

Section B

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

9. Starting from the *n-p* scattering explain the characteristics of a nuclear force.

10. Derive an expression for the total magnetic moment of the nucleus and explain with the help of Schmidt diagram.

11. With a neat block diagram explain the working of a Scintillation detector.

12. Explain the conservation laws of elementary particles reaction.

(2 × 5 = 10 weightage)

Section C

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

13. Using the Shell model predict the ground state spin and parity of ${}^{17}_{8}O$ and ${}_{20}^{40}Ca$.

14. Bring out the angular momentum and parity selection rules in β decay.

15. Discuss the vibrational energy state of nucleus.

16. Discuss the strange behaviour of elementary particles. Calculate the strangeness of K^+, 'Ω^-.

17. What is the principle of operation of ionisation chamber ?

18. Describe any *two* methods for the determination of nuclear mass.

19. Briefly explain nucleon-nucleon scattering.

(4 × 3 = 12 weightage)

D 91051 (Pages : 2) Name.....................................

Reg. No.....................................

THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE (REGULAR) EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY 3C 09—QUANTUM MECHANICS—II

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

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

Section A

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

1. Give the WK B wave function in a classical region. Explain its features.
2. What is intermediate field Zeeman effect ?
3. Give the general formulation of time independent perturbation theory.
4. Give the criteria for choosing the trial wave function for the first excited excited states for the Variational method.
5. What is electric dipole approximation ?
6. What is scattering amplitude and differential scattering cross section ? How are they related ?
7. Explain hole theory. State the hypotheses which form the basis of the hole theory.
8. What are the draw backs of Klein Gordon equation ?

(8 × 1 = 8 weightage)

Section B

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

9. Using time independent perturbation theory discuss Weak field and strong field Zeeman effect.

10. Describe the WKB method with respect to connection formulae and apply it to find the wave function inside and outside of a potential well with no vertical walls.

11. Describe briefly the Time dependent perturbation theory and apply it to find the scattering cross section in the Born approximation.

12. Show that the Dirac particles have spin ½.

(2 × 5 = 10 weightage)

Section C

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

13. Apply time independent perturbation theory to find the exact wave function and energy of linear harmonic oscillator.

14. Apply variational method to find the ground state wave function and the ground state energy of Helium atom.

15. Discuss the theory of constant perturbation and deduce Fermi-Golden rule.

16. Deduce the expression for scattering cross section by the method of partial wave expansion for scattering by central potential.

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

18. Derive the expression for conserved current from Dirac equation.

19. From the relativistic expression for the Hamiltonian derive the Klein Gordon equation

(4 × 3 = 12 weightage)

D 90750 **(Pages : 2)** Name.....................................

Reg. No...................................

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

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

1. What is meant by backing / roughing pump ? Which pumps are usually used as backing / roughing pumps ?
2. What are the advantages of turbo molecular pump ?
3. Explain how a typical gate valve operates.
4. Explain Knudsen cosine law.
5. What are multilayered films ? Give their advantages.
6. Illustrate the principle of thickness measurement of thin films by interference method.
7. How is the difficulty with respect to a maximum voltage limit in an electrostatic accelerator overcome to a certain extent in a Van de Graaff accelerator ?
8. What is ion channeling ? How can one avoid the channeling peak in ion implantation ?
9. List the important applications of PIXE.
10. What is meant by energy straggling ?
11. What are the applications of XRD ?
12. Derive Scherrer equation.

($12 \times 1 = 12$ weightage)

Section B

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

13. Explain the principle and working of Pirani gauge, Thermocouple gauge and Penning gauge.
14. What is meant by sputtering? Describe any one sputtering technique useful in thin film deposition.

Turn over

15. Describe the principle of the cyclotron. Explain with reference to a diagram, how the magnetic field and radio frequency electric field helps in imparting energy to the ions in each half turn of the orbit.

16. Explain the principle and experimental arrangement of neutron activation analysis technique for elemental analysis.

(2 × 6 = 12 weightage)

Section C

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

17. In a pumping system, a diffusion pump with a pumping speed of 100 Torr litres s^{-1} is backed by a rotary pump. The ultimate pressure achieved in the pumped chamber is 5×10^{-5} Torr. Calculate the pumping speed of the rotary pump.

18. A quartz crystal monitor indicates a change in frequency of 1600 Hz when an aluminium film of density 2.7g/cm^3 is deposited on its face. Determine the film thickness. If the quartz crystal is 0.2mm thick and the density of quartz is 2.3g/cm^3, estimate the starting frequency of the crystal.

19. For an electron and proton moving along circles in a uniform magnetic field of B = 10kG, determine the orbital periods and radii if the kinetic energy of the particles is 10 MeV.

20. In a proton synchrotron, both the frequency of the accelerating electric field and magnetic field vary with time. Derive a relation between these quantities, allowing the particles to traverse along a fixed orbit of radius r as they are accelerated.

21. An alpha-particle with a momentum 53 MeV/c is scattered at an angle 60° by the Coulomb field of a stationary uranium nucleus (A = 238). Find the impact parameter.

22. Discuss about the instrumentation of diffractometer.

(4 × 3 = 12 weightage)

D 90749 (Pages : 2) Name.......................................

Reg. No..................................

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY 3E 04—DIGITAL SIGNAL PROCESSING

(2017 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 Notch filter.
2. Explain shifting property of DFT using an example.
3. Distinguish between Fourier transforms of a discrete time signal and that of a continuous time signal.
4. Define system function of a LTI system.
5. Explain the need of a sampling and hold circuit in an A/D convertor.
6. Explain the term "Digital Resonator".
7. Explain the meaning of the poles and zeros in terms of a transfer function $H(z)=\frac{Y(z)}{X(z)}$.
8. How is the power density spectrum computed ?
9. What is meant by Region of convergence ?
10. Distinguish stable and unstable systems.
11. What are the different methods of evaluating inverse z-transform ?
12. What are the techniques of designing FIR filters ?

(12 × 1 = 12 weightage)

Section B

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

13. Explain in detail the theory of analog to digital conversion followed in converting an analog signal to a discreet time signal.

14. What are the properties of the region of convergence ? Enlist the properties of Z-transform.

15. Explain the theory and procedure of designing FIR filter using windows. What are the desirable characteristics of the windows ?

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. Find the convolution of the following using z-transform.

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

    (1) $h(n)=\delta(n)-\delta(n-1)$.

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

    (3) $h(n)=\left(\frac{1}{2}\right)^n u(n)$.

(4 × 3 = 12 weightage)

D 90747 (Pages : 2) Name.......................................

Reg. No...................................

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY 3E 01—PLASMA PHYSICS

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A (Short Questions)

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

1. Give the criteria for plasma.
2. Explain the term 'curvature shift'.
3. What are adiabatic invariants ?
4. Define Alfven velocity.
5. Give the dispersion relation for electrostatic-ion cyclotron waves.
6. Explain diamagnetic drift. Give its direction.
7. Distinguish between reactive and dissipative instability.
8. It is not possible for a magnetically confined plasma to have $\beta > 1$. Why ?
9. How the Bernstein waves are generated ?
10. What are resonant particles ?
11. What is meant by Lawson criterion ?
12. Explain the ion wave heating in plasmas.

($12 \times 1 = 12$ weightage)

Section B (Essay Questions)

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

13. Derive the dispersion relation for magnetosonic waves, that are propagating perpendicular to B_o? Why are they called 'fast hydromagnetic wave' ?
14. Comment on the term 'instability' in plasma. Obtain an expression for the growth rate of plasmas under gravitational instability ?

Turn over

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

16. Explain the methods to achieve laser fusion. Mention the technical difficulties for realizing fusion reactors.

($2 \times 6 = 12$ weightage)

Section C (Problem Questions)

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

17. (a) In a Fusion reactor, the ions are compressed to a density of $10^{32}/m^3$ at a temperature of 3×10^8 K. Compute the values of N_D and λ_D ?

(b) Compute the larmor radius for a 7 keV electron in the earth's magnetic field of strength 3×10^{-5} T ?

18. Suppose the earth's magnetic field is 3×10^{-5} T at the equator and falls off as $1/r^3$, as for a perfect dipole. Let there be an isotropic population of 3 eV protons and 30 keV electrons, each with density $n = 10^9$ m^{-3} at $r = 5$ earth radii in the equatorial plane. Compute the ion and electron ∇B drift velocities ?

19. Calculate the group velocity of whistler mode under the conditions ; $\omega < \omega_c$ and $\varepsilon > 1$?

20. Assume a two-stream instability, when there are two cold electron streams with equal and opposite V_0 in a background of fixed ions. Each stream has a density n_0. Calculate the maximum growth rate ?

21. Ion waves with $\lambda = 15$ cm are excited in a singly ionized argon plasma with $n_e = 10^{16}$ m^{-3}, $T_e = 2$ eV, $T_i = 0.2$ eV ; and the Landau damping rate is measured. A hydrogen impurity of density $n_H = \alpha\ n_e$ is then introduced. Calculate the value of α that will double the damping rate ?

22. The Bennett-pinch condition is followed by a thermodynamic plasma in a column of radius 0.4 cm, in the case of z-pinch. If the number of ions per centimeter is 2×10^{28}, compute the current needed to confine the plasma at a temperature of 200 K, and thereby the magnetic field at the surface of plasma column ?

($4 \times 3 = 12$ weightage)

D 90746 (Pages : 2) Name.......................................

Reg. No...................................

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY 3C 11—SOLID STATE PHYSICS

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Part A

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

1. What are Miller indices ? Outline the procedures to determine it.
2. Distinguish between metallic and ionic bonding in solids.
3. Define crystal momentum. What is its importance ?
4. Distinguish between Umklapp and normal processes in phonon collisions.
5. What are the assumptions of free electron model of metals ?
6. Explain temperature dependence of resistivity in metals using Matthiessen's rule.
7. Discuss Wiedemann-Franz law for metals. What is the reason for the failure of this law at very low temperatures ?
8. Briefly explain the origin of permanent magnetic dipoles in magnetic materials.
9. Discuss the concept of ferromagnetic domains.
10. Briefly explain any *one* of the applications of piezoelectric crystals.
11. Distinguish between type-I and type-II superconductors.
12. What is Meissner effect ?

(12 × 1 = 12 weightage)

Part B

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

13. Explain BCC, FCC and HCP structures with the help of neat diagrams. Discuss the co-ordination numbers and packing fraction in each case.
14. Derive the dispersion relation for vibrations of diatomic lattices.
15. Obtain the expression for ground state energy (Fermi energy) of free electron gas in metals.
16. Derive the Curie law for paramagnetic materials.

(2 × 6 = 12 weightage)

Part C

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

17. Show that the volume of the first Brillouin zone is $(2\pi)^3/V_c$, where V_c is the volume of a primitive cell of real lattice space.
18. Debye characteristic frequency for carbon (diamond) is 3.85×10^{13} Hz. Calculate the (i) Debye temperature ; and (ii) specific heat capacity at 20 K. (Given $k_B = 1.38 \times 10^{-23}$ JK^{-1}, $N = 6.02 \times 10^{23}$ atoms/mole)
19. Na metal has a typical electron density of 10^{28} m^{-3}. If Na has a room temperature conductivity of 2×10^7 Ω^{-1} m^{-1}, calculate electron mean free path in this metal.
20. Using Hund's rule, obtain the quantum numbers S, L and J of the ground state of V^{3+} and Fe^{2+} ions (V: [Ar]$3d^3 4s^2$ and Fe : [Ar]$3d^6 4s^2$).
21. The critical fields for a superconducting specimen are 1.4×10^5 and 4.2×10^5 A/m for 14 K and 13 K respectively. Calculate the (i) transition temperature ; and (ii) critical field at 5K.
22. If the electron concentration in a superconducting material at 0 K is 10^{29} m^{-3}, calculate London penetration depth assuming all electrons in the sample are superconducting electrons at 0 K.

(4 × 3 = 12 weightage)

D 90745 (Pages : 2) Name.................................

Reg. No..............................

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION, NOVEMBER 2020

(CUCSS)

Physics

PHY 3C 10—NUCLEAR AND PARTICLE PHYSICS

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

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

1. Briefly explain a particle decay process in the quark model.
2. What are magic numbers, singly magic and doubly magic nuclei ? Which nuclear model explain the stability of magic nuclei ?
3. Mention the condition of requirement for a thermo nuclear fusion reactor.
4. What is deuteron ? Mention its properties.
5. Briefly explain magnetic moment of the nuclei.
6. Briefly explain the saturation property of nuclear forces.
7. Correlate Binding Energy per nucleon and fission reaction.
8. What are the limitations of a GM counter ?
9. What is the difference between internal conversion and electron capture?
10. Explain the Lawson criterion for nuclear fusion.
11. Why solid-state detectors are preferred over scintillation detectors?
12. Classify the various interactions types interactions in relation to elementary particles.

($12 \times 1 = 12$ weightage)

Section B

Answer any **two** *questions.*

Each question carries 6 *weightage.*

13. Describe partial wave analysis of nuclear reaction and deduce the formula for the reaction cross-section.

14. Give the quantum mechanical theory to explain the α-decay process.

15. Explain the shell model of the nucleus. What are its merits and demerits ?

16. Discuss the conservation laws in particle physics. How are the conservation laws related to the symmetry properties ?

(2 × 6 = 12 weightage)

Section C

Answer any **four** *of the following questions.*

Each question carries 3 *weightage.*

17. Calculate the energy released by fission of 1 kg. of U^{235} in kWh. The energy released per fission is 200 MeV and Avogadro number are 6.023×10^{23}.

18. A 0.01 mm thick ${}_{3}^{7}Li$ target is bombarded with a beam of flux of 10^{13} particles /cm^2-s. as a result 10^8 neutrons/s are produced. Calculate the cross-section for this reaction. Density of lithium is 500 kg/m^3.

19. The activity of a certain nuclide decreases to 25 % of its original value in 20 days. Find its half-life.

20. The radius of the central wire of a proportional counter is 0.1 mm. and the radius of the cylinder tube is 2 cm. Calculate the electric field developed at the surface of the wire, when the potential difference of 1,500 volts is applied between the two.

21. A positive pion collides with a proton, two protons plus other particles are created. What is the other particle ?

22. A GM counter with a dead time of 2×10^{-4} seconds register 30.000 counts per minute. Find the intensity of the incoming beam of particles in terms of the particles received per second.

(4 × 3 = 12 weightage)

D 90744 (Pages : 2) Name.......................................

Reg. No..................................

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION NOVEMBER 2020

(CUCSS)

Physics

PHY 3C 09—QUANTUM MECHANICS—II

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

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

1. Give the criteria for validity of WKB approximation.
2. Describe removal of degeneracy on application of magnetic field in the case of hydrogen atom.
3. What is Rayleigh Ritz method ?
4. Give the connection formulae for WKB approximations.
5. How the trial wave function for excited states is chosen for the Variational method ?
6. What is meant by Dyson's series ?
7. Give an account of electric dipole approximation and obtain expression for transition probability for unit time.
8. Give Dirac equation and hence give Dirac Hamiltonian. Give the matrices involved in the equation.
9. What are the draw backs of Klein Gordon equation ?
10. What are the differences between Weyl equations and Dirac equations ?
11. Define conjugate field and Hamiltonian density with respect to fields.
12. What is second quantization ? Give the features of second quantization.

(12 × 1 = 12 weightage)

Section B

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

13. Discuss the method of Time independent perturbation theory in the case of non-degenerate states and apply the same to find the energy states and wave functions of anharmonic oscillator.

14. Describe briefly the Time dependent perturbation theory and apply it to find the absorption energy from the field in the case of Harmonic perturbation.

15. Discuss spin orbit coupling. Also deduce the Hamiltonian corresponding to the non-relativistic limit of the Dirac equation. Give the interpretations to each term.

16. Derive Euler-Lagrange equation for the fields.

(2 × 6 = 12 weightage)

Section C

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

17. Apply WKB approximation method to find the transmission co-efficient of a potential barrier.

18. Using Variational principle to find the ground state energy for Helium atom.

19. Find the transition probability per unit time for absorption when an atom is placed in electromagnetic field.

20. Derive the quantization rules for bosons.

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

22. Derive the Hamiltonian form of the Klein Gordon equation.

(4 × 3 = 12 weightage)

C 63481 (Pages : 2) Name.....................................

Reg. No.................................

THIRD SEMESTER M.Sc. (S.S.E.) DEGREE EXAMINATION, APRIL 2019

Physics

PHY 303—QUANTUM MECHANICS—II

(2003 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answe any **five** *questions.*
Each question carries 4 *marks.*

1. Write a brief note on how Zeeman effect is explained by perturbation theory.
2. What is Stark effect ?
3. What are the important conditions for the validity of Born approximation ?
4. Write a brief note on Weyl theory.
5. What is meant by non-conservation of parity ?
6. Write down the important properties of Dirac matrices.
7. Write a note on the covariance of the Dirac equation.
8. What is the difference in the way fermionic and bosonic fields are quantized ?

($5 \times 4 = 20$ marks)

Section B

Answer **both** *questions.*
Each question carries 20 *marks.*

9. (a) Explain the WKB method and derive the expression for barrier tunnelling.

Or

(b) Explain the variation method and apply it to the case of Helium atom.

10. (a) Discuss the relativistic Klein-Gordon equation for scalars.

Or

(b) Write down the Dirac equations and derive the free particle solutions.

($2 \times 20 = 40$ marks)

Turn over

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

11. Explain the basic ideas of time independant perturbation theory and get the expression for first order correction to energy levels.

12. Discuss the hole theory proposed by Dirac.

13. Derive the Fermi's Golden rule.

14. Discuss second quantisation of the Schrödinger wave field.

($2 \times 10 = 20$ marks)

C 63480 (Pages : 2) Name.....................................

Reg. No.....................................

THIRD SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, APRIL 2019

Physics

PHY 302—SOLID STATE PHYSICS

(2003 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **five** *questions.*
Each question carries 4 *marks.*

1. What is co-ordination number ? Obtain the co-ordination number for simple cubic, bcc and fcc lattices ?
2. What are Miller indices ? How are they determined ? With a neat diagram represent the Miller indices of important planes of cubic crystal ?
3. What is the type of bonding in inert gases ? Explain its properties ?
4. What is Hall effect ? Explain the significance of Hall voltage ?
5. What do you mean by the effective mass of an electron ? How does it vary with the crystal momentum ?
6. Explain local field in dielectrics ?
7. Differentiate between Ferrimagnetism and Antiferromagnetism ?
8. Explain a. c. Josephson effect with an example ?

($5 \times 4 = 20$ marks)

Section B

Answer **Both** *questions.*
Each question carries 20 *marks.*

9. What is an ionic crystal ? Explain the formation of an ionic crystal and derive the relation for its cohesive energy ? Calculate the Madelung constant for NaCl lattice.

Or

10. Derive the relation for the specific heat of solids on the basis of Debye model. How does the Debye model differs from the Einstein model ? Discuss the variation of Debye specific heat with temperature.

Turn over

11. Give an account of Weiss theory of ferromagnetism. On the basis of this theory how will you explain hysteresis effect and Curie point. Explain clearly the difference between paramagnetism and ferromagnetism.

Or

12. Give an account of BCS theory of superconductivity. How does it explain the energy gap at OK and the isotope effect

($2 \times 20 = 40$ marks)

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

13. Explain Weidmann Franz law ? A uniform Cu wire of length 0.5 m and diameter 0.3 mm has a resistance of 0.12 R at 293 K. If the thermal conductivity of the specimen at the same temperature is 390 $Wm^{-1}K^{-1}$. Calculate the Lorentz number ?

14. What do you mean by Debye temperature ? Explain its significance? Estimate the Debye temperature of gold if its atomic weight is 197 ; the density is 1.9×10^4 kg/m^3 and the velocity of sound in it is 2100 m/s

15. Differentiate between intrinsic and extrinsic semiconductor with examples. An intrinsic germanium semiconductor has a charge density of 2.4×10^{19} charges per m^3 at 300 K. The material is made extrinsic with an indium p impurity at the rate of one indium atom per 4×10^8 germanium atoms. If there are 4.4×10^{28} jgermanium atoms per m3, determine the concentration of minority charge carrier and discuss the result

16. Derive the Clausius_Mosotti equation. Assuming the polarizability of Kr atom is 2.18×10^{-40}Fm^2, calculate the dielectric constant at 0 °C and 1 atmosphere.

($2 \times 10 = 20$ marks)

C 63479 (Pages : 2) Name.....................................

Reg. No.....................................

THIRD SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, APRIL 2019

Physics

PHY 301—NUCLEAR PHYSICS

(2003 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answe any **five** *questions.*
Each question carries 4 marks.

1. Write a brief note on neutrinos.
2. Explain Fermi-Kurie plot.
3. Describe general characteristics of nuclear forces.
4. What do you mean by tensor forces ?
5. Briefly explain the idea of isospin symmetry.
6. Write a note on nuclear fusion as a source of energy.
7. What are the advantages of semiconductor detectors of radiation ?
8. What is the working principle of proportional counter ?

(5 × 4 = 20 marks)

Section B

Answer **both** *questions.*
Each question carries 20 marks.

9. (a) (i) Describe a simple theory of deuteron structure. How much does it agree with experimental results ?

(ii) Discuss parity violation in beta decay.

(10 + 10 = 20 marks)

Or

(b) (i) Discuss effective range theory.

(ii) Discuss *n-p* scattering.

(10 + 10 = 20 marks)

Turn over

10. (a) (i) Discuss the working of a typical nuclear reactor working on uranium as a fuel.

(ii) With a neat diagram, explain the working of Geiger-Muller counter.

(10+ 10 = 20 marks)

Or

(b) (i) Discuss the working of ionization chamber.

(ii) Describe the working of scintillation detectors.

(10 + 10 = 20 marks)

Section C

Answer **two** *questions.*
Each question carries 10 *marks.*

11. Find out the spin and parities of the following nuclei :

(a) ${}^{11}_{6}C$.

(b) ${}^{35}_{17}Cl$.

(c) ${}^{15}_{7}N$.

(d) ${}^{4}_{2}He$.

(e) ${}^{23}_{11}Na$.

12. Fill in the missing terms in the following nuclear reactions :

(a) $n \rightarrow p + e^{-} + ?$

(b) ${}^{4}_{2}He + {}^{14}_{7}N \rightarrow {}^{17}_{8}O + ?$

(c) ${}^{6}_{2}Li + {}^{1}_{1}H \rightarrow {}^{3}_{2}He + ?$

(d) ${}^{12}_{6}C + {}^{2}_{1}H \rightarrow {}^{13}_{7}N + ?$

(e) ${}^{2}_{1}H + \gamma \rightarrow {}^{1}_{1}H + ?$

13. In the Sun 0.7% of the mass of Hydrogen gets converted into energy in the fusion process. If the luminosity of Sun is nearly 3.8×10^{26}W make an estimate of the rate at which Hydrogen gets consumed in the Sun.

14. A radioactive element has a half-life of 20 days, calculate the disintegration constant and mean life.

(2 × 10 = 20 marks)

C 63458 (Pages : 2) Name..............................

Reg. No..............................

THIRD SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, MARCH 2019

Physics

PHY 303—QUANTUM MECHANICS—II

(2008 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **two** *questions from each module.*
Each question carries 3 *marks.*

1. (a) Discuss briefly the validity conditions of WKB approximation.
   (b) Develop the stationary perturbation theory for a non-degenerate case upto second order.
   (c) Explain Quadratic Stark effect.
2. (a) Briefly explain the variational method for excited states.
   (b) Discuss the validity conditions for Born approximation.
   (c) Write a note on spin of Dirac particle.
3. (a) Explain Fermi's golden rule.
   (b) Obtain the Hamiltonian operator for a charged particle in an electromagnetic field.
   (c) Explain what is dipole approximation.
4. (a) What are negative energy states ? What is a hole ?
   (b) Express Dirac's equation in the covariant form.
   (c) Discuss Weyl equation of a neutrino.
5. (a) What is first and second quantization ?
   (b) Derive the quantum conditions for the canonical field variables.
   (c) How does second quantization leads to symmetrization for bosons.

(10 × 3 = 30 marks)

Section B

Answer any **two** *questions.*
Each question carries 15 *marks.*

6. Calculate the probability for transmission of a particle through a potential barrier of arbitrary shape using the WKB method.
7. Use variation method to obtain the ground state energy of hydrogen atom assuming a trial function $\varphi(r) = Ae^{-\alpha r}$ where α is the variational parameter and A is the normalization constant.

Turn over

8. Discuss the Einstein's coefficients of spontaneous and stimulated emission of radiation. Derive a relation between A and B coefficients.

9. Explain the principle of canonical quantization of fields. Discuss how the second quantization leads to Fermi-Dirac statistics.

(2 × 15 = 30 marks)

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

10. Using WKB method, calculate the transmission coefficient for the parabolic potential barrier given by

$$V(x) = V_0\left(1-\frac{x^2}{a^2}\right); \quad |x| \le a$$
$$= 0 \quad ; \quad |x| \ge a$$

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

12. Calculate the square of the electric dipole transition moment $|\langle 310|\mu|200\rangle|^2$ for Hydrogen atom.

13. If $\sigma' = \begin{bmatrix} \sigma & 0 \\ 0 & \sigma \end{bmatrix}$, show that (i) $\sigma_x'^2 = \sigma_y'^2 = \sigma_z'^2 = 1$ (ii) $[\sigma_x', \sigma_x] = 0, [\sigma_x', \sigma_y] = 2i\alpha_z, [\sigma_x', \sigma_z] = -2i\alpha_y$

where symbol is the Pauli matrix and $\alpha_y, \alpha_y, \alpha_y$ are the Dirac matrices.

(2 × 10 = 20 marks)

C 63457 (Pages : 2) Name.....................................

Reg. No.....................................

THIRD SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, MARCH 2019

Physics

PHY 302—SOLID STATE PHYSICS

(2008 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **two** *questions from each module.*
Each question carries 3 *marks.*

I. 1 Explain Bragg's law on the frame work of wave vector notation.

2 What is reciprocal lattice ? Prove that the *fcc* lattice is the reciprocal of the *bcc* lattice.

3 Write a note on van der Waals-London interaction.

II. 4 Discuss the effect of variations of relative masses of the two types of atoms on the forbidden gap of a linear diatomic lattice.

5 How does Debye theory differ from Einstein's theory of lattice heat capacity ? Discuss the onsequences of these differences explaining the low temperatre behaviour of specific heat in each case.

6 What are phonons and how do you measure phonon spectra ? Why are neutrons a superior tool for investigating dispersion curves in solids ?

III. 7 Explain the concept of Brillouin zones. What are extended zone, reduced zone and periodic zone schemes ?

8 What are excitons ? Distinguish between Frenkel and Wannier exciton.

9 Explain direct and indirect band gap semiconductors with necessary diagrams.

IV. 10 What do you mean by exchange interaction ? Explain ferromagnetic properties using mean field theory.

11 Describe the diferent polarization mechanisms in dielectrics.

12 Explain Neel's theory of antiferromagnetism.

V. 13 What are the theoretical evidences to prove that superconducting phase is more ordered than normal phase and it is a second order phase transition.

14 Explain Meissner effect. Discuss Type I and Type II superconductors.

15 Briefly explain BCS theory of superconductivity and flux quantization in superconducting ring.

($10 \times 3 = 30$ marks)

Turn over

Section B

Answer any **two** *questions.*
Each question carries 15 *marks.*

16 What do you understand by Milelr indices of a crystal plane ? Show that in a cubic crystal, the interplanar spacing $d_{hkl} = a/\left(h^2 + k^2 + l^2\right)^{1/2}$.

17 Explain Bloch theorem. Discuss Kronig-penny model for the motion of electron in a periodic potential. Show from the E vs. K graph, solids can be classified into metals, semiconductors are insulators.

18 Discuss the theory of vibraion of a diatomic lattice. Explain the acoustic and optical branches of dispersion.

19 Briefly discuss a.c. and d.c. Josephson's effect giving specific relevance to superconducting order parameter and how it is useful in the precise determination of the value of h/e.

(2 × 15 = 30 marks)

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

20 The lattice parameter and atomic mass of diamond crystal are 3.57 Å and 12 respectively. Calculate the density of the same.

21 Find the resistance of an intrinsic germanium rod which is 1 cm. long, 1 mm. wide and 1 mm. thick at 300 K. The intrinsic carrier density at 300 K is $2.5 \times 10^{19}/\text{m.}^3$ and the mobilities of electron and hole are 0.39 and 0.19 $\text{m.}^2\text{V}^{-1} s^{-1}$ respectively.

22 Calculate the maximum frequency which a monoatomic crystal of interatomic distance as 3×10^{-10} m. will allow to pass through. Given the velocity of sound in the crystal is 3×10^3 ms^{-1}.

23 A material with molecular density 4.14×10^{28} m^{-3} obeys Curie law. If the volume susceptibility of that substance at 300 K is found to be 12.568×10^{-3}, calculate the magnetic moment of the molecular dipole. $\left(k_B = 1.38 \times 10^{-23}\,\text{JK}^{-1}, \mu_0 = 4\pi \times 10^{-7}\,\text{henry m.}^{-1}\right)$.

(2 × 10 = 20 marks)

C 63456 (Pages : 2) Name..................................

Reg. No..................................

THIRD SEMESTER M.Sc. (SSE) DEGREE EXAMINATION, MARCH 2019

Physics

PHY 301—NUCLEAR PHYSICS

(2008 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer any **two** *questions from each module.*
Each question carries 3 *marks.*

1. (a) Draw the Fermi-Kuric plot and explain its significance.
   (b) Write a short note on the mass of the neutrino.
   (c) Briefly explain parity violation in beta decay.
2. (a) Write a short note on the spin and parity of deuteron.
   (b) Explain the statement : "Nucleon-Nucleon forces are nearly charge independent."
   (c) Explain the exchange force model.
3. (a) What is the degeneracy of a nuclear shell model level ? What is the reason for degeneracy ?
   (b) State Nordheim's rules.
   (c) What are the evidences for collective motion in nuclei ?
4. (a) State and explain any three conservation laws in nuclear reactions.
   (b) Explain Rutherford scattering.
   (c) Write the Carbon cycle.
5. (a) Obtain the expression for the loss in intensity of a gamma ray when it passes through a material of thickness t.
   (b) Write a short note on scintillation detectors.
   (c) Explain the working of a semiconductor detector.

(10 × 3 = 30 marks)

Section B

Answer any **two** *questions.*
Each question carries 15 *marks.*

6. Discuss the theory of low n-p scattering and obtain an expression for the differential scattering cross-section.
7. Explain Gamma decay. Discuss the quantum theory of gamma decay and obtain the Weisskopf estimates.

Turn over

8. What is spin-orbit coupling ? Explain how the correct magic numbers can be obtained in shell model. Also explain, with appropriate examples, how the spin and parity of nuclei are predicated using shell model.

9. Describe the different regions of operation of a gas filled counter. Discuss the working of a GM counter.

(2 × 15 = 30 marks)

Section C

Answer any **two** *questions.*
Each question carries 10 *marks.*

10. What is internal conversion ? A nucleus which can decay through both gamma ray emission and internal conversion has a half life of 8.7 ps and its probability for gamma emission is $\lambda_\gamma = 4.1 \times 10^{10}\, s^{-1}$. Find the probability for internal conversion for this nucleus.

11. The first excited state of ^{180}Hf is 2^+ and it is 93.3 keV above the ground state. Calculate the energies of the 4^+ and 6^+ excited states of ^{180}Hf. Also find the ratio of excitation of successive states.

12. Find the excitation energies of $^{236}U^*$ and $^{239}U^*$ formed by the capture of thermal neutrons. Using these values, explain why ^{235}U is fissionable, while ^{238}U is not. Assume Mass of $^{235}U = 235.043924u$, Mass of $^{236}U = 236.045563u$, Mass of $^{238}U = 238.050785u$, Mass of $^{239}U = 239.0542905u$, $M_n = 1.008665u$.

13. Discuss the production of energy in the sun through fusion.

(2 × 10 = 20 marks)