C 42047 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4C 12—ATOMIC AND MOLECULAR SPECTROSCOPY

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. Give the features of Paschen-Back effect.
2. IR and Raman measurement complement each other and the complete picture of the vibrational problem can only be obtained by using both the techniques. Substantiate.
3. The observed rotational spectrum of HF shows decrease in the line separation on the high frequency side. Why ?
4. State and explain Franck Condon Principle.
5. Obtain the resonance condition in NMR spectroscopy ?
6. Why microwave source and techniques have to be applied for the observation of ESR ?
7. What is the significance of spin-spin coupling ?
8. Explain how Mossbauer spectrum is useful in understanding electronic structure of molecules.

(8 × 1 = 8 weightage)

Section B

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

9. Explain the concepts underlaying vector atom model and discuss in details LS and JJ coupling schemes in many electron atoms. Give examples
10. Describe normal modes and vibration of H_2O and CO_2 molecules and explain the principle of Fourier transformation Infrared Spectroscopy.

Turn over

11. Explain the basic principle of stimulated Raman and Inverse Raman scattering.

12. Explain Recoilless emission and absorption of γ-rays and briefly explain the use of chemical shift in understanding molecular structure.

(2 × 5 = 10 weightage)

Section C

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

13. The red line of cadmium splits into three components separated by 120 MHz when the source is placed in a magnetic field of flux density 8.6 mT, the light being examined in direction perpendicular to the magnetic field. Calculate the ratio of charge to mass (e/m) of the electron.

14. The first line in the rotational spectrum of carbon monoxide has a frequency of 3.8424 cm^{-1}. Calculate the rotational constant and hence the C-O bond length in carbon monoxide. Avogadro number is 6.022×10^{23}/mol.

15. The first three rotational Raman lines of a linear triatomic molecular are at 4.86, 8.14 and 11.36 cm^{-1} from the exciting Raman lines. Estimate the rotational constant B and the moment of inertia of the molecule.

16. The spectroscopic bond dissociation energy of Cl^{35} O^{16} radical is 1.9 eV. Calculate the equilibrium bond dissociation energy of ClO , if the fundamental vibrational frequency is 780 cm^{-1}.

17. In the NMR spectrum of N^{14} with I = 1, how many spectral lines will be observed ? Calculate the frequency required for the NMR line at an external field of 1.4T (g = 0.403).

18. Calculate the recoil velocity and energy of the free Mossbauer nucleus S_n^{119} when emitting a γ-ray of frequency 5.76×10^{18} Hz. What is the Doppler shift of the γ-ray frequency to n outside observer ? Avogadro number is 6.02×10^{23} mol^{-1}.

19. Electron spin resonance is observed in atomic hydrogen at a magnetic field B = 0.34T. Calculate g value for the electron in the hydrogen atom. If the operating frequency is 9.5 GHz.

(4 × 3 = 12 weightage)

C 42052 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 12—MATERIALS SCIENCE

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. What you mean by geometry of dislocation ?
2. Explain lever rule phase diagrams.
3. Define Buckminsterfullerene.
4. Briefly explain shear strength of a perfect crystal.
5. Define Pick's Law.
6. Explain ceramic phases with suitable examples.
7. Briefly explain kirkendall effect in solids.
8. What you mean by dislocation multiplication.

(8 × 1 = 8 weightage)

Section B

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

9. Explain Electromagnetic and mechanical behaviour of Ceramics.
10. Explain Chemical vapour deposition and its advantages.
11. Explain Electrical behaviour and stability of polymers.
12. Explain Atomic Force microscopy and also explain the different modes used in AFM with suitable examples.

(2 × 5 = 10 weightage)

Turn over

Section C

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

13. If there are 10^{10} m^{-2} of edge dislocations in a simple cubic crystal, how much would each of these climbs down on an average when the crystal is heated from 0 to 1000 K ? The enthalpy of formation of vacancies is 100 kJ mol^{-1}. The lattice parameter is 2 Å. The volume of one mole of the crystal is 5.5×10^{-6} m^3 (5.5 cm^3).

14. In a cylindrical crystal of radius r (r = 10 mm.), calculate the ratio of cross-sectional area available for diffusion through the surface layers to the area available for mass transport through the cylinder.

15. The surface of a copper crystal is of the {111} type. Calculate the surface energy (enthalpy) of copper.

16. The activation volume for dislocation motion in a crystal is 20 b^3, where b is the Burgers vector of the moving dislocation, b = 2 Å. The P – N stress for this crystal is 1000 MN m^{-2}. For a specified rate of dislocation motion, the activation energy Q = 40 kT. Calculate the stress required to move the dislocation at (i) 0 K ; (ii) 100 K,

17. The half length of cracks in a steel is 2 μm. Taking Y = 200 GN m^{-2}, estimate the brittle fracture strength at low temperatures.

18. How much proeutectoid ferrite is there in a slowly cooled 0.6 % steel ? How much eutectoid ferrite is there in the same steel ?

19. Find the equilibrium concentration of vacancies in aluminium and nickel at 0 K, 300 K and 900 K.

(4 × 3 = 12 weightage)

C 42054 **(Pages : 2)** **Name**.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 14—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. Derive the rate equation for a four level laser system
2. Discuss briefly what unstable resonators are.
3. What is a line shape function ? What will be the total number of stimulated emissions per unit time per unit volume in terms of line shape function ?
4. Briefly explain the working principle of optical parametric oscillator.
5. What are single mode optical fibres ? What are the advantages and disadvantages of single mode fibres over multimode ones ?
6. Explain Z scan technique.
7. Briefly explain the mechanism in which a step index cylindrical optical fibre can act as a waveguide. Give the equation of motion and mention the different modes.
8. Explain any *two* applications of spatial frequency filter.

(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 any *three* line broadening mechanisms in a laser system.
10. Discuss the theory of Q- switching and how it generates high power pulses.

Turn over

11. Explain the working principle of a semiconductor laser and a fiber laser semiconductor laser.

12. Explain the application of lasers in material processing and isotope separation.

(2 × 5 = 10 weightage)

Section C

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

13. Derive Einstein's co-efficients in a laser. A He-Ne laser operating at 632.8 nm has an output power of 1.0 mW with a 1 mm beam diameter. Power in the cavity is 99 P since the output mirror has 1 % transmission. The beam diameter is also 1 mm inside the laser cavity and the power is uniform over the beam cross section. The laser linewidth is 1.5×10^8 Hz.

14. For a ruby laser of 6328 A° wavelength, the spontaneous emission co-efficient is 10^7 s^{-1}. The active medium of length 20 cm and refractive index of 1.76 is installed in a two-mirror cavity having mirror reflectivities of 99.9 % and 98 %. Calculate the time in which energy in the cavity is reduced by a factor of 1/e. Also find the threshold population inversion. Given the normalised line shape function as 1.6×10^{-10} s. Assume no losses in the cavity other than the mirror transmission losses.

15. Derive the criteria for a stable laser cavity.

16. Compute the Doppler broadening for the 632.8-nm laser transition in the He-Ne laser, assuming a single isotope of Ne^{20} and that the laser operates at a discharge bore temperature of 100°C.

17. Compare CO_2 laser with He-Ne laser with respect to the energy level diagram, frequency of emission, pumping and efficiency.

18. Compare step index and graded index optical fibre. Calculate the number of modes for a graded index optical fiber if its core diameter d = 62.5 μm, refractive index of core and cladding are 1.48 and 1.46 and its operating wavelength = 1433 nm.

19. The core diameter of a single mode optical fiber is 10 μm. the fiber is coupled to semiconductor laser rated to operate at 1.3 μm. The refractive index of the core glass material is 1.55. The maximum numerical aperture is 0.995. Calculate the refractive index of the cladding. Show that all the rays making an angle < 5.712° with the axis of fiber will be guided through it.

(4 × 3 = 12 weightage)

C 42055 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 15—COMMUNICATION ELECTRONICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. What is the theoretical bandwidth of FM ?
2. Differentiate AM and FM signals ?
3. How information is measured ?
4. What is the basic principle of the Teleprinter system ?
5. Differentiate VHF and UHF systems.
6. What is the basic principle of Satellite communications ?
7. Differentiate linear and non-linear systems.
8. Define radiation resistance of an antenna.

(8 × 1 = 8 weightage)

Section B

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

9. Represent an FM wave with suitable mathematical expression. Also, define the modulation index.
10. Explain PAM, PWM, and PTM systems with waveforms.
11. Explain a linear time-invariant causal system.
12. Obtain the signal in volts received by an antenna in free space having an effective height h_r, which is placed at a distance d from a transmitting antenna having an effective height h_t, for an antenna current 1 and wavelength.

(2 × 5 = 10 weightage)

Turn over

Section C

7 problems answerable within 15 minutes.

Answer any **four** *questions, each carries Weightage 3.*

13. A carrier wave of frequency 10 MHz and peak value 10 V is amplitude modulated by a 5–kHz sine wave of amplitude 6 V. Determine the modulation index and draw the amplitude spectrum.

14. A system has a bandwidth of 4 kHz and a signal-to-noise ratio of 28 dB at the receiver input. Calculate its information-carrying capacity ?

15. A receiver tunes signals from 550 to 1600 kHz with an IF of 455 kHz. Find the frequency tuning ranges and capacitor tuning ranges for the oscillator section.

16. In a broadcast superheterodyne receiver having no RF amplifier, the loaded Q of the antenna coupling circuit (at the input to the mixer) is 100. If the intermediate frequency is 455 kHz, calculate the image frequency and its rejection ratio at 1000 kHz.

17. Consider the analog signal $x(t) = 3 \cos 100 \pi t$, determine the minimum sampling rate to avoid aliasing ? What is the discrete-time signal obtained for a sampling frequency of 200 Hz ?

18. Determine the unit-step response of the linear time inavariant system with impulse response $h(n) = a^n u(n)$ for $|a| < 1$.

19. A half-wave dipole antenna is capable of radiating 1 kW and has 2.15 dB gain over an isotropic antenna. How much power must be delivered to the isotropic antenna to match the field strength of the directional antenna ?

(4 × 3 = 12 weightage)

C 42056 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 16—SYNTHESIS, CHARACTERIZATION TECHNIQUES AND APPLICATIONS OF NANOMATERIALS

(2020 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. What do you mean by molecular self-assembly ?
2. The bottom-up technique is more convenient for nanofabrication-Comment.
3. Explain the reasons for the broadening of diffraction peaks in XRD.
4. In what way does electron microscopy differ from optical microscopy ?
5. What are the advantages of MEMS ?
6. Explain the principle of XPS.
7. Explain the working principle of SQUID magnetometer.
8. List out the challenges faced by nanotechnology.

(8 × 1 = 8 weightage)

Section B

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

9. Illustrate the basic difference between scanning mode and transmission mode of electron microscopy with the help of schematic diagrams and complete working.

Turn over

10. Discuss the following synthesis methods of nanomaterials :

    (i) Hydrothermal ;

    (ii) Sonochemical ; and

    (iii) Microwave synthesis.

11. Discuss any *three* applications of nanomaterials in detail.

12. Differentiate between MEMS and NEMS. Discuss the major challenges faced in constructing nano-size devices.

(2 × 5 = 10 weightage)

Section C

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

13. Explain Laser ablation and laser pyrolysis methods of nano synthesis.

14. The spacing between the principal planes in a NaCl crystal is 2.82 Å. It is found that first-order reflection occurs at 10°.

    (a) What is the wavelength of the Xrays ?

    (b) At what angle, does second-order reflection occur ?

    (c) What is the highest order of reflection seen ?

15. Explain the working of Atomic force Microscope

16. The intensity of incident light on a sample is 0.50 W/m^2, and the intensity of light entering the detector is 0.36 W/m^2. Calculate the transmittance and absorbance.

17. (i) How will you determine the size of particles using XRD techniques.

    (ii) Calculate the FWHM for a cubic crystallite of size 20 nm, if the diffraction happens at glancing angle of 60°. Given that the shape factor is 0.9 and the wavelength of incident radiation is 0.15406 nm.

18. A copper strip of 2 cm wide and 1 mm thick is placed in a magnetic field of 1.5 Wb/m^2. If a current of 200 A is set up in the strip, calculate the Hall voltage that appears across the strip. $R_H = 6 \times 10^{-7}$ m^3/C.

19. Nanomaterials as source for Hydrogen storage. Comment on the statement.

(4 × 3 = 12 weightage)

C 42057 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 17—ASTROPHYSICS AND POSITIONAL ASTRONOMY

(2020 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. Briefly discuss altitude -azimuth coordinate system.
2. Why are sidereal and solar time not equal ? Explain
3. What are cosmic rays ? Where are they coming from ?
4. Why adaptive optics is not considered in space based observations / telescopes ?
5. "Hubble tuning fork diagram does not depict the evolutionary sequence of galaxies ?" Comment.
6. Write a short note on (i) UCD galaxies ; and (ii) Dwarf galaxies.
7. Write a note on galaxy mergers.
8. What are active galactic nuclei (AGN) ? Give an example for AGN.

(8 × 1 = 8 weightage)

Section B

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

9. What is a celestial sphere ? How do you represent the position of an object in the celestial sphere ? Represent in one diagram, the horizon, the celestial equator, the ecliptic, and the latitude, longitude, declination, right ascension, hour angle, zenith distance and the azimuth of a star.

Turn over

10. (i) What are the basic components of an optical telescope ? Explain the purpose of each component.

    (ii) Why do larger telescopes use mirrors instead of lenses ? Note down the limitations of refractive telescopes compared with reflecting telescope.

    (iii) Explain the advantages of adaptive optics. Why don't we use adaptive optics for space telescope ?

11. Discuss the differential rotation of Milky Way galaxy. How does the rotation curve of the Milkyway reveal the presence of dark matter in the galaxy ?

12. Discuss the distance measurements to galaxies at different ranges of distance.

(2 × 5 = 10 weightage)

Section C

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

13. Prove that the celestial equator cuts the horizon at azimuth 90° and 270°, at any latitude (except at the North and South Poles).

14. The most northerly star of the Southern Cross, γ Crucis, has declination -57°. At what latitude will it pass directly overhead? At what latitudes will it never set ?

15. The North Galactic Pole is at Right Ascension 12h49m, declination + 27°24′. What is the tilt of the galactic plane to the celestial equator ?

16. Calculate the effective surface temperature of a star with radius 1.39×10^9 m and which radiates 1.56×10^{27} Joules per second, integrated over all wavelengths.

17. If the rotation rate of the Galaxy remains at about 220 km/sec out to a radius of at least 15 kpc, then what is the minimum mass of the Galaxy ?

18. The Virgo Cluster of galaxies is at a distance of 65 million light years, and has a redshift equivalent to 1400 km/sec. Assuming the speed has remained constant throughout the past and the cluster has no tangential motion, then when were we and the cluster at the same location ?

19. The active galactic nucleus in the galaxy NGC 4151 is observed as basically a point source with a V-band magnitude of 12. If the Hα line (rest = 656.3 nm) from the nucleus is observed at 658.5 nm, then what is the galaxy's distance (assume Ho = 75 km/sec/Mpc) ?

(4 × 3 = 12 weightage)

C 42060 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 20—ADVANCED CONDENSED MATTER PHYSICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. What are Wannier excitons ?
2. Describe the concept of Phonons.
3. Write a note on quantum well structures.
4. List different type of fractures in solids.
5. Describe the term creep in materials.
6. Neatly draw the density of states diagram of a zero dimensional system.
7. Write down the Hamiltonian of a molecule with N atoms and K electrons.
8. What is a thin film transistor? Compare it with MOSFET.

(8 × 1 = 8 weightage)

Section B

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

9. Obtain the classical equation of motion of ion-ion interaction.
10. Explain the band structure calculation of alloys super structures.
11. Describe the details of radiation damages in solids.

12. Neatly describe the sputtering process for thin film deposition. Discuss various types of sputtering processes and its advantages and limitations.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.

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

13. Discuss the concept of density of states.

14. Write a note on electron-plasmon interaction.

15. Describe ternary groups and quaternary groups.

16. Describe the generalized creep behaviour of materials.

17. Show that the energy of a particle in a one dimensional potential well of width d in the ground state is $h^2/8md^2$.

18. Describe the advantages and limitations of solution deposition techniques

19. Explain the evolution of energy levels when atoms are brought close together.

(4 × 3 = 12 weightage)

C 42061 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 21—MODERN OPTICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. Distinguish between plane wave and spherical waves.
2. What is the principle of FTIR spectroscopy ?
3. Discuss about the resolution of a Fabry-Perot Interferometer.
4. Describe an optical element which uses diffraction to focus light.
5. Explain Pockle effect.
6. Distinguish between phase velocity and group velocity.
7. Explain the significance of Cornu spiral.
8. Explain double refraction phenomenon.

(8 × 1 = 8 weightage)

Section B

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

9. Using Jones calculus method arrive at the matrix representation of polarization.
10. Describe the Fresnel's diffraction from a circular aperture with the necessary theory. Also extend the discussion for a rectangular aperture also.
11. In terms of the transfer matrix for a multilayer layer thin film obtain the transmission and reflection coefficients.
12. Using Maxwell equation describe the propagation of light waves in a homogenous dielectric media.

(2 × 5 = 10 weightage)

Turn over

Section C

7 problems answerable within 15 minutes.

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

13. What resolvance is required in a Fabry-Perot interferometer to resolve the two sodium "D-lines" ?

14. Determine the result of the super position of the following harmonic waves : $E_1 = 7 \cos(\{\pi/3\} - \omega t)$, $E_2 = 12 \sin(\{\pi/4\} - \omega t)$, and $E_3 = 20 \cos(\{\pi/5\} - \omega t)$.

15. If light of λ = 632.8 nm. illuminates a zone plate, what is the first zone radius relative to a point 30 cm. from the zone plate on the central axis ? How many half-period zones are contained in an aperture with radius 100 times larger ?

16. A Kerr cell has $K = 2.4 \times 10^{-12}$ m/V_2 at room temperature and works at $\lambda = 589$ nm. If d = 1 cm and L = 3 cm. what will be the half wave voltage needed for the Kerr cell to behave as a halfwave plate ?

17. When a monochromatic light source shines through a 0.2 mm. wide slit onto a screen 3.5 m. away, the first dark band in the pattern appears 9.1 mm. from the center of the bright band. What is the wavelength of the light ?

18. An electromagnetic wave in the free space satisfy the following relationships :

$$\vec{K} \times \vec{H} = Z\vec{H}, \vec{E} = Z\vec{H} \times \vec{K}, Z = \sqrt{\frac{\mu}{E}}.$$

Find local relationship between electromagnetic energy density and magnetic flux density.

19. What is the skin depth for a 3 cm. microwave in copper with conductivity 5.8×10^7 Ω/m ?

($4 \times 3 = 12$ weightage)

C 42062 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 22—PHYSICS OF SEMICONDUCTORS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. Explain Burstein Moss effect.
2. Why does the energy band gap decrease in semiconductors as temperature is increased ?
3. What are the different types of capacitance exhibited by a *p-n* junction diode ?
4. Distinguish between quantum dot and a quantum well structures.
5. Distinguish between drift and diffusion current in semiconductors.
6. How does a Light emitting diode work ?
7. Enlist the characteristics of an ideal diode.
8. Explain an application of thermoelectric electromotive force.

(8 × 1 = 8 weightage)

Section B

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

9. With neat diagram explain the quantum mechanical tunnelling in a tunnel diode.
10. Explain the concept of Fermi level in semiconductors and its variation with doping density. With proper mathematical steps show the Fermi level in an intrinsic semiconductor is located in the middle of the forbidden gap.

Turn over

11. Write explanatory notes on any *two* methods of preparation of low dimensional semiconductor structure like quantum wells and quantum dots.

12. Explain the theory of Hall Effect. Using the two band model of Hall Effect derive an expression for the total Hall co-efficient.

(2 × 5 = 10 weightage)

Section C

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

1. A potential well has a height of 0.05 eV. What should be the width of the well so that the binding energy of the electron ($m^* = 0.063\ m_e$) would be equal to 0.025 eV.

2. The following data are given for intrinsic germanium at 300 K $n_i = 2.4 \times 10^{19}/m^3$; $\mu_e = 0.39\ m^2/V\text{-}s$; $\mu_h = 0.19\ m^2/V\text{-}s$. Calculate the resistivity of the sample.

3. Consider a silicon crystal at room temperature, doped with both donor and acceptor atoms so that $N_D = 2 \times 10^{15}\ cm^{-3}$ and $N_A = 1 \times 10^{15}\ cm^{-3}$. What type of material would this yield ? What will the hole concentration be in this material ? Intrinsic carrier concentration for Si is $1.45 \times 10^{10}\ cm^{-3}$.

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

5. Calculate the space charge width at zero bias for a Schottky contact with the following parameters: capacitance permittivity $\varepsilon_s = 11.7$, built in potential barrier $V_{bi} = 0.334$ V, doping density $N_d = 10^{16}\ cm^{-3}$.

6. Find the relaxation time of conduction electrons in a metal of resistivity $1.54 \times 10^{-8}\ \Omega$-m, if the metal has 5.8×10^{28} conduction electrons/m^3.

7. Calculate the mobility of the electrons in copper obeying classical laws. Given that the density of copper = $8.92 \times 10^3\ kg/m^3$, Resistivity of copper = 1.73×10^{-8} ohm-m, atomic weight of copper = 63.5 and Avogadro's number = 6.02×10^{26} per k-mol.

(4 × 3 = 12 weightage)

C 42063 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 23—MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. Briefly describe Port C of the AVR and explain some of its functions.
2. Distinguish between the variables- long and long long used for AVR programming.
3. Explain the purpose of EEPROM.
4. Explain the concept of formation of a control word.
5. Briefly explain the different memory interface schemes.
6. What are the important features of the Shift instruction in microprocessor ?
7. Briefly explain how an ADC works.
8. Enlist and explain any three control signals of 8085 microprocessor.

(8 × 1 = 8 weightage)

Section B

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

9. With suitable examples explain the addressing modes of 8085 microprocessor.
10. With a neat schematic explain the architecture of the 8085 microprocessor.
11. Explain the data transfer schemes of 8085 based on DMA.
12. Explain features of the I/O ports of AVR.

(2 × 5 = 10 weightage)

Turn over

Section C

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

13. What does the below code implement in AVR ?

```
{
ADCO_CTRLA &= ~ADC_ENABLE_bm;
}
```

14. Write the AVR code line for "PORTB set to tri-state inputs"

15. Write a programme to multiply two 8 bit numbers stored at address 2050 and 2051 and store the result at the address 3050 and 3051.

16. Write an assembly level programme to find the largest number among numbers in an array starting at address 5000 and store it at the address 6000.

17. What logic operation is implemented with the below program in AVR ?

```
int main()
{
DDRB = Oxff;
PORTB = 0x00;
while (1)
{
delay–ms(500);
tbi(PORTB, PB0);
}
return 0;
}
```

18. Find2's compliment with carry of an 8 bit number stored at address 2050. Result is to be stored at address 3050 and 3051. Starting address of program is taken as 2000.

19. Write a programme to multiply two 8 bit numbers stored at address 2050 and 2051 and store the result at the address 3050 and 3051.

(4 × 3 = 12 weightage)

C 42064 **(Pages : 2)** **Name**.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 24—BIOPHYSICS

(2020 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. Write a short note on Ramachandran plot.
2. How is a nerve impulse transmitted across a chemical synapse ?
3. Why semiconductor nano crystals are called quantum dots ?
4. What are Biomaterials ? Explain the three major classes of biomaterials ?
5. Write a short note on interference biosensors ?
6. Define Wearable biosensor and explain its importance.
7. Why bioactive ceramics is considered as the intermediate between resorbable and bioinert ceramics ?
8. What do you mean by an active transport mechanism ?

(8 × 1 = 8 weightage)

Section B

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

9. With a neat diagram explain the protein structure.
10. Briefly explain CNT based biosensors, its importance and classifications in medicinal sector.

Turn over

11. What are Bio ceramics ? Give its classifications and explain its each category in detail.

12. What are Biomaterials ? Spell out a detailed picture of its use in Cardiovascular applications.

(2 × 5 = 10 weightage)

Section C

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

13. Briefly explain chemi-osmotic theory of passive transport.

14. Comment on the Group transfer potential ?

15. Illustrate the mechanism of muscle contraction.

16. How can quantum dots be used for bio imaging applications ?

17. What are the characteristics of electrochemical biosensors ?

18. Schematically explain SPR based optical biosensors.

19. Calcium phosphate based bioceramic are important in medical field. Justify the statement.

(4 × 3 = 12 weightage)

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FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 25—SPACE PHYSICS

(2020 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

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

1. Explain the working of GPS.
2. What are the important components of an earth station ?
3. Briefly discuss the design and components of communication satellites.
4. Distinguish between Jovian and terrestrial planets.
5. Write a note on satellite launch vehicles.
6. What is Ionosodes ?
7. What do you mean by the solar cycle ?
8. Write a note on the altitude and orbit control system.

(8 × 1 = 8 weightage)

Section B

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

9. Discuss the theory of the formation of the ionosphere.
10. i) What are the different layers of the atmosphere ?

    ii) Discuss the role of various fundamental and apparent forces in the atmosphere.

Turn over

11. Derive the equation of motion of an equivalent one-body problem of planetary motion.

12. i) Briefly explain altitude and orbital control system.

    ii) Explain with neat diagram telemetry, tracking and command system.

    iii) Explain transponder with a simple block diagram.

(2 × 5 = 10 weightage)

Section C

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

13. Find the altitude at which a satellite of mass 2105 kg orbits the Earth. The gravitational force is 649 N and the universal constant of gravitation G is 6.673×10^{-11} Nm^2/kg^2. Given the mass of the Earth as 5.988×10^{24} kg.

14. A comet approaches the sun within 0.570 A.U., and its orbital period is 75.6 years. (1 A.U. = 1.5×10^{11} m is the mean Earth-Sun distance.) How far from the sun will Haley's comet travel before it starts its return journey ?

15. The planet Venus orbits around the Sun with a mean orbital radius of 1.076×10^{11} m. The mass of the Sun is 1.99×10^{30} kg. Using Newton's version of Kepler's third law, find the orbital period of Venus.

16. The mean orbital of a planet is 1.22×10^9 m which has an orbital period of 15.95 days. Another planet orbits at a mean radius of 1.48×10^9 m away from the source. Use Kepler's third law of planetary motion to predict the orbital period of Hyperion in days.

17. Find the speed and height of a geosynchronous satellite above Earth's surface ?

18. The period of the moon is approximately 27.2 days (2.35×10^6 s). Determine the radius of the moon's orbit and the orbital speed. (Given : $M_{earth} = 5.98 \times 10^{24}$ kg, $R_{earth} = 6.37 \times 10^6$ m).

19. Earth has a radius of 6378 kilometers. The Moon is located 3,80,000 kilometres from Earth. During the Apollo-11 mission in 1969, engineers on Earth would communicate with the astronauts walking on the lunar surface, how long did they have to wait to get a reply from the astronauts ?

(4 × 3 = 12 weightage)