C 63491 (Pages : 2) Name.....

Reg. No.....

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

Physics

PHY 403 C—MATERIAL SCIENCE

Time : Three Hours Maximum : 80 Marks

Section A

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

1. What are point imperfections? Describe using a neat diagram Schottkey imperfection and Frenkel defect ?
2. Explain the terms Eutectic temperature and Eutectic composition for any binary solution ?
3. What are ceramics ? How can a ceramic phase be distinguished from a non-ceramic phase ?
4. Distinguish between thermoplastic and thermosetting resins ?
5. What are cross-linking polymers ? Explain the characteristic featured using an example ?
6. What are quasi crystals ? Mention its applications ?
7. What is Allotropy ? Which are the different allotropic forms of carbon ?
8. What is quantum confinement ? How does it affect the optical properties of nano particles ?

(5 × 4 = 20 marks)

Section B

Answer Both questions.
Each question carries 20 marks.

9. Describe the three different types of crystal imperfections explaining the various classifications in each of them ?

Or

10. What multiple beam interferometry ? How this technique can be used to determine the thickness of thin films ?

11. What are carbon nanotubes ? Explain the different classification of single walled carbon nano tube on the basis of its chirality ? How can you differentiate a carbon nano tube from a fullerene ?

Or

12. What are polymers ? Explain the different polymerization mechanisms.

(20 × 2 = 40 marks)

Section C

Answer any **two** *questions.*

Each question carries 10 *marks.*

13. Explain the different types of atomic arrangement adopted in silicates to maintain the charge balance ?

14. Explain with a schematic diagram the working of an atomic force microscope (AFM) ?

15. What do you mean by a slip and slip plane? Explain Frank-Read mechanism of dislocation multiplication ?

16. Explain a bottom up approach for the synthesis of nano materials ?

(10 × 2 = 20 marks)

C 63484 (Pages : 2) Name.....

Reg. No.....

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

Physics

PHY 402 (A)—ADVANCED ELECTRONICS

(2003 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. Illustrate decimal to hexadecimal conversion with a suitable example.
2. Differentiate between the Program Counter/ Instruction Pointer and Index Register of a microprocessor.
3. Explain the actions taken by the Z80 in executing a CALL instruction.
4. Explain the basic functions of a Programmable peripheral interface.
5. Explain DMA.
6. Write a note on arithmetic processors.
7. Explain the working of LDR.
8. Write a note on delay subroutine.

(5 × 4 = 20 marks)

Section B

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

9. (a) (i) Explain the internal architecture of 8085 Microprocessor.

(ii) Explain the register organization of Z80.

Or

(b) (i) Explain any one of the modes of 8255 PPI in detail.

(ii) Explain the features of Dynamic RAM Controllers.

10. (a) (i) Draw the logical block diagram of 8279 keyboard display controller and explain.

(ii) Give an account of the Op-amp circuits for current-to voltage conversion and differential amplification.

Or

(b) (i) Explain how to convert an analog signal into digital signal.

(ii) Describe the interfacing of seven segment display to a microprocessor.

(2 × 20 = 40 marks)

Section C

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

11. Write a note on the addressing modes of 8085 microprocessor with suitable examples.

12. Write a program in 8085 assembly language to sort an array in the ascending order. Give algorithm/ flowchart.

13. Draw and explain the functional block diagram of 8259 programmable interrupt controller.

14. With functional block diagram, explain the operation and programming of 8251 USART.

(2 × 10 = 20 marks)

C 63464 (Pages : 2) Name.....

Reg. No.....

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

Physics

PHY 403(B)—COMMUNICATION ELECTRONICS

(2008 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. (a) Sketch and explain the basic circuit for a BJT collector modulator.
   (b) Explain the noise in FM systems.
   (c) Give an account of the comparison between Frequency modulation and Phase modulation.
2. (a) Define and explain information and information theory.
   (b) With a diagram briefly explain double polarity pulse amplitude modulation.
   (c) Explain the quantization of signal for pulse code modulation.
3. (a) Explain the principle and operation of a practical diode detector.
   (b) With a circuit diagram, explain the principle and operation of a balanced slope detector.
   (c) What are the advantages of microwave system in communication.
4. (a) With a block diagram, explain the principle of a A/D converter.
   (b) What is pre-emphasis and de-emphasis.
   (c) Explain Carson's rule.
5. (a) Briefly explain Log-periodic antennas.
   (b) Give a short note on propagation of ground waves.
   (c) Explain the radiation from an oscillating dipole.

(10 × 3 = 30 marks)

Section B

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

6. Explain the following receier parameters :
   (i) Selectivity. (ii) Sensitivity.
   (iii) Dynamic range. (iv) Image frequency rejection.
   (v) Double spotting.

Turn over

7. What is sinusoidal FM ? Explain in detail the frequency spectrum of sinusoidal FM.
8. (a) Define and describe PPM, and explain with waveforms how it is derived from PWM.
   (b) Differentiate between FDM and TDM.
   (c) Explain the working of a teleprinter.
9. List and explain the properties of convolution and the interconnection of LTI systems.

(2 × 15 = 30 marks)

Section C

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

10. (a) A certain AM transmitter radiates 10 kW with the carrier modulated, and 11.8 kW when the carrier is sinusoidally modulated. Calculate the modulation index. If another sine wave, corresponding to 30 % modulation, is transmitted simultaneously, determine the total radiated power.
    (b) What is the bandwidth required for an FM signal in which the modulating frequency is 2 kHz and the maximum deviation is 10 kHz.
11. An analog signal is expressed by the equation $x(t) = 3 \cos(50 \pi t) + 10 \sin(300 \pi t) - \cos(100 \pi t)$. Calculate the Nyquist rate for this signal.
12. In a broadcast super heterodyne receier 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 (i) the image frequency and its rejection ratio at 1000 kHz and (ii) the image frequency and its rejection ratio at 25 MHz.
13. A telephone signal with a cut-off frequency of 4 kHz is digitized into 8 bit samples at the Nyquist sampling rate $f_s = 2W$. Assuming raised-cosine filtering is used with a roll-off factor of unity, calculate (a) the base band transmission bandwidth and (b) the quantization S/N ratio.

(2 × 10 = 20 marks)

C 63461 (Pages : 2) Name.....

Reg. No.....

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

Physics

PHY 402 (A)—ADVANCED ELECTRONICS

(2008 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. (a) Explain the terms operand and mnemonic in assembly level programming.
   (b) What are the important features of the Zilog Z80 microprocessor ?
   (c) Explain advantage of assembly level programming.
2. (a) Enlist the programmable register of 8085 microprocessor.
   (b) Enlist the different functional groups of 8085 microprocessor instruction set.
   (c) Explain use of ALE in the 8085 microprocessor.
3. (a) Explain the flags in 8085 microprocessor.
   (b) Define (i) Instruction cycle ; (ii) Machine cycle ; (iii) T-state.
   (c) Explain the purpose of timing diagram.
4. (a) Distinguish between a compiler and interpreter.
   (b) Explain the instruction format of 8085 microprocessor.
   (c) Explain features of 8279 DMA controller.
5. (a) Explain Programmed I/O.
   (b) Enlist and explain any three control signals of 8085 microprocessor.
   (c) Explain interrupts in 8085 microprocessor.

(10 × 3 = 30 marks)

Section B

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

6. With a neat schematic explain the architecture of the 8085 microprocessor.
7. With suitable examples explain the addressing modes and interrupts of 8085 microprocessor.

Turn over

8. With circuit diagram, explain the 8279 programmable keyboard interface.
9. Explain the working of an ADC 0800 8-bit A/D converter.

(2 × 15 = 30 marks)

Section C

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

10. Write an assembly level programme to find the smallest number among numbers in an array starting at address 5000 and store it at the address 6000.
11. Write an assembly level programme for the division of two 8 bit numbers stored at consecutive address starting from 4150.
12. Write a program to find the sum of a series where series starts from memory address 3001 and count of series is at memory address 3000 and starting address of the given program is 2000. Store the sum of the series into memory addres 4000.
13. Find 2'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.

(2 × 10 = 20 marks)

C 2730 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER P.G. DEGREE EXAMINATION, APRIL 2021

(CCSS)

M.Sc. Physics

PHY 4E 11—RADIATION PHYSICS

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

Answer **all** *questions.*

Each question carries 2 *marks.*

1) Explain why cyclotron is not suitable to accelerate electrons ?
2) How does Bremsstrahlung result in energy loss of charged particles in matter ?
3) Show that the shift in wavelength due to Compton scattering by electrons is very small.
4) What are particle fluence and energy fluence ? How are they related to each other ?
5) Elucidate the formation of free radicals by radiolysis and their action on DNA.
6) Explain the concept of ALARA.
7) Why do we need artificial isotopes ?
8) Interaction of radiation with matter is often quantified by the term 'Cross section'. What does it mean ?
9) Distinguish between the terms 'radiation exposure' and 'radiation dose'.
10) How do we preserve food using radiation ?
11) Explain any two precautions taken while transferring a radioactive source.
12) What are radiation weighing factors used in radiation dosimetry ?

(12 × 2 = 24 marks)

Section B

Answer any **two** *questions.*

Each question carries 14 *marks.*

13) Discuss different modes of gamma ray interactions with matter. What are the conditions for the occurrence of each phenomenon ?
14) Explain radiation activity, exposure, absorbed dose, equivalent dose, effective dose, collective dose and committed dose and their relationships.

Turn over

15) (i) With help of a diagram, explain the theory and working of cyclotron accelerator. How is radius of the cyclotron related to kinetic energy attainable ?

(ii) Briefly explain the effects of ionising radiations at molecular, sub molecular and cellular levels.

16) (i) What are the methods to minimize radiation exposure to persons ?

(ii) What are half value and tenth value thicknesses of shielding ? How are they related to each other ?

(2 × 14 = 28 marks)

Section C

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

17) Derive an expression for the maximum energy gained by the positive ion using a cyclotron.

18) Estimate the percentage of energy of photons of 1.0 MeV that will be transmitted through a lead block of thickness 5 cm. (Absorption coefficient, $\mu = 0.795\ cm^{-1}$). What is the half thickness for these photons in lead ?

19) Calculate the maximum shift in frequency for an incident photon of wavelength 1°A scattering off a target at rest ?

20) In a CT scan the tissues breast, lung, bone marrow and stomach receive dose of 21, 23.5,5.17 and 2.30 mSv respectively. Calculate the effective dose assuming the tissue weighting factors as 0.12.

21) Briefly explain the terms stochastic and deterministic effects of radiation.

22) The exposure rate from a fluoroscopic X-ray machine is 5 R/ min at 50 cm. What would be the exposure rates at : (i) 40 cm, and (ii) 60 cm ?

(4 × 7 = 28 marks)

C 2729 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER P.G. DEGREE EXAMINATION, APRIL 2021

(CCSS)

M.Sc. Physics

PHY 4E 10—ADVANCED MATERIALS SCIENCE

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. Distinguish between Schottky and Frenkel defects in solids.
2. Briefly describe the Frank-Read mechanism of dislocation multiplication.
3. Discuss the Hume-Rothery rules for substitutional solid solutions.
4. Explain thin film thickness measurement using a profilometer.
5. What is a phase diagram ? What kind of information can be obtained from it ?
6. What is polymorphism ? Mention any *two* examples.
7. Distinguish between bridging oxygens and non-bridging oxygens, and their effect on glass deformation.
8. Write a short note on elastomers.
9. How do you estimate the size of a polymer ?
10. Distinguish between crystals and liquid crystals.
11. Briefly describe any application of carbon nanotube.
12. What are quantum confinement effects ?

(12 × 2 = 24 marks)

Section B

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

13. Give a detailed description of various types of dislocations in solids.

14. With the help of neat diagrams, explain how multiple beam interferometry can be used to study the surface topography of films.

15. Explain the following :

    (i) Addition polymerization ; (ii) Copolymers ; (iii) Condensation polymerization ; and (iv) Thermosets and thermoplasts.

16. What are the advantages of electron microscopy for characterising nanostructured materials ? Explain how TEM and SEM are used for characterising nanomaterials, each with its merits and demerits.

(2 × 14 = 28 marks)

Section C

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

17. Derive the expression for diffusion constant for impurity diffusion through solids.

18. Explain the working mechanism of atomic force microscopy.

19. Describe any *two* applications of Ceramic materials.

20. Explain the structure of silica. Distinguish between simple silicates and layered silicates.

21. A rubber contains 54 % butadiene, 34 % isoprene, 9 % sulfur and 3 % carbon balck. What fraction of the possible cross-links are joined by vulcanization ? Assume that all the sulfur is used in cross-linking.

22. Neatly describe any two applications of liquid crystals.

(4 × 7 = 28 marks)

C 2728 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER P.G. DEGREE EXAMINATION, APRIL 2021

(CCSS)

M.Sc. Physics

PHY 4E 07—ADVANCED NUCLEAR PHYSICS

(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. Explain the importance of magic numbers in nuclear shell structure.
2. Define a realistic potential for nucleus. Why is it 'realistic' ?
3. How does extreme single particle shell model account for electric quadrupole moment of nuclei ?
4. Explain any experimental evidence for the existence of vibrational levels of nuclei.
5. Give an outline of cranking shell model for rotational bands of nuclei.
6. How can the evaporation model be applied to compound nuclear reactions ?
7. What are the characteristics of resonance reactions ?
8. Explain stability peninsula of nuclei.
9. Give a brief outline of statistical model of fission.
10. What is the working principle of electrostatic accelerator ?
11. Explain the working of LINAC.
12. How do synchrotrons differ from cyclotrons ?

(12 × 2 = 24 marks)

Section B

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

13. Explain how spin orbit interaction accounts for magic numbers and magnetic moment of odd A nuclei.
14. Considering the nucleus as a symmetric top derive the rotational energy spectrum and wave function for even- even nuclei.

Turn over

15. Define scattering and reaction cross sections for a nuclear reaction. Using partial wave analysis method derive the reaction and scattering cross sections for low energy *np* scattering and find the limits of scattering cross section for a given reaction cross section.

16. Explain liquid drop model of nucleus. Considering the nucleus as a charged drop of constant density, derive the condition for nuclear stability. Define the fissionability parameter and explain its significance.

(2 × 14 = 28 marks)

Section C

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

17. Calculate the magnetic dipole moments of $_{19}K^{39}$ and $_{21}Si^{45}$ using extreme single particle shell model.

18. Derive Breit-Wigner formula.

19. Prove that the radius of the orbit of an ion in a cyclotron after nth D crossings is given by $r = 1/B(2MV/q)^{1/2}n$ where B = magnetic field and q = charge of the particle.

20. If there are N drift tubes in a linear accelerator prove that the total length of the accelerator is $L = (2\lambda/3)(qV/2Mc^2)^{1/2}N^{3/2}$.

21. Derive an expression for electric quadrupole moment operator M'2 m(E) using the rotational wave function Ψ^I_{MK}.

22. Using Semi empirical Mass formula derive the condition for spontaneous fission to occur. Check whether $_{54}Xe^{132}$ is stable against spontaneous fission.

(4 × 7 = 28 marks)

C 2727 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER P.G. DEGREE EXAMINATION, APRIL 2021

(CCSS)

M.Sc. Physics

PHY 4C 17—SPECTROSCOPY

(2019 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A

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

1. Give the characteristics of rotational spectrum of molecules.
2. Write down the equation for energy levels of a non rigid rotator. Compare it with a rigid rotator.
3. Explain Isotope shift in microwave spectrum.
4. Distinguish between harmonic and an-harmonic oscillators. Sketch the corresponding energy levels.
5. What is the principle behind Fourier transform spectroscopy ?
6. Give an account of the allowed transitions of rotational Raman Spectra of linear diatomic molecules.
7. Give a qualitative account of Inverse Raman effect.
8. Explain how Frank-Condon Principle accounts for the intensity of spectral lines.
9. Discuss the origin of P, Q and R branches in electronic vibration spectra.
10. Draw a schematic diagram and give a brief account of Raman spectrometer.
11. Explain Nuclear Magnetic Resonance ?
12. What is recoilless emission of spectra ? What is its significance in spectroscopy ?

(12 × 2 = 24 marks)

Section B

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

13. Explain Born-Oppenheimer approximation and its break down . Discuss the features of vibration rotation spectra of diatomic molecules.

14. Explain the vibrational coarse structure and rotational fine structure of electronic spectra of diatomic molecules.

15. Explain Raman Effect. Give the classical theory of Raman effect and list its shortcomings. Explain how the quantum theory could be able to get rid of them.

16. Give an account of the various applications of spin resonance spectroscopy.

(2 × 14 = 28 marks)

Section C

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

17. The bond length of HF molecule is 0.0927 nm and centrifugal distortion co-efficient $D = 10^{-3}$ cm^{-1}. Find the wave numbers of first three transitions and mention the regions of the spectrum

18. What is the average period of rotation of HCl molecule in J = 1 state. The inter-nuclear distance in HCl = 0.1274×10^{-9}m. Mass of Hydrogen atom = 1.673×10^{-23} kg and mass of Cl atom = 58.06×10^{-27}Kg.

19. The fundamental vibration frequency of $H^{35}Cl$ is 2989 cm^{-1}. Find the force constant of HCl bond. Also find the separation between infra red absorption lines of $H^{35}Cl$ and $H^{37}Cl$.

20. Show that the separation between adjacent rotational Raman lines is 4B in H_2 molecule. Explain why the separation is 8B in the case of O_2.

21. The vibrational structure of the absorption spectrum of O_2 becomes a continuum at 56,876 cm^{-1}. If the upper electronic state dissociates into one ground state atom and one excited atom with excitation energy 15,875 cm^{-1}, estimate the dissociation energy of the ground state and the equilibrium dissociation energy D_e of O_2. Given that zero point energy of ground state = 793 cm^{-1}.

22. Calculate the recoil velocity and energy of a free Mossbaur nucleus $^{57}Fe^*$ when emitting a gamma ray frequency of 3.5×10^{18} Hz. What is the Doppler shift of the gamma frequency to an outside observer.

(4 × 7 = 28 marks)

C 2072 (Pages : 3) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 20—MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS

(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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

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

1. Briefly describe Port B of the AVR and explain some of its functions.
2. Write short note on the following variable for AVR programming-unsigned char, unsigned int and unsigned long.
3. Distinguish between a micro-controller and a micro-processor.
4. What is a DMA controller ?
5. Explain concept of address space partition and its implementation in 8085 microprocessor.
6. Define- (1) Instruction cycle ; (2) Machine cycle ; and (3) T-state
7. Enlist the different functional groups of 8085 microprocessor instruction set.
8. Briefly explain the timing and control unit of 8085 microprocessor.

(8 × 1 = 8 weightage)

Section B

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

9. Describe the architecture of the Intel 8255 programmable peripheral interface. Explain the different modes of operation.

10. Explain memory mapped I/O interfacing scheme in 8085 microprocessor.

11. With a neat schematic explain the architecture of the 8085 microprocessor.

12. Explain features of the I/O ports of AVR.

(2 × 5 = 10 weightage)

Section C

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

13. Write an assembly level programme to find the square root of a number.

14. Write a program in 8085 microprocessor to sort numbers in ascending order in an array of *n* numbers, where size "*n*" is stored at memory address 2000 : 500 and the numbers are stored from memory address 2000 : 501.

15. Find 2'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.

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

```
int main()
{
DDRB = 0xff;
PORTB = 0x00;
while(1)
{
delay_ms(500);
tbi(PORTB, PB0);
}
return 0;
}
```

17. Write the code lines for AVR so that "All PORTA pins are set as inputs with pull-ups enabled and then read data from PORTA".

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

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

(4 × 3 = 12 weightage)

C 2071 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 19—PHYSICS OF SEMICONDUCTORS

(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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

(8 short questions answerable within 7.5 minutes)

Answer **all** *questions.*

Each question carries a weightage of 1.

1. Explain Burstein Moss effect.
2. Explain the concept of Effective mass.
3. What are the different types of capacitance exhibited by a *p-n* junction diode ?
4. Distinguish between fluorescence and phosphorescence.
5. What is a thin film ? Mention two applications.
6. Explain the Boltzmann transport equation.
7. Distinguish between drift and diffusion current in semiconductors.
8. What is the origin of negative resistance exhibited by a tunnel diode ?

(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. Explain the theory of carrier transport across a *p-n* junction. Enlist ideal *p-n* junction characteristics and explain origin of deviation from ideal behaviour.

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

11. Using the band theory write explanatory notes on the following- allowed and forbidden transitions, free and bound excitons, Franz-Keldysh effect.

12. Explain the construction and working of high electron mobility transistor.

(2 × 5 = 10 weightage)

Section C

(7 problems answerable within 15 minutes)
Answer any **four** *questions.*
Each question carries a weightage of 3.

1. 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.

2. Find the temperature at which there is 1% probability that a state with energy 0.5 eV above Fermi energy. Use $k_B = 1.38 \times 10^{-23}$ J/K.

3. 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.

4. Calculate the mobility of the electrons in copper obeying classical laws. Given that the density of copper = 8.92×10^3 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.

5. A uniform silver wire has a resistivity of $1.54 \times 10^{-8}\ \Omega$-m at a temperature 300 K. For an electric field along the wire of 1 V/cm. Calculate the thermal velocity of conduction electrons.

6. Calculate the energy band gap of germanium at 300 and 600 K. Given that $\alpha = 0.477$ meV/K and $\beta = 235$ K. Band gap at 0 K for Ge is 0.7437 eV.

7. A GaAs LED radiates at 900 nm. If the forward current in the LED is 20 mA, calculate the power output, assuming an internal quantum efficiency of 2%.

(4 × 3 = 12 weightage)

C 2070 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 18—MODERN OPTICS

(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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

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

1. What are the types of coherence ?
2. What is significance of Poynting vector ?
3. Explain Bainet's principle.
4. What is the relation between line width and coherence of a light source ?
5. Explain "Apodization".
6. Explain Kerr effect.
7. Explain the Sellmeier formula and mention its applications.
8. Explain relation between diffraction from a slit and Fourier transform.

(8 × 1 = 8 weightage)

Section B

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

9. Using the theory of multilayer films set up the transfer matrix for a single film on a substrate in the TE mode.

10. With a neat diagram explain the theory of diffraction grating.

11. Explain concept of Second Harmonic Generation describing its important aspects.

12. Explain the principle of working of a Fabry-Perot Interferometer. Comment on its resolving power and finesse.

(2 × 5 = 10 weightage)

Section C

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

13. Analyse the Jones vector $\begin{bmatrix} 2i \\ 2 \end{bmatrix}$ to identify the polarization.

14. Using Michelson fringe visibility, explain conditions for maxima and minimum fringe visibility.

15. A Fabry-Perot interferometer has 1 cm spacing between mirrors and a reflection co-efficient of $r = 0.95$. For a wavelength around 500 nm, determine its minimum resolvable wavelength interval and its resolving power.

16. Light of 5000 A is incident on a circular hole of radius (i) 1 cm ; and (ii) 1 mm. How many half period zones are contained in the circle if the screen is placed at a distance of 1 m to observe the diffraction ?

17. An electromagnetic wave is propagating in the z-direction in a lossy medium with attenuation constant $\alpha = 0.5\ m^{-1}$. If the wave's electric-field amplitude is 100 V/m at z = 0, how far can the wave travel before its amplitude will have been reduced to (a) 10 V/m ; (b) 1 V/m ; and (c) 1 μV/m ?

18. A high reflectance stack has 6 double layers of SiO_2 ($n = 1.46$) and ZnS ($n = 2.25$) films on a glass ($n = 1.48$) substrate. What is the reflectance for light of 550 nm at normal incidence ?

19. A screen is placed 2 m away from the lens to obtain the diffraction pattern in the focal plane of the lens in a single slit diffraction experiment. What will be the slit width if the first minimum lies 5 mm on either side of the central maximum when plane light waves of wavelength 4000 Å are incident on the slit ?

(4 × 3 = 12 weightage)

C 2069 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 17—ADVANCED CONDENSED MATTER 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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

(8 short questions answerable within 7.5 minutes)

Answer **all** *questions.*

Each question carries a weightage of 1.

1. What are Frenkel excitons ?
2. Write a short note on Plasmons.
3. Differentiate between ternary and quaternary groups.
4. Briefly describe about super lattices.
5. Write a note on Fatigue.
6. Neatly draw the density of states diagram of a two dimensional system.
7. Why do thin films exhibit properties different from bulk ?
8. Calculate the kinetic energy of an electron with de Broglie wavelength 1.5×10^{-12} m.

($8 \times 1 = 8$ weightage)

Section B

(4 essays questions answerable within 30 minutes)
Answer any **two** *questions.*
Each question carries a weightage of 5.

9. Describe the Hartree-Fock approximation for the interacting electron gas by considering the Coulomb interaction and comment on its limitations.

10. Describe the various types of dislocations in metals and relate them to the mechanical strength of the metals.

11. What is density of states ? Discuss density of states in bulk and two dimensional materials with neat diagrams.

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 question carries a weightage of 3.

13. Explain Bloch and Wannier representations.

14. Explain the phase diagram of alloy formation.

15. Explain the crack initiation and propagation in solids.

16. Describe the details of diffusion in solids.

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

18. Discuss the merits and demerits of physical vapour deposition technique.

19. Explain the construction and working of thin film transistors.

(4 × 3 = 12 weightage)

C 2066 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 14—COMMUNICATION ELECTRONICS

(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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

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

1. Give the use of Foster-Seeley discriminator.
2. Differentiate source coding and channel coding.
3. Differentiate PAM and PWM signals.
4. Differentiate causal and non-causal systems ?
5. How to determine the stability of a linear time-invariant system ?
6. Explain the principle of ionospheric propagation ?
7. Differentiate Log periodic antenna and Yagi antenna.
8. Explain the principle of Tropospheric scatter propagation ?

(8 × 1 = 8 weightage)

Section B

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

9. Obtain the frequency spectrum of the AM wave.
10. With a neat block diagram explain the basic stages in the generation of pulse modulations.
11. Compare AM receivers and FM receivers.
12. Represent following discrete-time signals 1) unit step 2) unit ramp 3) exponential signal.

(2 × 5 = 10 weightage)

Section C

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

13. The antenna current of an AM broadcast transmitter, modulated to a depth of 40 percent by an audio sine wave, is 11 A. It increases to 12 A as a result of simultaneous modulation by another audio sine wave. What is the modulation index due to this second wave ?
14. A 25-MHz carrier is modulated by a 400-Hz audio sine wave. If the carrier voltage is 4 V and the maximum deviation is 10 kHz, write the equation of this modulated wave for (a) FM ; and (b) PM.
15. Design a (7, 4) linear block code.
16. An AM broadcast receiver has an IF of 465 kHz and is tuned to 1000 kHz, and the RF stage has one tuned circuit with a Q of 50. (a) Find the image frequency ; and (b) Find the image rejection in decibels.
17. Determine the response at $n = 0$ of the system $y(n) = 1/3\{x(n+1) + x(n) + x(n-1)\}$ for the input signal $x(n) = |n|, -3 \le n \le 3$.
18. Obtain the directivity of a current element.
19. A uniform cross-section tower antenna is 400 ft high and 7 ft square. Calculate the characteristic impedance at a frequency of 1300 KHz.

(4 × 3 = 12 weightage)

C 2065 **(Pages : 2)** **Name**.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 13—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

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

1. What are the characteristic properties of laser light ?
2. Write a note on stable and unstable resonators.
3. Briefly explain industrial applications of laser.
4. How does light propagation takes place in an optical fiber ?
5. Differentiate between step index and graded index fiber.
6. Write a short note on second harmonic generation.
7. Explain any *two* methods to achieve Q-switching.
8. Explain acceptance angle and numerical aperture. How are they related ?

(8 × 1 = 8 weightage)

Section B

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

9. Explain the theory of Q switching and mode locking in lasers.
10. Explain recording and reconstruction of holograms.
11. With an energy level diagram explain the working principle of C02 laser.
12. Explain Z scan technique for measuring nonlinear refractive index and nonlinear absorption

(2 × 5 = 10 weightage)

Section C

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

13. Derive the relation between Einstein's co-efficients.
14. A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 50 μm. The fiber has a numerical aperture of 0.2. Estimate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1 μm.
15. In a Ruby Laser, the total number of Cr + 3 ions is 2.8×10^{19}. If the Laser emits radiation of wavelength 600 nm, then calculate the energy of one emitted photon and total energy available per pulse.
16. The refractive indices of core and cladding materials of a step index fibre are 1.53 and 1.445, respectively. Calculate : (i) Numerical aperture ; (ii) Acceptance angle ; and (iii) The critical angle at the core-cladding interface.
17. Consider the two-level system with $E_1 = -13.6$ eV and $E_2 = -3.4$ eV. Assume $A_{21} \approx 6 \times 10^8\ s^{-1}$. (a) What is the frequency of light emitted due to transitions from E_2 and E_1 ? (b) Assuming the emission to have only natural broadening, what is the FWHM of the emission ?
18. Calculate the gap in frequency between two longitudinal modes in a linear cavity whose optic length, L, = 250 mm.
19. The spontaneous lifetime of the sodium level leading to a D1 line (λ = 589. 1nm) is 16 ns. Find the natural line width Full width half maximum, $\Delta\lambda$?

(4 × 3 = 12 weightage)

C 2064 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 12—ELECTRONIC INSTRUMENTATION

(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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

(8 short questions answerable within 7.5 minutes)

Answer **all** *questions.*

Each question carries a weightage of 1.

1. Explain parameters control the execution time of instruction as well as programs in a microprocessor.
2. What is the principle of working of solid state scintillation detectors ?
3. What is the principle of working of a strain gauge ?
4. What is the significance of an oscilloscope probe ?
5. Briefly explain features of the IEEE 488 electrical interface.
6. How is triggering of an SCR achieved by phase shifting ?
7. Explain the working of a Bolometer.
8. Explain the function of optical time domain reflectometer.

(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. Using a schematic explain the working of a CRO.

10. Explain armature voltage control method for regulating the speed of a DC motor.

11. What is a function generator ? What are its capabilities ? What function generator controls are associated with it and enlist a few applications.

12. With a circuit diagram explain working of a Q meter and describe the methods of taking measurements using the instrument.

(2 × 5 = 10 weightage)

Section C

(7problems answerable within 15 minutes)

Answer any **four** *questions.*

Each question carries a weightage of 3.

13. A circuit tuned to a frequency of 1.5 MHz and having an effective capacitance of 150 pF. In this circuit, the current falls to 70.7 % of its resonant value. The frequency deviates from the resonant frequency by 5 kHz, What is the Q factor ?

14. A standard single mode fibre is to be characterised. The refractive index of the core is 1.44 and the relative refractive index difference is 10^{-3}. The fibre is to be used at 1.7 μ m and has the normalised frequency of 2. How large is the diameter of the core ?

15. A resistive strain gauge, G = 2.2, is cemented on a rectangular steel bar with the elastic modulus E = 205 × 106 KN/m^2, width 3.5 cm and thickness 0.55 cm. An axial force of 12KN is applied. Determine the change of the resistance of the strain gauge, Δ R, if the normal resistance of the gauge is R = 100 Ω.

16. The full scale reading of a 3 1/2 D digital voltmeter is 1000v. What is its resolution ?

17. What will be the frequency of output waveform of a square wave generator if R_2 = 1.16 R_1 and R = 10 KΩ and C = 1μF ?

18. A photodiode has a responsivity of 0.5 A/W at 850 nm. Find the efficiency of the detector.

19. What is the value of anode current of SCR. comprising two-transistor analogy with the gate current of 40 mA if the gain of PNP & NPN transistors are 0.3 & 0.4 respectively ?

(4 × 3 = 12 weightage)

C 2063 **(Pages : 2)** **Name**.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 11—MATERIALS SCIENCE

(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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

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

1. Define Point Imperfection and give examples.
2. Explain the importance of phase diagrams.
3. What is tunnelling current ?
4. Explain Top-down synthesis of materials.
5. Define ductile fracture.
6. Explain carbon nanotubes.
7. What is Binary phase diagram ?
8. Differentiate slip and twinning in solids.

(8 × 1 = 8 weightage)

Section B

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

9. Explain working and instrumentation of scanning electron microscope with the help of suitable diagrams.

10. Explain the phase diagrams of (i) Magnesium-Alumina System ; and (ii) Copper-zinc System with suitable diagrams.

11. Explain different type of fractures and explain the protections needed to prevent fracture.

12. Explain different type of dislocations and their properties.

(2 × 5 = 10 weightage)

Section C

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

13. Compute the line energy of dislocations in BCC iron. The Burgers vector in iron is ½ for <111> type. The shear modulus of iron is 80.2 GN m^{-2}.

14. A steel tank contains hydrogen at a constant pressure of 10 atm, with a vacuum outside. The hydrogen concentration at the inner surface of the tank is equal to 10 kg m^{-3}. The diffusion co-efficient of hydrogen in steel at room temperature is 10^{-9} m^2 s^{-1}. Calculate the rate at which hydrogen escapes through the wall of the steel tank, which has a thickness of 5 mm.

15. The length of a dislocation line between two pinning points is on an average equal to the reciprocal of the square root of the dislocation density in a crystal. Calculate the dislocation density in copper, work hardened to a stage where slip occurs at a shear stress of 35 MN m^{-2}.

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

17. A sample of glass has a crack of half-length 2 μm. The Young's modulus of the glass is 70 GN m^{-2} and the specific surface energy is 1 J m^{-2}. Estimate its fracture strength and compare it with its young's modulus.

18. At atmospheric pressure (pressure arbitrarily chosen), a material of unknown composition shows four phases in equilibrium at 987 K. What is the minimum number of components in the system ?

19. 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.

(4 × 3 = 12 weightage)

C 2060 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 08—ADVANCED 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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

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

1. With equation explain Wein's displacement law.
2. Explain radiation pressure.
3. Explain synchrotron radiation.
4. Define pulsating variables.
5. What is galaxy luminosity function ?
6. What is event horizon ?
7. Explain red shift.
8. What is the relation connecting period and luminosity ?

(8 × 1 = 8 weightage)

Section B

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

9. (a) State and explain Kirchhoff's laws regarding the formation of line spectra.
   (b) Explain Zeeman splitting
10. Briefly explain : (a) RV Tauri variables ; and (b) MIRA type variables.

Turn over

11. Explain the cosmological principle.

12. Write a note on Milkyway galaxy.

(2 × 5 = 10 weightage)

Section C

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

13. Calculate the frequency of the highest intensity radiation of a black body whose temperature is : (a) 6000 K ; and (b) 25000 K.

14. An object moves towards an observer with a velocity 1000 km/s. What will be the shift of the H_α line ?

15. Calculate the wavelength of radiations corresponding to photon energies of E = 13.6 eV, 10.2 eV, 3.4 eV and 1.8 eV. Deduce the frequencies of these photons.

16. Derive the equation for Thomson scattering cross-section for scattering of radiation for an electron.

17. Find the distance to the stellar system in which Type I Cepheids are observed to have

    (a) P = 40 days, m = +20.

    (b) P = 32, m = +15.

18. How can we relate gravity with Geometry ?

19. Write a note on gravitational waves.

(4 × 3 = 12 weightage)

C 2058 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4C 12—ATOMIC AND MOLECULAR SPECTROSCOPY

(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.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

(8 *Short questions answerable within 7½ minutes*)
Answer **all** *questions, each carry weightage* 1.

1. Explain spin-orbit coupling.
2. Iron could not be heated with a Microwave oven. But microwave oven can be used to heat food materials. Why ?
3. Explain Born -Oppenheimer approximation.
4. What is Inverse Raman effect ?
5. Explain briefly the information one can get from vibrational analysis of electronic spectra.
6. Explain the factors responsible for the hyperfine structure in ESR spectra.
7. What is isomer shift ? Explain with an example.
8. Explain Larmour precession. What is Larmour frequency ?

(8 × 1 = 8 weightage)

Section B

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

9. Discuss the theory of Zeeman effect and Explain Stark effect on one electron system.
10. Explain the basic principle of Non-linear Raman effect and Hyper Raman effect.

Turn over

11. (a) Discuss Franck Condon Principle.

    (b) Explain fortrat parabola, dissociation and pre dissociation energy.

12. Explain in detail :

    (a) Relaxation process in NMR.

    (b) Theory of Chemical shift with an example.

(2 × 5 = 10 weightage)

Section C

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

13. Electron spin resonance is observed for atomic hydrogen with an instrument operating at 9.5GHz. If the g value for the electron in the hydrogen atom is 2.0026, what is the magnetic field ? Bohr magnetron $\mu_B = 9.274 \times 10^{-24}$ J/K.

14. A Mossbauer nucleus Fe^{57} makes the transition from the excited state of energy 14.4 keV to the ground state. What is its recoil velocity ?

15. The band origin of a transition in C_2 is observed at 19378 cm^{-1} while the rotational fine structure indicates that the rotational constants in excited and ground states are respectively $B' = 1.7527\ cm^{-1}$ and $B'' = 1.6326\ cm^{-1}$. Estimate the position of the band head.

16. The first Stokes line in the rotational Raman Spectrum of $N^{14}N^{15}$ is observed at 11.5416 cm^{-1}. What is its B value ? Calculate its bond length.

17. Given that the spacing between the vibrational levels of a CO molecule is 8.45×10^{-2} electron volt and the reduced mass is 1.14×10^{-24} kg. Calculate the value of the force constant k of the bond in a CO molecule.

18. Calculate the wavelength separation between the two component lines which observed in the normal Zeeman effect. The magnetic field used is 0.4 weber/m^2 specific charge $= 1.76 \times 10^{11}$ Ckg^{-1} and $\lambda = 6000$Å.

19. What is the average period of rotation of HCl molecule if it is the in the $j = 1$ state? The internuclear distance of HCl is 0.1274 nm. Given the mass of hydrogen and Chlorine atom are 1.673×10^{-27}kg and 58.06×10^{-27}kg respectively.

(4 × 3 = 12 weightage)