UG/II/PHS/H/IV/18(New)

2018

PHYSICS

[Honours]

PAPER – IV

Full Marks : 90

Time : 4 hours

The figures in the right hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

[NEW SYLLABUS]

GROUP–A

Answer any two questions 15 × 2

1. (*a*) State D'Alembert's principle. Establish Lagranges' equation from D' Alembert's principle for a conservative, holonomic system. 1 + 5

(*b*) Two particles A and B having masses m_1 and m_2 respectively are moving in a two dimensional plane such that the distance between them remains constant.

(*i*) What is the number of degrees of freedom ?

(*ii*) Find the co-ordinates of centre of mass and the reduced mass.

(*iii*) Choose an appropriate set of generalised co-ordinates describing the dynamics of two particle system.

(*iv*) Set up Lagrange's equations of motion for these co-ordinates in absence of any applied field.

(*v*) Obtain solutions of these equation.

(*vi*) Give physical interpretation of each solution. 1 + 2 + 1 + 2 + 2 + 1

2. (*a*) What are the essential features of vector atom model. 2

(*b*) Explain, with a neat diagram, the doublet structure of Sodium lines. 3

(*c*) Explain LS coupling scheme for addition of angular momenta. What is jj coupling ? Why is it applicable only to heavy elements. 2 + 1 + 1

(*d*) What are Stokes and antistokes lines in Raman effect ? 2

(*e*) Why are the anti-stokes lines less intense that stokes line. The exciting line in an experiment is 5460A and that the stokes line is at 5520A. Find the wavelength of the antistokes line. 2 + 2

3. (*a*) Draw the circuit diagram of Wien-Bridge oscillator with OPAMP as an active element. Explain its operation. 2 + 4

(*b*) A Wien Bridge Oscillator is used for a frequency range 30 Hz to 3kHz. The variable capacitance has a range 50pF to 5000 pF.

Find out the resistance values required. If the resistance in the other arms are in the ratio 5 : 1, find out the gain of the amplifier. Deduce any formula used. 2 + 3

(*c*) Design a 4 bit shift register using *D* flip-flops and explain its operation. 2 + 2

4. (*a*) What are the process through which γ-ray interact with matter ? 3

(*b*) Explain the nature and origin of β ray spectrum. 2 + 2

(*c*) Explain how the conservation laws are hold in case of β-decay. 3

(*d*) Explain qualitatively that emission of *k* shell electron is more probable during photo-electric emission by γ-ray. 3

(*e*) Calculate the minimum energy required for pair-production. 2

GROUP –B

Answer any five questions : 8 × 5

5. (*a*) What are the advantages of using negative feedback over positive feedback in case of amplifier ? 2

(*b*) Draw a circuit diagram of a two stage RC coupled transistor amplifier and find the expression for mid frequency voltage gain. 1 + 2

(*c*) The mid band voltage gain of an RC coupled amplifier is 150. At frequencies of 100 Hz and 100 kHz, the gain fall to 75. Determine bandwidth. 3

6. (*a*) Derive the Euler's equation of motion for an ideal fluid. Hence device Bernoulli's equation. 2 + 3

(*b*) Find whether given $\vec{V}$ (Velocity) is a possible motion for an incompressible ideal fluid. 3

$$\vec{v} = -\frac{2xyz}{(x^2+y^2)}\,\hat{i} + \frac{(x^2-y^2)z}{(x^2+y^2)}\,\hat{j} + \frac{yz^2}{x^2+y^2}\,\hat{k}$$

7. (*a*) Using Hamilton's Canonical equations, derive the equation of motion of a particle moving in a force field in which the potential is given by

$V = -\frac{k}{r}$, where k is a positive constant.

Explain, whether energy and angular momentum is conserved or not in this motion. 3 + 2

(*b*) Define cyclic or ignorable co-ordinates. Show that the generalised momenta corresponding to cyclic co-ordinates are conserved. 1 + 2

8. (*a*) What is nuclear isomerism ? Explain with example. 2

(*b*) Describe Gamow's theory for decay of α particle from radioactive nuclei . 3

(*c*) What do you mean by fine structure of α-particle ? 3

9. (*a*) State the semi empirical mass formula for nuclear binding energy. 3

(*b*) What is Mass parabola ? How does mass parabola explain the stability of nuclei of same isobar. 1 + 2

(*c*) What is the value of electric quadrupole moment of $^{208}_{82}Pb$? 1

(*d*) Why $^{17}_{8}O$ is spontaneous neutron emitter when excited by preceding β–decay ? 1

10. (*a*) Explain the difference between the spontaneous and the stimulated emissions. 3

(*b*) What do you mean by Enistein's *A*, *B* coefficients ? Show that the ratio

$$\frac{A}{B} = \frac{8\pi h\nu^3}{c^3}$$

where the symbols used having their usual significance. 1 + 3

(*c*) Find the value of Lande *g*-factor for *S*-state. 1

11. (*a*) For the electronic transition $^1D_2 \rightarrow {}^1P_2$

(*i*) Draw the energy level diagram and show Zeeman splitting of the energy levels in the presence of a magnetic field.

(*ii*) Show allowed transitions

(*iii*) How many distinct lines are obtained in the Zeeman Spectrum. (2 + 2) + 2 + 1

(*b*) State Moseley's law of X-ray. 1

12. (*a*) What are the differences between combinational logic and sequential logic ? 2

(*b*) Design a 4 to 1 multiplexer using basic gates. 2

(*c*) "FET is a voltage controlled device whereas BJT is a current controlled device explain. 2

(*d*) Draw the transfer characteristic curve of an *n*-channel JFET and explain the nature of curve. 2

GROUP – C

Answer any five questions : 4×5

13. Two masses m_1 and m_2 rest on a smooth surface. A spring of negligible mass and spring constant k and of length to at rests joins the masses. Assuming the motion to remain one dimensional calculate (*i*) the normal frequency and (*ii*) normal co-ordinate. $2 + 2$

14. Show that

$$Q = \log\left(\frac{1}{q}\sin p\right)$$

and $p = q \cot p$ is a canonical transformation. Find the generating function. $2 + 2$

15. Prove that if the dynamical variables f and g are constant of motion, then their Poisson Bracket is also a constant of motion. 4

16. (*a*) What is continuous and characteristics X-ray spectrum.

(*b*) Find the critical voltage that must be applied to an X-ray tube to excite the *k*-series of copper. Given that *k*-absorption limit is 1·38A. 2 + 2

17. What are tuned amplifiers ? What are their practical uses ? Draw the circuit diagram of a single tuned RF transistor amplifier. Draw the nature of its frequency response curve. 1 + 1 + 1 + 1

18. (*a*) Draw an inverter circuit using MOSFET.

(*b*) Draw a single bit digital comparator using basic gates. 2 + 2

19. A radioactive sample has its half-life equal to 60 days. Calculate its

(*i*) disintegration constant

(*ii*) average life

(*iii*) time for $\frac{1}{4}$ of the original number of atoms to remain unchanged. 1 + 1 + 2

20. Suppose a sinusoidal signal $V_S = 10 \sin 2000 \pi t$ is applied to the input of the given OP-AMP circuit with $R = 1\ M\Omega$ and $C = 1\ \mu F$. Find the output voltage and draw its waveform. 4