**Sem-5 Honours Examination, 2020**

**Tutorial Examination**

**Sub – PHSA Paper - DSE-A1(Advanced Mathematical Methods)**

**FM - 15**

## Group – A : Linear Algebra and Vector Space - 5 marks

**Answer any one from the following.**

1. (a) Show that, $a \circ b = a + b - ab$ $(a, b \in Z)$ is a binary operation which is commutative and associative. 3

   (b) Suppose the mapping F: $R^2 \rightarrow R^2$ is defined by F (x, y) = (x + y, x). Show that F is linear (homomorphism). 2

2. Let F: $R^2 \rightarrow R^2$ is defined by F (x, y) = (4x + 5y, 2x - y).

   (a) Find the matrix representing F in the basis $S = \{u_1, u_2\} = \{(1,4), (2,9)\}$ 4

   (b) Find the matrix representation of F relative to the (usual) basis $E = \{e_1, e_2\} = \{(1,0), (0,1)\}$ 1

## Group –B : Tensors - 5 marks

**Answer any one from the following.**

3. (a) Let *Q* is a tensor of contravariant ranks *i, j* and covariant rank *k*. Consider another tensor *P* with contavariant rank *i* and covariant rank *s*. Verify whether their product is a tensor. 3

   (b) Write down the metric tensor of a coordinate system *(p,q,r)* which is related to cartesian coordinates by $x=qr, y=rp, z=pq$ . 2

4. (a) Prove that symmetry is an intrinsic property of a tensor independent of the choice of coordinate system. 3

   (b) Show that the contravariant and the covariant components of a vector are identical in cartesian coordinate system. 2

## Group –C : Group theory - 5 marks

**Answer any one from the following.**

1. (a) State the condition to be obeyed by a group *H* to be a subgroup of another group *G*. 2.5

   (b) What is a cyclic group ? 2.5

2. How many subgroups of a group *G* will have if the order of *G* is a prime? Will *G* be an abelian group? 3+2

**Sem-5 Honours Examination, 2020**

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**Sub – PHSA**

**Paper - DSE-A1(Laser and Fibre Optics)**

**FM – 15**

1. (a) Explain the process of optical pumping. 3

   (b) How does the output power of LASER vary with the level of excitation below and above the LASER threshold ? 2

2. (a) Draw the stability diagram of an optical resonator. 3

   (b) What is cavity lifetime ? 2

3. (a) How does the Rayleigh scattering loss in an optical fiber vary with space wavelength ? 1

   (b) Explain the phenomenon of pulse dispersion. 4

**SEM 5 PHSA DSE B1 – NUCLEAR PHYSICS (TUTORIAL)**

**F.M: 15**

*Answer Q 1. and **any five** from the rest*

1. a) Show that drift tube length of LINAC is proportional to square root of natural numbers.

b) Calculate the maximum energy of protons obtainable from a cyclotron having dees of diameter 1.2 meter each and 1.5 Wb/$m^2$ magnetic induction. At what frequency must the cyclotron be operated? If the average energy gain per dee passage is 50 KeV, how many revolutions do the photon make?

2+3

or

Explain why following processes are **not** allowed?

$i)\ p \to \pi^0 + e^+$

$ii) p + \pi^0 \to \bar{p} + \pi^+ + \pi^+$

$iii) n \to p + e^-$

$iv) e^- \to \nu_e + \gamma\left(photon\right)$

$v) \Xi^- \to n + \pi^-$

1+1+1+1+1

2. Explain briefly why free quarks are not observed in nature? 2

3. A member of the $\Sigma$ group of particles consists of two up quarks and one s quark. What is its charge?

Identify the particle. 1+1

4. What is the basic principle of synchrotron? 2

5. Check whether LF (lepton family) number is violated in the decay $\mu^- \to e^- + \bar{\nu}_e + \nu_\mu$ 2

6. Name a particle with non zero strangeness. Is it a good quantum number under all fundamental interaction? 2

7. A nucleus with mass number A=235 splits into two spherical fragments whose mass numbers are in the ratio 3:2. Find the separation between the centres of the fragments at the time of splitting. Given: nuclear radius parameter $R_0$ = 1.3 fm. 2

8. Show that pair production cannot take place in vacuum. 2

SEM 5 DSE (ASTRO PHYSICS)-TUTORIAL

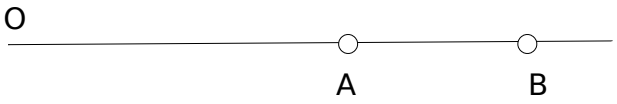
Answer ***any three*** questions .

F.M. =15

1. A galaxy has a red shift z = 0.02. What is its distance if we adopt Hubble's constant $H_0$ to be

$20 kms^{-1}$ / Mly

2. Two galaxies A and B, moving with velocities $v_A$ and $v_B$ respectively relative to the observer O, and are at distances $d_A$ and $d_B$, respectively, from the observer as shown below. The galaxies A and B follow the Hubble law when observed from O. Show that the galaxy follows the Hubble law when observed from A.




3. When a quasar has red shift of 4.5 how fast it is moving away and how far away it is. Hubble constant $H = 6.5 \times 10^4$ $ms^{-1}$./Mpc.

4. Suppose, two stars of apparent magnitudes $m_1$ and $m_2$ are at the distances $d_1$ and $d_2$ respectively. Calculate the difference between the absolute magnitude of the stars.

5. Apparent magnitude of the Sun is $m^e$ = -26.81. Calculate the absolute magnitude of Sun. Given, 1 AU = $1.50 \times 10^8$ km; 1pc = $3.09 \times 10^{16}$ m.

6. We are given mass of proton $m_p = 1.67 \times 10^{-27}$ kg, universal gravitational constant G = $6.673 \times 10^{-11}$ $m^3/s^2kg$, Planck constant h = $6.62 \times 10^{-34}$ Js, speed of light c= $3 \times 10^8$m/s. Calculate the Chandrasekhar limit.