FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION FOR
RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT, 2015

Roll Number

APPLIED MATHEMATICS, PAPER-I

TIME ALLOWED: THREE HOURS	**MAXIMUM MARKS = 100**

NOTE: (i) Attempt **ONLY FIVE** questions in all, by selecting **THREE** questions from **SECTION-I** and **TWO** questions from **SECTION-II. ALL** questions carry **EQUAL** marks.
(ii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
(iii) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
(iv) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
(v) Extra attempt of any question or any part of the attempted question will not be considered.
(vi) **Use of Calculator is allowed.**

SECTION-I

Q. No. 1 **(a)** Prove that $(\vec{A}+\vec{B})\cdot(\vec{B}+\vec{C})\times(\vec{C}+\vec{A}) = 2[\vec{A}\cdot(\vec{B}\times\vec{C})]$. **(10)**

(b) If $\vec{A}=(x-3y)\hat{i}+(y-2x)\hat{j}$, evaluate $\oint_c \vec{A}.d\vec{r}$ where c is an ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ in the xy- plane traversed in the positive direction. **(10)**

Q. No. 2 **(a)** Determine the expression for divergence in orthogonal curvilinear coordinates. **(10)**
(b) Determine the unit vectors in spherical coordinate system. **(10)**

Q. No. 3 **(a)** A particle moves from rest at a distance "*a*" from a fixed point *O* where the acceleration at distance *x* is «$x^{-\frac{5}{3}}$. Show that the time taken to arrive at *O* is given by an equation of the form $t = A\frac{a^{\frac{4}{3}}}{\sqrt{«}}$, where *A* is a number. **(10)**

(b) Three forces *P*, *Q*, *R* acting at a point, are in equilibrium, and the angle between *P* and *Q* is double of the angle between *P* and *R*. Prove that $R^2 = Q(Q-P)$. **(10)**

Q. No. 4 **(a)** *AB* and *AC* are similar uniform rods, of length *a*, smoothly joined at *A*.*BD* is a weightless bar, of length *b*, smoothly joined at *B*, and fastened at *D* to a smooth ring sliding on *AC*. The system is hung on a small smooth pin at *A*. Show that the rod *AC* makes with the vertical an angle $\tan^{-1}\frac{b}{a+\sqrt{a^2-b^2}}$. **(10)**

(b) Find the centroid of the arc of the curve $x^{\frac{2}{3}}+y^{\frac{2}{3}}=a^{\frac{2}{3}}$ lying in the first quadrant. **(10)**

Q. No. 5 **(a)** A hemispherical shell rests on a rough inclined plane whose angle of friction is ª. Show that the inclination of the plane base to the horizontal cannot be greater than $\sin^{-1}(2\sin$ ª$)$. **(10)**

(b) A regular octahedron formed of twelve equal rods, each of weight *w*, freely jointed together is suspended from one corner. Show that the thrust in each horizontal rod is $\frac{3}{2}\sqrt{2}w$. **(10)**

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SECTION-II

Q. No. 6 **(a)** A particle is moving with uniform speed *v* along the curve $x^2 y = a(x^2 + \frac{a^2}{\sqrt{5}})$. **(10)**

Show that its acceleration has the maximum value $\frac{10v^2}{9a}$.

(b) Discuss the motion of a particle moving in a straight line if it starts from rest at a distance *a* from a point *O* and moves with an acceleration equal to « times its distance from *O*. **(10)**

Q. No. 7 **(a)** Prove that the force field **(10)**

$F = (y^2 - 2xyz^3)i + (3 + 2xy - x^2 y^3)j + (6z^3 - 3x^2 yz^2)k$

is conservative, and determine its potential.

(b) The components of velocity along and perpendicular to the radius vector form a fixed origin are respectively ªr^2 and «¯^{2}. **(10)**

Find the polar equation of the path of the particle in terms of *r* and ¯.

Q. No. 8 **(a)** A particle is projected horizontally from the lowest point of a rough sphere of radius *a*. After describing an arc less than a quadrant, it returns and comes to rest at the lowest point. Show that the initial speed must be $(\sin\sim)\sqrt{\frac{2ag(1+«^2)}{(1-2«^2)}}$, **(10)**

Where « is the coefficient of friction and *a*~ is the arc through which the particle moves.

(b) The law of force is Mu^2 and a particle is projected from or apse at distance *a*. Find the orbit when the velocity of the projection is $\frac{\sqrt{M}}{a^2}$. **(10)**