



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

Roll Number

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

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 **(10)**
acceleration at distance x is $\sim x^{-\frac{5}{3}}$. Show that the time taken to arrive at O is given

by an equation of the form $t = A \frac{a^{\frac{4}{3}}}{\sqrt{\sim}}$, where A is a number.

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

Q. No. 4 (a) AB and AC are similar uniform rods, of length a , smoothly joined at A . BD is a **(10)**
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 $\tan^{-1} \frac{b}{a + \sqrt{a^2 - b^2}}$.

(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 **(10)**
 $\}$. Show that the inclination of the plane base to the horizontal cannot be greater than $\sin^{-1}(2 \sin \}$.

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

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SECTION-II

- Q. No. 6** (a) A particle is moving with uniform speed v along the curve $x^2y = a(x^2 + \frac{a^2}{\sqrt{5}})$. (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 $\frac{1}{5}$ times its distance from O . (10)
- Q. No. 7** (a) Prove that the force field (10)
 $F = (y^2 - 2xyz^3)i + (3 + 2xy - x^2y^3)j + (6z^3 - 3x^2yz^2)k$
 is conservative, and determine its potential.
- (b) The components of velocity along and perpendicular to the radius vector from a fixed origin are respectively $\frac{1}{r^2}$ and $\frac{1}{r^2}$. (10)
 Find the polar equation of the path of the particle in terms of r and θ .
- 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 $(\sin \alpha) \sqrt{\frac{2ag(1 + \mu^2)}{(1 - 2\mu^2)}}$, (10)
 Where μ is the coefficient of friction and α 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 (10)
 the orbit when the velocity of the projection is $\frac{\sqrt{M}}{a^2}$.