# FEDERAL PUBLIC SERVICE COMMISSION

**COMPETITIVE EXAMINATION FOR**
**RECRUITMENT TO POSTS IN BS-17**
**UNDER THE FEDERAL GOVERNMENT, 2014**

**Roll Number**

## APPLIED MATHEMATICS, PAPER-I

| TIME ALLOWED: THREE HOURS | MAXIMUM MARKS: 100 |
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**NOTE:(i)** Candidate must write **Q.No.** in the **Answer Book** in accordance with **Q.No.** in the **Q.Paper.**
**(ii)** Attempt **FIVE** questions in all by selecting **THREE** questions from **SECTION-A** and **TWO** questions from **SECTION-B. ALL** questions carry **EQUAL** marks.
**(iii)** No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
**(iv)** Extra attempt of any question or any part of the attempted question will not be considered.
**(v)** **Use of Calculator is allowed.**

## SECTION-A

**Q. No. 1.** **(a)** prove that $curl(¤\vec{F}) = (grad¤)$ x $\vec{F}$. If $\vec{F}$ is irrotational and $¤(x, y, z)$ is a scalar function. **(10)**

**(b)** Determine whether the line integral: **(10)**
$\int_c (2xyz^2 dx + (x^2 z^2 + zCosyz)dy + (2x^2 yz + yCosyz)dz$ is independent of the path of integration? If so, then compute it from (1,0,1) to $(0, \frac{®}{2}, 1)$.

**Q. No. 2.** **(a)** State and prove Stoke's Theorem. **(10)**

**(b)** Verify Stoke's Theorem for the function $F = x^2 i - xy\, j$ integrated round the square in the plane z=0 and bounded by the lines x = y = 0, x = y = a. **(10)**

**Q. No. 3.** **(a)** Three forces act perpendicularly to the sides of a triangle at their middle points and are proportional to the sides. Prove that they are in equilibrium. **(10)**

**(b)** Three forces P, Q, R act along the sides BC, CA, AB respectively of a triangle ABC. Prove that, if P Sec A + Q Sec B + R Sec C = 0, then the line of action of the resultant passes through the orthocentre of the triangle. **(10)**

**Q. No. 4.** **(a)** Find the centroid of the surface formed by the revolution of the cardioide $r = a(1 + Cos¯)$ about the initial line. **(10)**

**(b)** A uniform ladder rests with its upper end against a smooth vertical wall and its foot on rough horizontal ground. Show that the force of friction at the ground is $\frac{1}{2}W \tan ¯$, where $W$ is the weight of the ladder and $¯$ is its inclination with the vertical. **(10)**

**Q. No. 5.** **(a)** Define briefly laws of friction give atleast one example of each law. **(10)**

**(b)** A uniform semi-circular wire hangs on a rough peg, the line joining its extremities making an angle of $45^o$ with the horizontal. If it is just on the point of slipping, find the coefficient of friction between the wire and the peg. **(10)**

## SECTION-B

**Q. No. 6.** **(a)** If a point P moves with a velocity $v$ given by $v^2=n^2(ax^2+2bx+c)$, show that P executes a simple harmonic motion. Find the center, the amplitude and the time-period of the motion. **(10)**

**(b)** A particle P moves in a plane in such a way that at any time t its distance from a fixed point O is $r= at+bt^2$ and the line connecting O and P makes an angle $^{-} = ct^{\frac{3}{2}}$ with a fixed line OA. Find the radial and transverse components of the velocity and acceleration of the particle at $t=1$. **(10)**

**Q. No. 7.** **(a)** A particle of mass m moves under the influence of the force $F = a(i\,Sin\,\mu\, t + j\,Cos\,\mu\, t)$. If the particles is initially at rest on the origin, prove that the work done upto time $t$ is given by $\frac{a^2}{m\mu^2}(1-Cos\,\mu\, t)$, and that the instantaneous power applied is $\frac{a^2}{m\mu^2}Sin\,\mu\, t$. **(10)**

**(b)** A battleship is streaming ahead with speed V, and a gun is mounted on the battleship so as to point straight backwards, and is set an angle of elevation $a$, if $v_o$ is the speed of projection relative to the gun, show that the range is $\frac{2v_o}{g}Sin\sim(v_oCos\sim - V)$. Also prove that the angle of elevation for maximum range is $arcCos\left(\frac{V-\sqrt{V^2-8v_0^2}}{4v_0}\right)$. **(10)**

**Q. No. 8.** **(a)** Show that the law of force towards the pole, of a particle describing the curve $r^n = a^n Cos\, n^{-}$ is given by $f = \frac{(n+1)h^2 a^{2n}}{r^{2n+3}}$. **(10)**

**(b)** A bar 2 ft. long of mass 10 Ib., lies on a smooth horizontal table. It is struck horizontally at a distance of 6 inches from one end, the blow being perpendicular to the bar. The magnitude of the blow is such that it would impart a velocity of 3 ft./sec. to a mass of 2 Ib. Find the velocities of the ends of the bar just after it is struck. **(10)**

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