FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT, 2012

APPLIED MATHS, PAPER-I

PART-II:

Time Allowed: 2 Hours & 30 Minutes　　　　Maximum Marks: 100

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) Use of Scientific Calculator is allowed.
(iv) Extra attempt of any question or any part of the attempted question will not be considered.

SECTION-A

Q.1: Explain the following: (5 x 4=20)
(a) Laplacian
(b) Simply and Multiply connected regions
(c) Directional derivatives
(d) Green's second Identity
(e) $\nabla\times\ \nabla\times\overline{A}\ =\nabla\ \nabla,\overline{A}\ -\nabla^2\,\overline{A}$

Q.2: (a) State and prove Gauss Divergence theorem. (10)
(b) Evaluate, $\iint_s \ \ \overline{r}\,\hat{n}\,dS$ (10)
Where S is the Surface of the ellipsoid.

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$$

Q.3: (a) 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: (10)

$$R^2 = Q(Q-P)$$

(b) Find the distance from the cusp of the centroid of the region bounded by the cardioide. (10)

$$r = a\,(1 + \cos\quad)$$

Q.4: (a) Find the centroid of the arc of the curve. (10)

$$x^{2/3}+y^{2/3}=a^{2/3}$$

Lying in the first quadrant.

(b) A uniform rod of weight *W* is placed with its lower end on a rough horizontal floor and its upper end against an equally rough vertical wall. The rod makes an angle   with the wall and is just prevented from slipping down by a horizontal force P applied at its middle point. (10)

Prove that,

$$P = W\tan(\quad - 2\lambda);\ \text{where } \lambda \text{ is the angle of friction } \lambda<\frac{1}{2}$$

Q.5: (a) Six equal uniform rods freely jointed at their extremities form a tetrahedron. If this tetrahedron is placed with one face on a smooth horizontal table. Prove that the thrust along the horizontal rod is $\frac{w}{2\sqrt{6}}$. Where W=weight of the rod. (10)

(b) Write expression for arc length, area and volume elements in orthogonal curvilinear coordinates.

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APPLIED MATHS, PAPER-II

Time Allowed: 3 hours — Maximum Marks: 100

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 TWO questions from SECTION-A and ONE question from SECTION-B and TWO questions from SECTION-C. All questions carry EQUAL marks.

(iii) Extra attempt of any question or any part of the attempted question will not be considered.

(iv) Use of Scientific Calculator is allowed.

SECTION-A

Q.1: Solve the following differential equations:

(a) $y''' - 3y'' + 2y' = \frac{e^x}{1+e^{-x}}$ (10)

(b) $y' = \frac{2xye^{x/y^2}}{y^2 + y^2 e^{x/y^2} + 2x^2 e^{x/y^2}}$ (10)

Q.2: (a) Find the series solution of the following differential equation:

$y'' - xy = 0$ (10)

(b) Use the method of Fourier integrals to find the solution of initial value problem with the partial differential equation.

$$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2} \quad ; \quad (-\infty < x < \infty)$$

And with initial condition $u(x, 0) = f(x)$ (10)

Q.3: (a) Solve $x^2y'' - 3xy' + 5y = x^2 \sin(\ln x)$ (10)

(b) Find the solution of wave equation

$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ with boundary and initial conditions

$u\ 0,t\ = u\ l,t\ = 0,\ u\ x,0\ = f(x),\ \frac{\partial u\ x,t}{\partial t} = g(x)$ (10)

SECTION-B

Q.4: Discuss the following terms: (5x4=20)

(i) Tensors (ii) Kronecker delta (iii) Contraction (iv) Metric Tensor

(v) Contravariant tensor of order two

Q.5: (a) Prove that $\begin{matrix} i \\ ij \end{matrix} = \frac{\partial}{\partial x^i} \log\sqrt{g}$ (10)

(b) Prove that (10)

$$\Delta = \begin{vmatrix} \delta_{m1} & \delta_{m2} & \delta_{m3} \\ \delta_{n1} & \delta_{n2} & \delta_{n3} \\ \delta_{p1} & \delta_{p2} & \delta_{p3} \end{vmatrix} = \in_{mnp} \ and \in_{ijk} = \begin{vmatrix} \delta_{mi} & \delta_{mj} & \delta_{mk} \\ \delta_{ni} & \delta_{nj} & \delta_{nk} \\ \delta_{pi} & \delta_{pj} & \delta_{pk} \end{vmatrix}$$

Hence prove that $\in_{ijk} \in_{mnp} = \delta_{im}\ \delta_{jn} - \delta_{in}\ \delta_{\partial jm}$