**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) $\nabla\times\ \nabla\times\overline{\text{A}}\ =\nabla\ \nabla,\overline{\text{A}}\ -\nabla^2\ \overline{\text{A}}$

Q.2: (a) State and prove Gauss Divergence theorem. (10)

(b) Evaluate, $\iint_s \quad \overline{r}\,\hat{n}\,dS$ (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)

$$R^2 = \text{Q}(\text{Q} - \text{P})$$

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

$$\text{r} = \text{a}\ (1 + \cos\quad)$$

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,

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

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.

# FEDERAL PUBLIC SERVICE COMMISSION

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

**Roll Number**

## APPLIED MATHS, PAPER-II

| **TIME ALLOWED: THREE 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) $y''' - 3y'' + 2y' = \dfrac{e^x}{1+e^{-x}}$ **(10)**

(b) $y' = \dfrac{2xye^{(x/y)^2}}{y^2 + y^2e^{(x/y)^2} + 2x^2e^{(x/y)^2}}$ **(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.

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

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

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

$u(0,t) = u(l,t) = 0$, $u(x,0) = f(x)$, $\dfrac{\partial u(x,t)}{\partial t} = g(x)$ **(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 $\left\{\begin{matrix} i \\ ij \end{matrix}\right\} = \dfrac{\partial}{\partial x^i}(\log\sqrt{g})$ **(10)**

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

Hence prove that $\in_{ijk}\in_{mnp} = \delta_{im}\delta_{jn} - \delta_{in}\delta_{jm}$ **(10)**

# APPLIED MATHS, PAPER-II

## SECTION-C

**Q. 6.** (a) (i) What is the difference between secant and false position method? Show also graphically. **(5+5=10)**

(ii) Prove that $x_{n+1} = x_n - \dfrac{f(x_n)}{f^2(x_n)}$

(b) Solve the following system by Jacobi method. (Up to four decimal places).

8x + y – z = 8
2x + y + 9z = 12
x – 8y + 12z = 35

**Q. 7.** (a) Evaluate by $\frac{3}{8}$ Simpson's rule **(10)**

$\int_0^3 x\sqrt{1+x^2}\,dx$ ; with n = 6

Also calculate the absolute error.

(b) The amount *A* of a substance remaining in a reacting system after an interval of time *t* in a certain chemical experiment is given by following data:

| | | | | |
|---|---|---|---|---|
| *A*: | 94.8 | 87.9 | 81.3 | 68.7 |
| *t*: | 2 | 5 | 8 | 14 |

Find *t* when *A*=80. **(10)**

**Q. 8.** (a) If $f(x) = x^3$, show that $f$(a,b,c) = a + b + c **(10)**

(b) Solve by trapezoidal rule

$\int_0^{2\pi} x\sin x\,dx$ ; with $n = 8$ **(10)**

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