



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 $\oint_c \vec{A} \cdot d\vec{r}$ 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 $\frac{3}{2}\sqrt{2}w$.

APPLIED MATHEMATICS, PAPER-I

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 (10)

at the lowest point. Show that the initial speed must be $(\sin \alpha) \sqrt{\frac{2ag(1 + \mu^2)}{(1 - 2\mu^2)}}$,

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 $\frac{\sqrt{M}}{a^2}$.



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APPLIED MATHEMATICS, PAPER-II

TIME ALLOWED:
THREE HOURS

MAXIMUM MARKS: 100

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

SECTION-A

- Q. No. 1.** (a) Solve the initial value problem. (10)

$$\frac{dy}{dx} + \frac{y}{2x} = \frac{x}{y^3}, y(1) = 2$$

- (b) Solve $y'' - 4y' + 4y = e^{2x}$ (10)

- Q. No. 2.** Solve the following equations: (10)

(a) $(1 - x^2) \frac{d^2y}{dx^2} - 2x \frac{dy}{dx} + 2y = 0$

(b) $\frac{d^3y}{dx^3} + \frac{dy}{dx} = \cos ecx$ (10)

- Q. No. 3.** (a) Classify the following: (5 each) (10)

(i) $x^2 U_{xx} + (a^2 - y^2) U_{yy} = 0$, $-\infty < x < \infty, -a < y < a$

(ii) $U_{xx} - 6U_{xy} + 9U_{yy} + 3y = 0$

- (b) Solve (10)

$$\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2} \quad 0 < x < 5$$

$$u(0, t) = u(5, t) = 0$$

$$u(x, 0) = x^2(x - 5)$$

$$u_t(x, 0) = 0$$

SECTION-B

- Q. No. 4.** (a) Prove that if A_i and B_j are two first order tensors, then their product (7)

$A_i B_j (i, j = 1, 2, 3)$ is a second order tensor.

- (b) If $W(x_1, x_2, x_3)$ is a scalar point function then $\frac{\partial W}{\partial x_i}$ are the components of a first (7)
- order tensor.

- (c) Find the invariant of the following second order tensor (6)

$$\begin{bmatrix} 2 & 4 & -1 \\ 6 & -7 & 10 \\ 3 & -4 & 6 \end{bmatrix}$$

APPLIED MATHEMATICS, PAPER-II

- Q. No. 5. (a)** Verify that the transformation (7)

$$x'_1 = \frac{1}{15}(5x_1 - 14x_2 + 2x_3)$$

$$x'_2 = -\frac{1}{3}(2x_1 + x_2 + 2x_3)$$

$$x'_3 = \frac{1}{15}(10x_1 + 2x_2 - 11x_3)$$

Is orthogonal and right handed. A vector field \vec{A} is defined in the system

$$Ox_1x_2x_3 \text{ by } A_1 = x_1^2, A_2 = x_2^2, A_3 = x_3^2$$

Evaluate the components A'_j of the vector field in the new system $Ox'_1x'_2x'_3$.

- (b)** Prove that any second order tensor A_{ij} can be written as the sum of a deviator and an isotropic tensor. (7)

- (c)** If $a_{ij} = a_{ji}$ are constants. Calculate. (6)

$$\frac{\partial^2}{\partial X_k \partial X_m} (a_{ij} X_i X_j)$$

SECTION-C

- Q. No. 6. (a)** Find the real root of the equation by using Newton – Raphson's method. (10)

$$3x - \cos x - 1 = 0$$

- (b)** Solve the following system of equations by Gauss-Seidel method. (10)

Take initial approximation as $x_1 = 0, x_2 = 0, x_3 = 0$. Perform 3 Iterations.

$$20x_1 + x_2 - 2x_3 = 17$$

$$3x_1 + 20x_2 - x_3 = -18$$

$$2x_1 - 3x_2 + 20x_3 = 25$$

- Q. No. 7. (a)** Find the real root of the equation $x^3 - 4x - 9 = 0$ by Regular falsi method. Take the interval of the root as (2,3) and perform 4 iterations. (10)

- (b)** Find a polynomial which possess through the following points: (10)

$$\begin{array}{l} x: \quad -1 \quad 0 \quad 1 \quad 2 \\ f(x): 2 \quad 1 \quad 2 \quad 5 \end{array}$$

- Q. No. 8. (a)** Use the langrage's Interpolation formula to find the value $f(12)$ if the values of x and $f(x)$ are given below (10)

$x:$	5	7	11	13
$f(x)$	150	392	1452	2366

- (b)** Evaluate $\int_0^3 x\sqrt{1+x^2} dx$ using $\frac{1}{3}$ Simpson's rule and trapezoidal rule for $n = 6$ (10)
