ALLAMA IQBAL OPEN UNIVERSITY, ISLAMABAD

(Department of Science Education)

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All questions are compulsory and carry equal marks, but within a question, the marks are distributed according to its requirements.

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Course: MATHEMATICS-I (6446)
Level: B.ED (2.5/4 Years) **Semester: Spring 2026**
Total Marks: 100 **Passing Marks: 50**

ASSIGNMENT No. 1

(Units: 1–4)

Q1. Find the vector equation and the corresponding parametric equations of a straight line passing through the point $\boldsymbol{A}(\mathbf{2}, -\mathbf{1}, \mathbf{4})$ and moving parallel to the line segment connecting the points $\boldsymbol{P}(\mathbf{3}, \mathbf{5}, -\mathbf{2})$ and $\boldsymbol{Q}(-\mathbf{1}, \mathbf{4}, \mathbf{6})$, and then determine if the point $\boldsymbol{R}(-\mathbf{6}, -\mathbf{3}, \mathbf{20})$ lies strictly on this derived line. **[20 Marks]**

Q2. Using pure vector and scalar dot product methods, prove the classical geometric **Law of Cosines** for any oblique triangle $\Delta\boldsymbol{ABC}$ (establishing that $\boldsymbol{c}^2 = \boldsymbol{a}^2 + \boldsymbol{b}^2 - 2\boldsymbol{abcosC}$, and apply this law to find the internal angle $\boldsymbol{B}$ of a triangle whose vector vertices are positioned at $\boldsymbol{A}(\mathbf{1}, \mathbf{0}, \mathbf{2}), \boldsymbol{B}(\mathbf{3}, -\mathbf{1}, \mathbf{5})$, and $\boldsymbol{C}(\mathbf{0}, \mathbf{4}, \mathbf{1})$. **[20 Marks]**

Q3. Given three spatial vectors $\boldsymbol{a} = 2\boldsymbol{i} - \boldsymbol{j} + \boldsymbol{k}$, $\boldsymbol{b} = \boldsymbol{i} + 2\boldsymbol{j} + 3\boldsymbol{k}$, and $\boldsymbol{c} = 3\boldsymbol{i} + \boldsymbol{\mu}\boldsymbol{j} + 5\boldsymbol{k}$, determine the exact scalar value of $\boldsymbol{\mu}$ that the vectors are coplanar, and using that calculated value of $\boldsymbol{\mu}$, evaluate the vector triple product $\boldsymbol{a} \times (\boldsymbol{b} \times \boldsymbol{c})$. **[20 Marks]**

Q4. Find the complete scalar equation of the plane that passes through the three distinct, non-collinear spatial points $\boldsymbol{P_1}$**(1, 2, 3)**, $\boldsymbol{P_2}$**(3, 2, -1),** and $\boldsymbol{P_3}$ **(-1, 0, 4),** and subsequently compute the shortest perpendicular distance from an external point **Q(4, 5, 6)** to this newly established plane. **[20 Marks]**

Q5. A dynamic particle moves smoothly through three-dimensional space with an instantaneous acceleration vector at any scalar time $\boldsymbol{t}$ given by $\boldsymbol{a(t) = 12t\,i - Sin(t)j + 2e^{t}k}$; find the particle's definitive position vector $\boldsymbol{r(t)}$ at any time $\boldsymbol{t}$, given the initial boundary constraints that its velocity vector $\boldsymbol{v(0) = i + 2j}$ is and its position vector $\boldsymbol{r(0) = 3k}$ is at time $\boldsymbol{t = 0}$. **[20 Marks]**

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ASSIGNMENT No. 2

(Units: 5–9)

Q1. Given a scalar field $\boldsymbol{\phi(x,y,z) = 3x^2y - y^3z^2}$and a vector velocity field $V(\boldsymbol{x,y,z}) = \boldsymbol{x^2z\,i - 2y^3z\,j + xy^2z^2\,k}$**,** calculate the directional derivative of $\boldsymbol{\phi}$ at the point $\boldsymbol{P(1,-2,-1)}$ in the direction of the vector $\boldsymbol{A = 2i\} - j - 2k}$ and subsequently evaluate the divergence of the **curl** $(\boldsymbol{\nabla \cdot (\nabla \times V)}$)at the same point to prove it satisfies the fundamental identity of vector calculus. **[20 Marks]**

Q2. Derive the complete dimensional formulas and standard SI units for the physical quantities of linear momentum, angular velocity, torque, and kinetic energy, and use fundamental physical laws to analytically demonstrate that the time rate of change of linear momentum of a particle yields the exact dimensions and units of a force vector as governed by Newton's Second Law of Motion. **[20 Marks]**

Q3. State and rigorously prove the $(\boldsymbol{\lambda,\mu})$ **Theorem** for a system of two concurrent forces acting along the lines joining a point to two other points, and apply this theorem to a triangle. $\boldsymbol{\Delta ABC}$ **w**here a point $\boldsymbol{P}$ divides the base segment $\boldsymbol{BC}$ internally in the ratio $\boldsymbol{3:2}$ to find the resultant of the vector forces representing and $\boldsymbol{2\overrightarrow{AB}}$ and $\boldsymbol{3\overrightarrow{AC}}$ in terms of the position vector line $\boldsymbol{\overrightarrow{AP}}$. **[20 Marks]**

Q4. Define an idealized mechanical couple, prove analytically that the algebraic sum of the moments of the two constituent forces forming a couple is completely constant about any arbitrary point in their plane, and use this property to find the magnitude and location of a single resultant force that can perfectly replace a system of three parallel forces of $\boldsymbol{10N, -15N, and\ 25N}$ acting perpendicularly along a rigid beam at distances of $\boldsymbol{0\ m, 2\ m\ and\ 5\ m}$ respectively from a fixed origin point. **[20 Marks]**

Q5. A heavy uniform block of mass $\boldsymbol{M = 40kg}$ rests in a state of limiting equilibrium on a rough horizontal surface characterized by a coefficient of static friction $\boldsymbol{\mu_S = 0.35}$; find the exact minimum force $\boldsymbol{P}$ required to initiate sliding if the force is applied upwards at an angle $\boldsymbol{\theta}$ relative to the horizontal plane, and mathematically determine the optimum angle $\boldsymbol{\theta}$ at which this pulling force reaches its absolute numerical minimum. **[20 Marks]**