B-5/2110
STATICS-III
SEMESTER-III
(SYLLABUS DECEMBER-2019)

TIME ALLOWED 3 Hrs M.M 40

NOTE: The candidates are required to attempt two questions each from Section A & B. Section C will be compulsory.

SECTION-A

I State and prove theorem of resolved parts. (6)

II (a) If the greatest possible resultant of two forces acting at a point is n times the least, show that the angle between them when their resultant is half their sum is $\cos^{-1}\left[-\frac{n^2+2}{2(n^2-1)}\right]$ (3)

II (b) Let ABC be an equilateral triangle and E, F be the middle points of the sides CA and AB. Forces of magnitude 4, P, 2, P and Q kg weight act at A in the direction of the lines BC, BE, CA, CF and AB respectively. If the system is in equilibrium, find the values of P and Q. (3)

III (a) Six coplanar forces act on a rigid body along the sides AB, BC, CD, DE, EF and FA of a regular hexagon ABCDEF of side 1 unit of magnitude 10, 20, 30, 40, P and Q units respectively. Find P and Q so that the system reduces to a couple. Also find the moment of the couple. (3)

III (b) Three forces acting at a point are parallel to the sides of a triangle ABC, taken in order and their magnitudes are proportional to the cosines of the opposite angles. Show that magnitude of their resultant is proportional to $\sqrt{1-8\cos A\cos B\cos C}$ (3)

IV (a) Two like parallel forces $\vec{P}$ and $\vec{Q}$ acts at two points of a body. If Q be changed to $\frac{P^2}{Q}$, show that the line of action of the resultant is same as it would be if the forces are simply interchanged. (3)

IV (b) If two forces acting on a rigid body intersect at a point, then prove that the algebraic sum of the moments of the forces about any point in their plane is equal to the moment of their resultant about that point. (3)

SECTION-B

V(a) State and prove Lami's theorem. (3)

V(b) A heavy rod AB whose centre of gravity divides it into two portions of lengths a and b is placed inside a smooth sphere. The rod subtends an angle of 2θ at the centre. Find the inclination of the rod to the vertical. (3)

VI (a) Prove that the centre of gravity of hollow right circular cone lies on its axis and divides it in the ratio 2 : 1 from the vertex. (3)

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VI (b) A solid hemisphere and a solid right circular cone have their bases joined together, the bases being of the same size. Find the semi-vertical angle of the cone so that centre of gravity of the combined body may be at the centre of the common base; two solids being made of the same material. (3)

VII Equal weights $\vec{W}$ and $\vec{W}$ are attached to two ends of a string passing over a smooth peg at O. The two portions of the string are separated by a heavy beam AB of weight $\overrightarrow{W'}$, whose centre of gravity is at a distance a from A and b from B. Show that AB is inclined to the horizontal at an angle $\tan^{-1}\left[\frac{a-b}{a+b}\tan\left(\sin^{-1}\frac{W'}{2W}\right)\right]$. (6)

VIII (a) A uniform ladder of weight $\vec{W}$ rests in limiting equilibrium with one end on a rough floor whose coefficient of friction is μ and the other end against a smooth vertical wall. Show that its inclination to the vertical is $\tan^{-1}(2\mu)$. (3)

VIII (b) How high can a particle rest inside a rough hollow sphere of radius a if the coefficient of friction is μ . (3)

SECTION-C

IX (a) Two forces $\vec{P}$ and $\vec{Q}$ acting at an angle 120°. The resultant $\vec{R}$ of these forces act in the direction perpendicular to $\vec{P}$. Find Q.

IX (b) Define couple

IX (c) State Varignon's Theorem.

IX (d) Let four forces of magnitudes P, P, P and 2P acts along sides DA, AB, BC and CD of a square ABCD. Find a point on AD such that the algebraic sum of moments of forces about it vanishes.

IX (e) State Laws of Dynamical Friction.

IX (f) State the Triangle theorem of moments.

IX (g) Let D, E and F be the mid-points of sides of a triangle ABC and G be its centroid. Prove that the forces $\overrightarrow{GD}, \overrightarrow{GE}$ and $\overrightarrow{GF}$ are in equilibrium.

IX (h) Define Centre of Gravity of a body.

$(2\times 8 = 16)$