國立成功大學

114學年度碩士班招生考試試題

編　號：90

系　所：工程科學系

科　目：工程力學

日　期：0211

節　次：第 1 節

注　意：1.可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

＊考生請注意：本試題可使用計算機。請於答案卷（卡）作答，於本試題紙上作答者，不予計分。工程力學共有4題，請詳細條列計算或推導過程。請考生將每題的答案（若有單位請包含單位）以方匡標註出來，以利批改考卷，謝謝!

1. A collar that slides along a vertical rod is subjected to the three forces illustrated. Find (a) the value of α that makes the resultant of the three forces horizontal, and (b) the magnitude of the resultant force under these conditions. (20%) (hint: $\sin^2\alpha+\cos^2\alpha=1$)

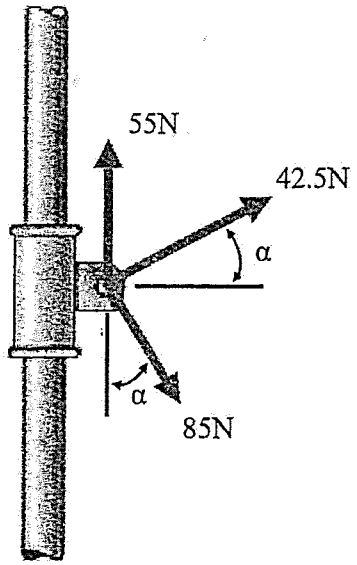

Fig.1

2. Determine the force in each member of the given truss using the method of joints. Indicate whether each member is experiencing tension or compression. (30%)

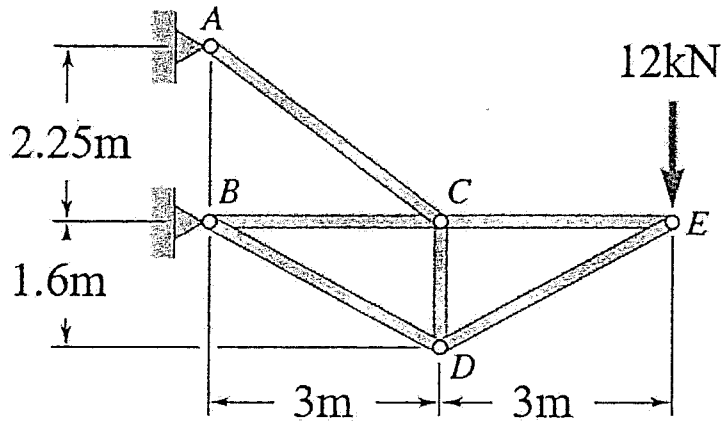

Fig.2

3.

(a)Consider a particle P, described by polar coordinates r and θ, moving in a plane under the influence of multiple forces (Fig. 3). Demonstrate how the forces acting on the particle can be resolved into radial and transverse components. (5%)

(b) Let particle P, with mass m, move with respect to a Newtonian reference frame Oxyz (Fig. 4). Prove that the angular momentum of the particle can be fully expressed by the scalar Ho. (10%)

(c) Show that the sum of the moments about point O of the forces acting on the particle is equal to the time rate of change of the particle's angular momentum (or moment of momentum) about O. (5%)

(d) If the only force acting on particle P is a central force **F** directed toward or away from a fixed point O (Fig. 5), prove that the angular momentum of the particle remains constant in both magnitude and direction. (5%)

(e) For a particle moving under the influence of a central force, demonstrate that its areal velocity remains constant. (5%)

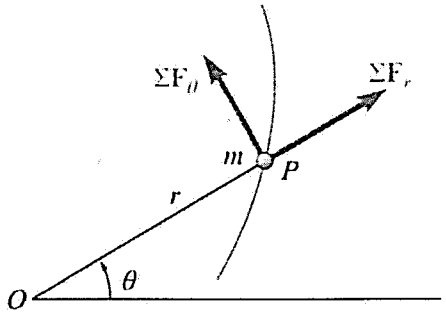

Fig. 3

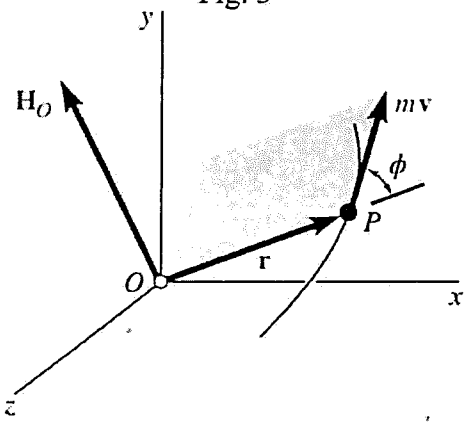

Fig. 4

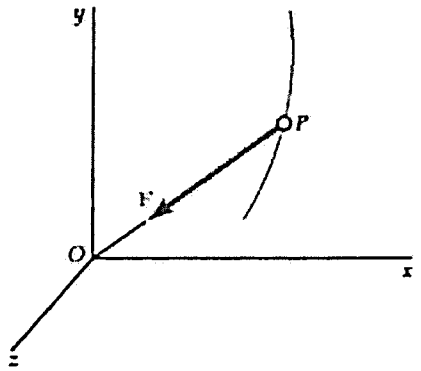

Fig. 5

4.Consider a rigid body rotating about a fixed axis AA'. Let P be a point on the body, and **r** represent its position vector relative to a fixed reference frame. Assume the reference frame is centered at point O on axis AA', with the z-axis aligned along AA' (Fig. 6). Let B be the projection of P onto AA'. Since P must remain at a constant distance from B, it traces a circular path with center B and radius r sinϕ, where ϕ is the angle between **r** and AA'.

(a) Derive the acceleration a of particle P, given by the expression:($\vec{a} = \vec{\alpha} \times \vec{r} + \vec{\omega} \times \vec{\omega} \times \vec{r}$, *where* $\vec{\alpha} \times \vec{r}$= tangential acceleration component, $\vec{\omega} \times \vec{\omega} \times \vec{r} =$ radial acceleration component) (10%)

(b) To describe the rotation of a rigid body about a fixed axis, analyze the motion of a representative slab located in a reference plane perpendicular to the axis of rotation. Let the xy-plane serve as the reference plane, coinciding with the plane of the figure, and assume the z-axis points out of the page (Fig. 7). Show the given relationship: $\mathbf{a} = \alpha\mathbf{k} \times \mathbf{r} - \omega^2\mathbf{r}$ (10%)

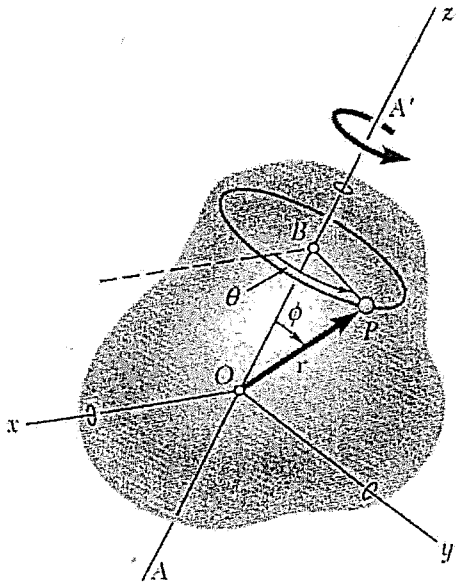

Fig. 6

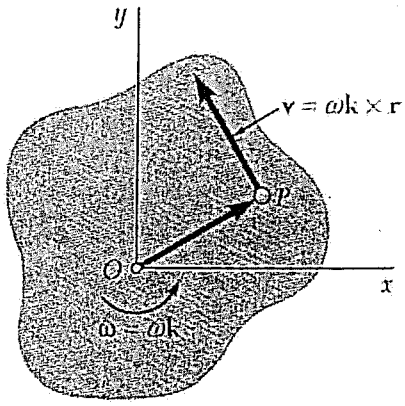

Fig. 7