First Semester Examination
2022/2023 Academic Session

February 2023

# EMM 101 – Engineering Mechanics
***(Mekanik Kejuruteraan)***

Duration: 3 hours
*(Masa: 3 Jam)*

Please check that this examination paper consists of FIVE (5) pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMA (5) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

**Instructions**: Answer ALL **FOUR (4)** questions.

*[**Arahan**: Jawab **EMPAT (4)** soalan]*

...2/-

1. (a) i. Figure Q1(a) shows three forces that are acting on a bracket. If $\phi$ = 30° and $F_1$ = 250 N, determine the magnitude of the resultant force acting on the bracket and its direction measured clockwise from the positive *x* axis.

ii. If the resultant force acting on the bracket is now to be directed along the positive *x* axis and the magnitude of $F_1$ is required to be a minimum, determine the magnitudes of the resultant force and $F_1$.

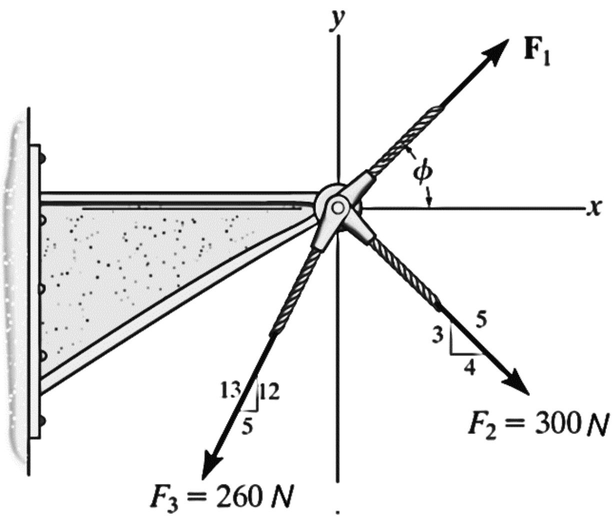


Figure Q1(a)

**(60 marks)**

(b) Figure Q1 (b) shows a hinge that is acting by a force with magnitude of 150 N at point D. Compute the equivalent force and moment acting at A in vector notation.

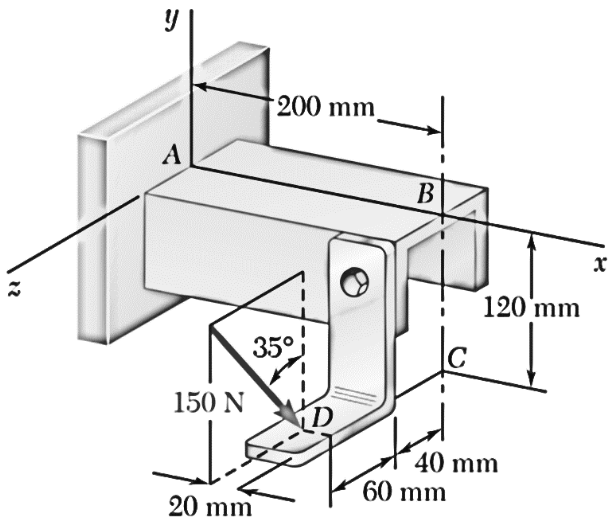


Figure Q1(b)

**(40 marks)**

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2. (a) Figure Q2 (a) shows the rod AB, which is supported by two cables BC, BD and a ball-and-socket connection at A.

   i. Draw the free body diagram of the assembly of Figure Q2 [a].

   ii. Determine the components of reaction at the ball-and-socket joint *A* and the tension in each cable necessary for equilibrium of the rod.

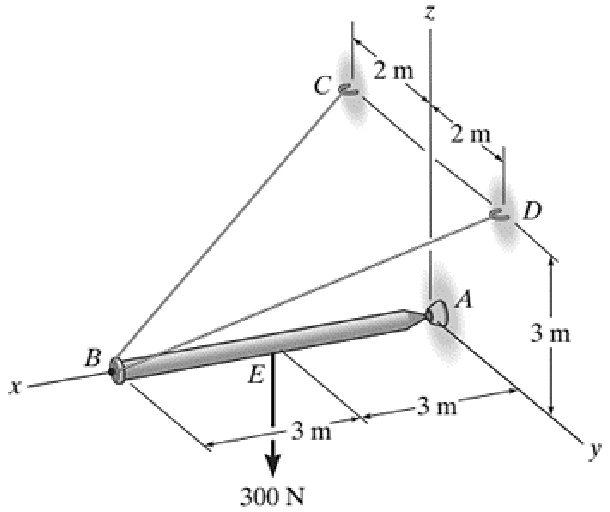


Figure Q2 (a)

**(60 marks)**

(b) Figure Q2 (b) shows the composite cross-sectional area of the C-shape beam.

   i. Determine the centroid $\bar{x}$ of the beam's cross-sectional area.

   ii. Determine the moment of inertia of the area about the centroidal *y'* axis.

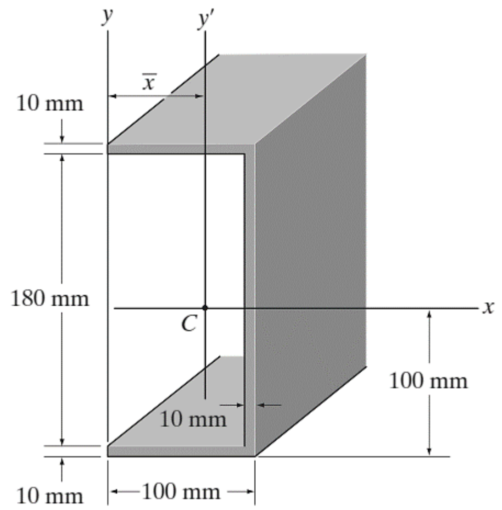


Figure Q2 (b)

**(40 marks)**

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3. (a) The truck shown in Figure 3 (a) is traveling at 90 km/h when the driver applies the brakes to come to stop. The deceleration of the truck is constant and the truck comes to a complete stop after braking for a distance of 100 m.

i. Determine the minimum coefficient of static friction between crate A and the truck bed so that the crate does not slide relative to the truck.

**(30 marks)**

ii. If the coefficient of kinetic friction between crate A and the bed of the truck is 0.3 and static friction is not sufficient to prevent slip, determine the minimum distance d between crate A and truck B so that crate A never hits the truck at B.

**(30 marks)**

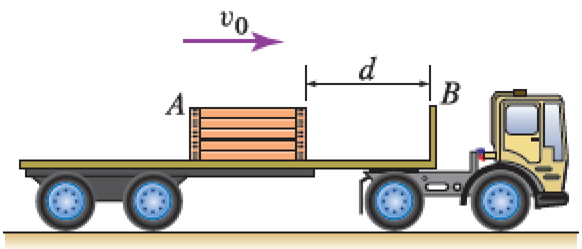


Figure 3 (a)

(b) Car bumpers are designed to limit the extent of damage to the car in the case of low-velocity collisions. Consider a 1500 kg car as shown in Figure 3 (b) impacting a concrete barrier while traveling at a speed of 6 km/h. If the type of bumper is a linear spring of constant *k* in parallel with a shock absorbing unit generating a nearly constant force of 3000 N over 8 cm, determine the value of *k* necessary to stop the car when the bumper is pre-compressed 8 cm.

**(40 marks)**

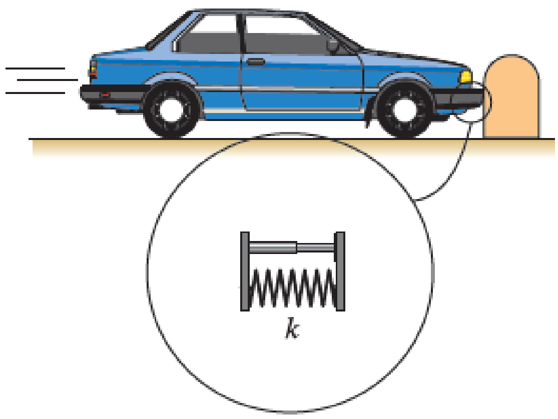


Figure 3 (b)

...5/-

4. (a) Figure 4 (a) shows a 0.347 kg ball rolling on an irregular and frictionless loop. The radius of curvature at the top of the loop (**T**) is $\rho$ = 1.4 m.

i. Determine the minimum speed of the ball required at point **T** such that it can stay on the loop.

ii. Determine the minimum initial velocity of the ball ($V_{initial}$) such that the ball could stay on the loop without falling.

iii. Determine the final velocity of the ball at location B if the initial velocity at A is $V_{initial}$ = 10 m/s.

iv. Determine the normal force N of the loop against the ball at T if the initial velocity at A is $V_{initial}$ = 10 m/s

**(60 marks)**

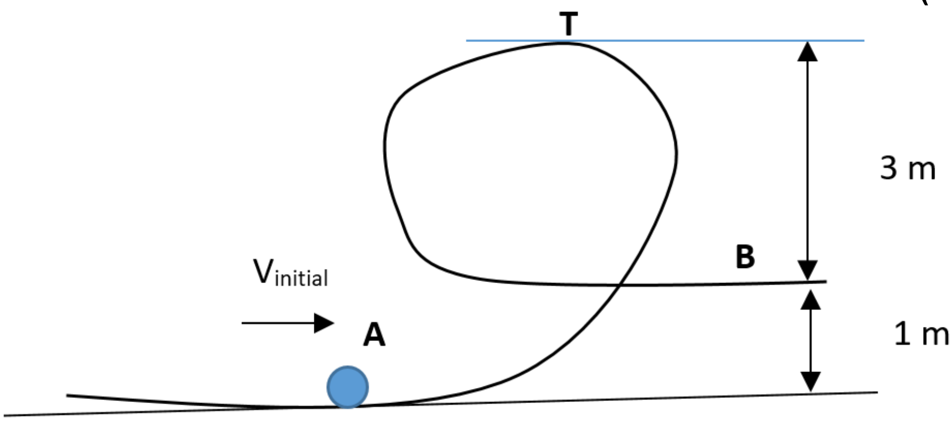


Figure 4 (a)

(b) Figure 4 (b) shows a girl throws a 0.6kg ball with a horizontal velocity of $v_1$= 2.4 m/s at height of 0.9m. If the coefficient of restitution between the ball and the ground is $e$= 0.8, determine:

i. The verticle velocity of the ball just after it rebounds from the ground

ii. The horizontal velocity of the ball just after it rebounds from the ground

iii. The maximum height ($h$) to which the ball rises after the first bounce.

**(40 marks)**

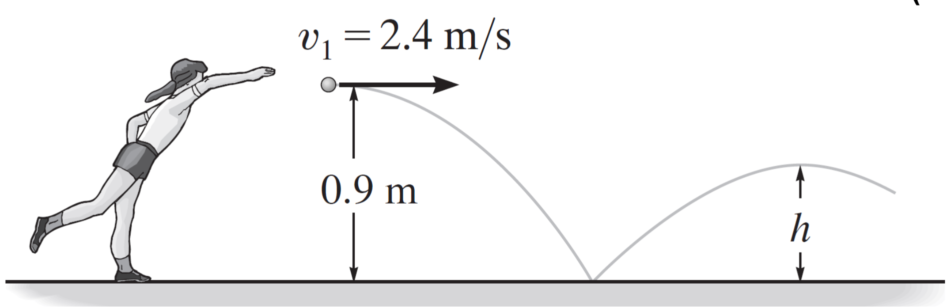


Figure 4 (b)

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