**注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。**

國立清華大學 110 學年度碩士班考試入學試題

系所班組別：動力機械工程學系
丙組(固體與奈微米力學組)

科目代碼：1301

考試科目：工程力學（含材力、靜力、動力）

## －作答注意事項－

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「▼ 由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

# 國立清華大學 110 學年度碩士班考試入學試題

系所班組別： 動機系 丙組

考試科目（代碼）： 工程力學(含材力、靜力、動力)(1301)



You might need to use the law of cosines in this exam: $c^2 = a^2 + b^2 - 2ab\cos\theta$, where $\theta$ denotes the angle between sides of length $a$ and $b$ and opposite the side of length $c$, to solve the Dynamics problem(s).

1. For the beam shown in Figure 1, answer the following questions:
   (1) (5 pts) determine the shear force and bending moment at point A.
   (2) (10 pts) draw the shear and bending-moment diagrams.
   (3) (5 pts) determine the maximum absolute value of the bending moment

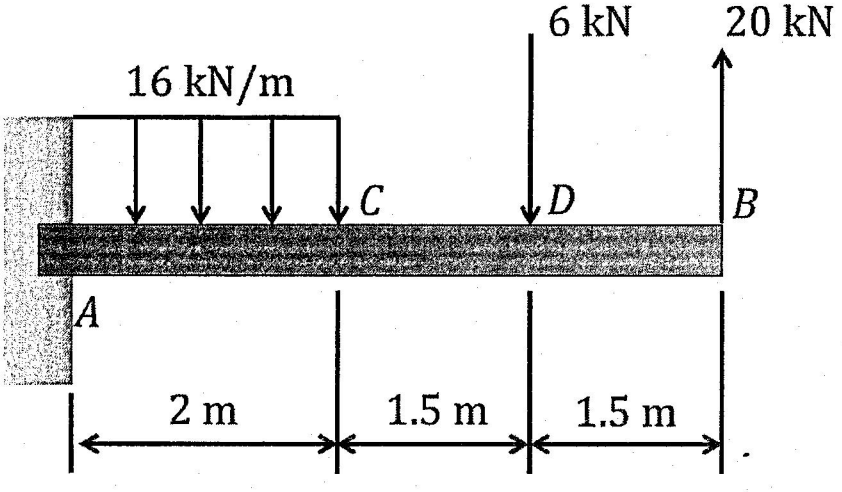


Figure 1. A beam structure under different loading.

2. The mechanism in Figure 2 consists of identical meshed gears $A$ and $B$ and arms are fixed to the gears. The spring attached to the ends of the arms has an unstarched length of $D$ = 12 cm and a stiffness $k$ = 280 N/m. A torque $M$ is applied to gear $A$ to yield an angular displacement $\theta$ through each arm ($a$ = 22 cm) rotates. The gears can be viewed as circles with radius $R = D/2$. Each gear is pinned to fixed supports at their centers.

   (1) (5 pts) draw the free body diagram of the gears.

   (2) (15 pts) determine the angular displacement $\theta$ in degrees for $M$ = 20 N·m.

# 國立清華大學 110 學年度碩士班考試入學試題

系所班組別： 動機系 丙組

考試科目（代碼）： 工程力學(含材力、靜力、動力) (1301)

 *請在【答案卷、卡】作答

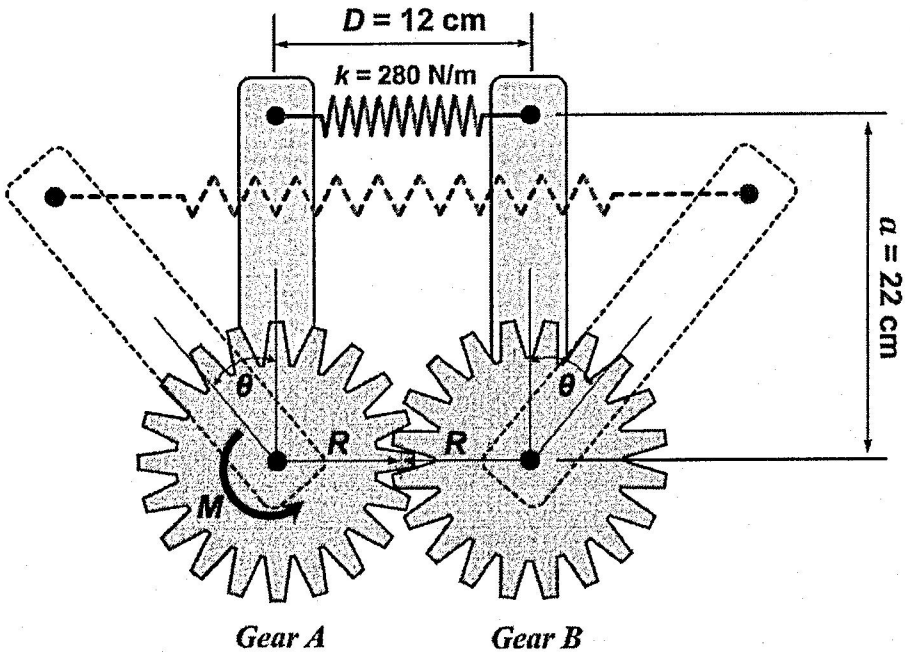


Figure 2. A gear mechanism.

3. As shown in Figure 3, member *ABCD* is supported by a pin and bracket at *C* and by an inextensible cord attached at *A* and *D* and passing over frictionless pulleys at *B* and *E*. Neglecting the size of the pulleys.

   (1) (10 pts) draw the free body diagram.

   (2) (10 pts) determine the tension in the cord.

   (3) (10 pts) determine the reaction at point *C*.

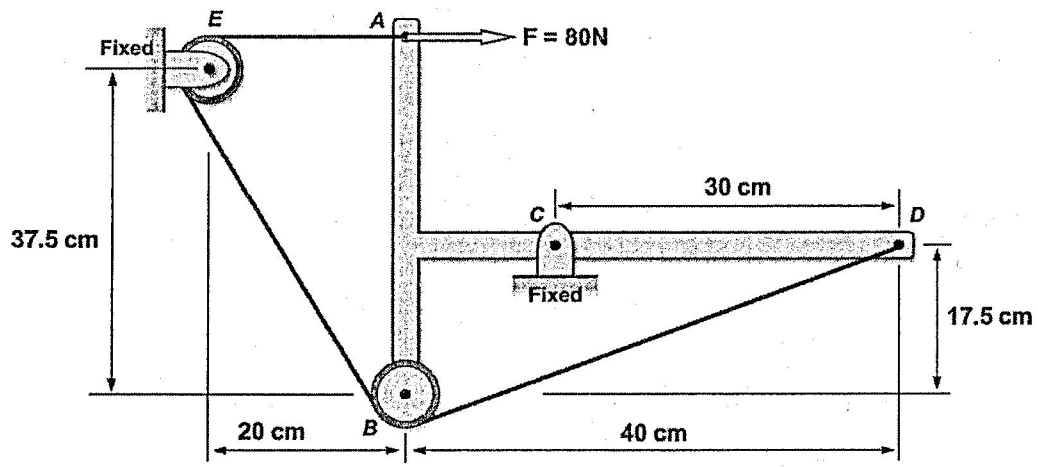


Figure 3. A mechanism including pulleys and cords.

4. An open-ended thin-wall cylinder with inner radius $r = 10$ m and thickness $t = 0.1$ m is subjected to an axial force $F$ and an internal pressure $P$ as shown in Figure 4. Let the normal stresses of a square element on the outer surface of the cylinder as shown in Figure 4 (left) be $\sigma_{x'} = 5000$ N/m$^2$ and $\sigma_{y'} = 15000$ N/m$^2$. Answer the following questions (assume the thin-wall is in plane stress condition):

   (1) (10 pts) Find the values of $P$ and $F$

   (2) (10 pts) Obtain the shear stress $\tau_{x'y'}$ and plot the Mohr circle.

   (3) (5 pts) Obtain the absolute maximum shear stress

   (4) (5 pts) Let Young's modulus $E = 30 \times 10^6$ N/m$^2$ and Poisson's ratio $\nu = 0.3$, find normal strains in the $x$ and $y$ direction

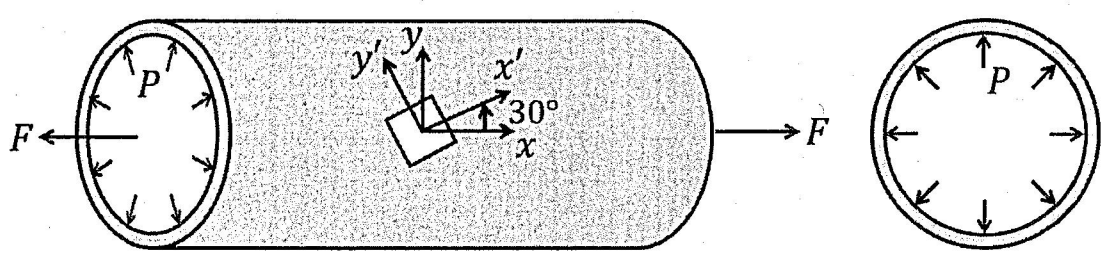


Figure 4. An open-ended thin-wall cylinder subject to an internal pressure and an axial load.

# 國立清華大學 110 學年度碩士班考試入學試題

系所班組別： 動機系 丙組

考試科目（代碼）： 工程力學(含材力、靜力、動力)(1301)



5. As shown in Figure 5, a 20-g bullet is fired at angle of 15° with the horizontal into a 4-kg wooden block and becomes embedded in it. Knowing that the block and bullet then move up the smooth incline of angle 15° for 1.5 seconds before they come to a stop, determine (1) the magnitude of the initial velocity $v_0$ of the bullet, (2) the magnitude of the impulse of the force exerted by the bullet on the block. (22 pts)

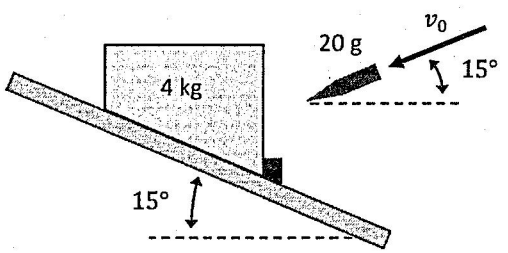


Figure 5. The bullet-block problem.

6. The motion of a uniform slender 2.4-kg rod $AB$ is guided at $A$ and $C$ by collars of negligible mass (Figure 6). The system is released from rest in the position $\theta = 45°$. Ignore the friction between components and determine the angular velocity $\omega$ of rod $AB$ when $\theta = 35°$. (28 pts)

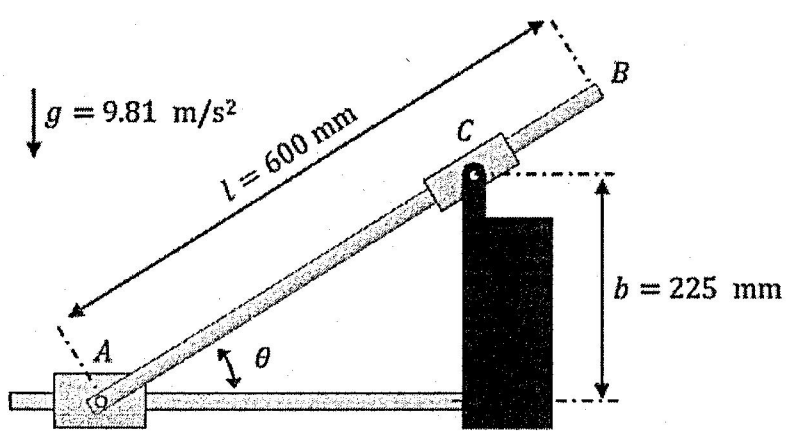


Figure 6. The guiding mechanism problem.