Technological University Dublin

# ARROW@TU Dublin

Technical Schools:Examination Papers

City of Dublin Technical Schools

1934

# Mathematics and Mechanics (2nd Year): Technical School Examinations 1934

Department of Education: Technical Instruction Branch

## Recommended Citation

# COURSES IN MECHANICAL ENGINEERING.

## AN ROINN OIDEACHAIS.
### (Department of Education.)

## BRAINSE AN CHEÁRD-OIDEACHAIS.
### (Technical Instruction Branch.)

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## TECHNICAL SCHOOL EXAMINATIONS.
### 1934.

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## MATHEMATICS AND MECHANICS.
### (Second Year.)

*Thursday, May 24th—7 to 10 p.m.*

*Examiner*—F. W. WARWICK, ESQ., B.A., B.E., A.R.C.SC.I.

*Co-Examiner*—PEADAR A. MACCIONNAITH, M.SC., A.C.SC.I.

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### GENERAL INSTRUCTIONS.

You are carefully to enter on the Answer Book and Envelope supplied your Examination Number and the subject of examination, but you are not to write your name on either. No credit will be given for any Answer Book upon which your name is written, or upon which your Examination Number is not written.

You must not have with you any book, notes or scribbling-paper, except the book of logarithms supplied to you.

You are not allowed to write or make any marks upon your paper of questions.

You must not, under any circumstances whatever, speak to or communicate with another candidate ; and no explanation of the subject of the examination may be asked for or given.

You must remain seated until your answer-book has been taken up, and then leave the examination-room quietly. You will not be permitted to leave before the expiration of twenty minutes from the beginning of the examination, and will not be re-admitted after having once left the room.

If you break any of these rules, or use any unfair means, you are liable to be dismissed from the examination, and your examination may be cancelled by the Department.

*Three hours are allowed for this paper. Answer-books, unless previously given up, will be collected at 10 p.m.*

## Instructions.

### Read the General Instructions on page 1.

(a) The working of the questions and the answers must be in *ink*.

(b) Diagrams and drawings must be made in *pencil*.

(c) Full credit cannot be obtained for any question unless all the calculations are shown clearly, and construction-lines definitely indicated.

Where calculations are made with the aid of the slide-rule, a note should be made in the margin, thus—(S.R.)

(d) *Seven* questions only may be attempted, *not* more than *four* being taken from either Section A or Section B. Equal values are assigned to the questions.

(e) Write the number of the question before the answer.

NOTE.—You are expected to make neat and correct diagrams. Books of logarithmic and trigonometrical tables (four places) are provided. You may use a slide-rule and drawing instruments.

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### SECTION A.

*(Not more than four of the seven questions you may attempt may be taken from this section.)*

1. A relation between the cutting speed $s$ feet per minute, the feed per rev. $f$ inch, the depth of cut $d$ inch and the tensile strength $T$ tons per sq. inch of the material cut is given by the formula :

$$s = \frac{(65-T)0\cdot2}{\sqrt[3]{f^2 \times d}}.$$

Transpose the equation to show the value of $d$ in terms of the other variables and find its value when $T=28$ tons per square inch, $f=\frac{1}{16}$ inch and $s=130$ feet per minute.

2. The work done, W foot-lbs., by one pound of dry steam expanding from a pressure of $p_1$ to $p_2$ lbs. per square inch is given by the formula :

$$W = \frac{n}{n-1} p_1 v_1 \left\{ 1 - \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} \right\}.$$

Find its value when $p_1=200$, $p_2=1$, $v_1=2\cdot29$ and $n=1\cdot135$.

3. In the case of a built-in beam uniformly loaded, the angle of slope $\theta$ at a distance $x$ from one support is given by the formula :

$$\theta = \frac{1}{EI}\left(\frac{wx^3}{6} + \frac{x^2}{2}A + xB\right).$$

If $\theta = 0$ when $x = l$ and E and I are both constant, find the value of B in terms of $w$, $l$ and A.

4. The displacement of a piston from the centre of its stroke is given by the equation :

$$x = r\left(\cos\alpha - \frac{1 - \cos 2\alpha}{4n}\right)$$

Where $\alpha$ is the angle which the crank makes with the inner dead centre.

If $r = 16$ and $n = 4$ calculate the values of $x$ when $\alpha$ has values $0°$, $30°$, $60°$ and $90°$.

Plot $x$ against $\alpha$ and from your graph, find the value of $\alpha$ when the piston is at the centre of its stroke.

5. The centres of four holes A, B, C and D in a jig are fixed by the following dimensions : AB = 4 ins., AD = $1\frac{1}{4}$ ins., BC = 3 ins., angle BAD = $90°$ and angle ABC = $75°$.

The lengths BD and DC are required for setting out. Calculate these and check your calculations by drawing.

6. The wheel of a motor is 36 inches diameter. What is its speed of rotation ($a$) in revolutions per minute ; ($b$) in radians per second, when the motor is travelling at 30 miles per hour ? How long does it take the wheel to rotate through an angle of one radian ?

7. The floors of two rooms are equal in area. One is 6 feet longer than the other. If one is 16 feet wide and the other 20 feet wide, what is the area of each floor ?

## SECTION B.

*(Not more than four of the seven questions you may attempt may be taken from this section.)*

8. A bracket crane, Figure 8, is supported by a footstep bearing at A and by a bearing at B which exerts only a horizontal force F.

When the crane carries a load of 3 cwt. in the position shown, find :

(a) the magnitude of F ;

(b) the magnitude and direction of the force acting at A.

9. Three forces : $\overrightarrow{OA} = 2$ tons, $\overrightarrow{BO} = 4$ tons and $\overrightarrow{CO} = 3$ tons act at the point O in the sense indicated. The directions OB and OC make respectively angles of 45° and 240° measured counter-clockwise with the direction OA.

Calculate (a) the components of each of the forces parallel and perpendicular to the direction OA ; (b) the components of the resultant in the same two directions; (c) the magnitude and direction of the resultant.

10. Calculate the weight of the cast iron bracket whose dimensions are given at Figure 10. Cast iron weighs 450 lbs. per cubic foot. Calculate also the distance of its centre of gravity from the face YY.

11. In a differential pulley block the diameter of the larger wheel is 9 inches and the diameter of the smaller 8 inches. Draw a sketch to show the arrangement. What is the velocity ratio of the machine ? If the efficiency is 80% what load can be raised by an effort of 50 lbs. ?

12. A lever ABC has its fulcrum at B. A load W is suspended from A at a fixed distance of one inch from B. A jockey weight of 4 lb. can slide along the arm BC.

When $W = 100$ lb. and the jockey weight is 15 inches from B the lever is in equilibrium. What is the moment of the lever about B ? If the lever weighs 10 lbs. where is its centre of gravity ?

13. A tie bar $\frac{3}{8}$ inch thick is required to carry a tensile load of 11 tons. What is its effective width if the tensile stress is limited to 8 tons per square inch ?

If a riveted lap joint occurs in this member, how many $\frac{3}{4}$ inch diameter rivets are required allowing a shearing stress of 5 tons per square inch ?

14. A form of cantilever truss is shown to scale at Figure 14. Obtain the nature and magnitude of the forces in the members when a load of 3 tons is suspended from its extremity.

# Courses in Mechanical Engineering, 1934
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*Note: The Diagrams are numbered to correspond with the questions to which they refer.*



8.



10.



14.