1933

Mathematics (3rd Year): Technical School Examinations 1933

Department of Education: Technical Instruction Branch

COURSES IN MECHANICAL ENGINEERING.

AN ROINN OIDEACHAIS.
(Department of Education.)

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

TECHNICAL SCHOOL EXAMINATIONS.
1933.

MATHEMATICS.
(Third Year.)

Friday, May 12th—7 *p.m.* to 10 *p.m.*

Examiner—THOMAS GORMLEY, ESQ., A.R.C.SC.I.

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

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 in your place 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 commencement 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*) You may attempt not more than *six* questions.

(*b*) Equal values are attached to the questions.

(*c*) Answers must be written in *ink*; diagrams may be drawn in *pencil*.

(*d*) Write the number of the question distinctly in the margin of your paper before the answer.

(*e*) Slide-rules, drawing instruments and tables may be used.

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1. A body is moving in a straight line, towards a fixed point, under the action of a variable force F. If s inches is the distance of the body from the fixed point, then $F=200/s^2$ lbs.

Find, using Simpson's rule, the work done, in inch-pounds, in moving the body from $s=12''$ to $s=4''$.

2. The efficiency n of a differential pulley block, when raising a load of W lbs., is

$$n=\frac{W}{aW+b}$$

where a and b are constants. If $n=0{\cdot}24$ when $W=57$ lbs., and $n=0{\cdot}36$ when $W=342$ lbs., find the values of the constants a and b. What is the efficiency of the machine when raising a load of 114 lbs.?

3. The height h feet reached in time t seconds by a jet of water projected vertically upwards from a nozzle is given by $h=vt-16t^2$ where v is the nozzle velocity of the jet in feet per second.

If v is 200 feet per second, calculate (without using the calculus) the greatest height reached.

Verify your answer by drawing a graph of h against t.

4. In the Otto Cycle the formula for finding the efficiency of the air standard is

$$E=1-\left(\frac{P_r}{P_m}\right)^{\frac{\gamma-1}{\gamma}}$$

Given $E=0{\cdot}384$, $P_r=14{\cdot}7$, $P_m=80$, find the value of γ.

5. If x is the common logarithm of a number, and y is the Naperian logarithm of the same number, find the value of c in the relationship $y=cx$.

The mean effective pressure P of steam in an engine cylinder is

$$P=P_1\left(\frac{1+\log_e r}{r}\right)-P_b.$$

Find P when $P_1=120$, $r=3$, and $P_b=24$. [$e=2{\cdot}718$].

6. For a triangle ABC write down, without proof, the value of $\tan\frac{1}{2}A$ in terms of the three sides and the semi-perimeter.

Three forces of 17·9 lbs., 14·6 lbs., and 12·4 lbs., respectively, acting outwards from a point, are in equilibrium. Find by calculation the angles between the lines of action of the forces.

7. Express, without proof, $\cos(A+B)$ in terms of sines and cosines of A and B. Hence find $\cos 2A$ in terms of $\cos A$.

In a steam engine mechanism the displacement x of the piston from its outer dead centre, when the crank revolves through an angle θ degrees, is

$$x=r(1-\cos\theta)+\frac{r^2}{4l}(1-\cos 2\theta).$$

Find the value of θ in the first quadrant when $x=0{\cdot}75$, $r=1$, and $l=6{\cdot}5$.

8. Plot the curve $y=\sin\theta+\frac{1}{2}\sin 4\theta$ from $\theta=0°$ to $\theta=90°$.

Find from the graph the values of θ when the curve has zero slope.

9. The following table gives the distance s centimetres moved in time t seconds by a body acted upon by an increasing force.

s	0	13	56	135	256	425	648	931	1280
t	0	2	4	6	8	10	12	14	16

From these values draw up tables and plot graphs of velocity (v) against t, and acceleration (f) against t.

Find from the latter graph the relation connecting f and t.