1933

Mathematics (4th 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.
(Fourth Year.)

Wednesday, May 31st—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 books, 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 beforethe 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*) 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. If r is the length of the crank, and l the length of the connecting rod, in a steam engine mechanism, prove that the displacement x of the piston from its outer dead centre, when the crank revolves through an angle θ, is given very approximately by

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

2. If $y=u/v$, where u and v are functions of x, find from first principles an expression for dy/dx in terms of u, v, du/dx and dv/dx.

A tank contains 20 cubic feet of water. Nitric acid of specific gravity 1·4 flows in at the rate of 3 cubic feet per minute. Find the rate of increase of the specific gravity of the liquid at the end of t minutes. What is the rate of increase when $t=5$?

3. Find from first principles the first derivative of $\sin x$.

A particle moves in a straight line, and at time t its distance from a fixed point O is given by $x=a\cos(nt+m)$ where a, n and m are constants. Prove that the acceleration at any time $=-n^2x$.

4. If y is the deflection at distance x from the centre of a simply supported beam, of length l, carrying a central load W, then

$$\frac{d^2y}{dx^2}=-\frac{W}{2EI}\left(\frac{l}{2}-x\right)$$

where E and I are constants. Express y in terms of x, given that $dy/dx=0$ when $x=0$, and $y=0$ when $x=\frac{1}{2}l$.

5. A circle of 6 feet diameter has a chord drawn at a distance $1\frac{1}{2}$ feet from the centre. Find by integration the area of the smaller segment so formed.

A cylindrical tank, 12 feet long and 6 feet in diameter, lies with its axis horizontal. Petrol is poured in to a depth in the centre of $1\frac{1}{2}$ feet. How many gallons of petrol are in the tank ?

6. Find by integration the volume, and the position of the centre of gravity, of a solid cone of height h, and diameter of base d.

7. Find the moment of inertia of a circular disc of mass m and radius r about an axis through the centre of the disc and perpendicular to its plane.

Hence find the moment of inertia of a sphere of mass M and radius R about a diameter.

8. A point F is distant $2a$ from a straight line PQ. V is the middle point of the perpendicular drawn from F to PQ. Taking V as the origin, and VF as the x axis, find the equation of the curve, every point on which is equidistant from point F and line PQ.

Show that the equation of the tangent to the curve at the point (x_1y_1) is $yy_1=2a(x+x_1)$.

9. Plot the graph of $y=\frac{1}{2}(e^x+e^{-x})$ for values of x from -1 to $+1$.

Name the curve so obtained. [$e=2{\cdot}718$].