# Mathematics, Mechanics and Technical Drawing (2nd Year): Technical School Examinations 1933

Department of Education: Technical Instruction Branch

# COURSE IN ELECTRICAL ENGINEERING.

## AN ROINN OIDEACHAIS.
### (Department of Education.)
### BRAINSE AN CHEÁRD-OIDEACHAIS.
### (Technical Instruction Branch.)

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## TECHNICAL SCHOOL EXAMINATIONS.
## 1933.

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## MATHEMATICS, MECHANICS AND TECHNICAL DRAWING.

### (Second Year.)

*Tuesday, May 30th—7 to 10 p.m.*

*Examiner*—R. G. ALLEN, ESQ., B.SC., A.R.C.SC.I., M.I.E.E.

*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, of which not more than *three* may be selected from Section A, *two* from Section B, and *two* from Section C. *Question No.* 11 must be one of the questions attempted. 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 of reasonable size. 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 three of the seven questions to be attempted should be taken from this section*).

1. Find the value of

(*a*) $\log \dfrac{B}{A} + \log \dfrac{A}{C}$ and

(*b*) $\log \dfrac{C}{A} - \log \dfrac{D}{A}$,

when B=4·57, C=1·39, and D=5·27.

2. Estimate the value of

$$24B^{1·6} + 6B^2$$

when B=8·49, and find the ratio of the first to the second term of the expression.

3. Describe two methods by which the area of any enclosed plane figure may be estimated. A horizontal base line AB of length 18 inches is divided into 12 equal parts. Vertical ordinates are drawn from the points of division beginning at A and ending at B to a curve above AB and their respective values are 18, 20, 24, 20, 18, 16, 14, 12, 9, 6, 5, 4, and 3 inches. Estimate the area of the figure bounded by the curve, AB, and the end ordinates. Also find the average value of the ordinates.

4. Two coils of wire are arranged in series and their combined resistance is 40 ohms. Combined in parallel their resistance is 6·4 ohms. Find the resistance of each coil.

5. Prove that cos A=sin (A+90°), and then show that Cos (*at*−60°)=sin (*at*+30°).

Also find the value of

$$40 \sin (at+45°)$$

at time *t*=0·0025 second, when *a*=314 radians per second.

6. The annual expense £P for a cable of certain length is

$$24a + \frac{6}{a}$$

Graph P against *a*, using a range of values between *a*=0·1 and 1·0, and find what value of *a* will make this expense a minimum.

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## SECTION B.

(*Not more than two of the seven questions to be attempted should be taken from this section*).

7. Make a sketch showing the main features of a screw-jack, and, neglecting friction, derive a formula for the mechanical advantage of the machine. Explain how the force of friction operates in this machine.

8. A train moves off from a station with a uniform acceleration of 2 miles per hour per second. Calculate its speed in miles per hour after 12 seconds, and if the total weight of the train is 110 tons, find its kinetic energy in foot-pounds at the end of the same interval.

9. Explain what is meant by the term *centrifugal force*. The cylindrical rotor of a turbo-alternator is not to be subjected to a greater centrifugal force than 2000 lb. wt. per pound of material. Estimate the largest radius the rotor can have for a speed of 1500 R.P.M.

## Section C.

*(Not more than two of the seven questions to be attempted should be taken from this section).*

10. Draw a free-hand sketch of *either*—

(a) An outline of the field magnet system of a four pole D.C. machine fitted with interpoles when used as (1) a generator, (2) a motor. The directions of the exciting currents, the polarities of the poles, and the direction of rotation should be clearly indicated.

*Or*

(b) A line diagram of a starter suitable for a large D.C. shunt wound motor showing overload and no-volt release devices.

11. On the accompanying sheet is shown a free-hand dimensioned sketch of an enclosed electromagnetic switch with its interior part shown through the surrounding iron shell. Draw to a suitable scale a sectional elevation through AB at right angles to the view shown. The letter *d* in the sketch represents diameter.

Ques. 11



$A$

$d = 1\frac{1}{2}''$

$\frac{1}{4}''$

$d = \frac{3}{4}''$

$\frac{1}{4}''$

$\frac{1}{2}''$

$d = 1\frac{1}{2}''$

$\frac{3}{8}$

$C$

$C$

$d = 1\frac{1}{4}''$

$d = 1\frac{3}{8}''$

$d = 2\frac{3}{8}''$

$d = 2\frac{3}{4}''$

EXCITING COIL CC

$3\frac{1}{2}''$

$d = \frac{1}{2}''$

$\frac{3}{8}$

$\frac{5}{8}''$

$\frac{1}{2}''$

$d = 2\frac{3}{8}$

$\frac{1}{4}''$

$2\frac{5}{8}''$

$\frac{3}{8}''$

ELEVATION

$B$