1933

Electrical Engineering (3rd Year): Technical School Examinations 1933

Department of Education: Technical Instruction Branch

COURSE IN ELECTRICAL ENGINEERING.

(53.)

AN ROINN OIDEACHAIS.
(Department of Education.)

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

TECHNICAL SCHOOL EXAMINATIONS.
1933.

ELECTRICAL ENGINEERING.
(Third Year.)

Wednesday, May 24th—7 *p.m. to* 10 *p.m.*

Examiner—PROFESSOR W. BROWN, B.SC., M.I.E.E.
Co-Examiner—J. P. HACKETT, ESQ., B.E., A.R.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.

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*) Not more than *seven* questions are to be attempted.

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

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

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

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1. Describe, with the help of a neat sketch, the construction and action of a milliammeter. A milliammeter, of 2·5 ohms. resistance, which gives its full scale deflection with 200 milliamperes, is to be used as a voltmeter (*a*) reading up to 5 volts, (*b*) reading up to 200 volts. Find the necessary resistance and power absorbed in each case.

2. Define the terms microhm, megohm, mho, and specific conductivity.

Find the conductivity of an aluminium bus-bar 20 feet long, 4 inches wide and 0·5 inch thick. The specific conductivity of aluminium is 61 per cent. of that of copper which is 58 × 10^4 mhos per cm. cube.

3. A coil carrying a current when placed in a magnetic field tends to set itself so that its axis is parallel to the lines of force of the field. Does this kind of action explain the working of a d.c. motor? Explain and give reasons.

4. Draw a typical half-loop of the B-H curve for iron and indicate on it the *coercive force, retentivity,* and *maximum induction.*

Find (1) the reluctance, (2) the magneto-motive force, (3) the magnetic force, (4) the ampere-turns required to produce a flux density of 6,000 lines per sq. cm. in an iron core with a mean length of magnetic path = 50 cms. and cross-sectional area = 30 sq. cms. The permeability of the iron being = 1,600.

5. A d.c. generator has an open circuit curve given by the following values:—

Field amperes ...	1	2	3	5	7	10	12	15
Open circuit volts	80	156	228	376	460	568	604	616

Find the open circuit voltage of the machine if the

resistance of the shunt circuit = 44 ohms. On full load, the terminal volts = 500; find the current out-put if the armature resistance = 0·08 ohm.

6. A 220 volt 7 H.P. motor has an armature resistance = 0·25 ohm. When running without load at 1,200 r.p.m. the armature takes 6 amperes. Find (*a*) the resistance to be joined in series with the armature in order to reduce the speed to 600 r.p.m. at the rated load of 30 amperes, (*b*) the power lost in the resistance, (*c*) the speed regulation of the motor. Neglect armature reaction.

7. An electric tramway system being practically a constant potential system, why are shunt motors not used on the cars?

To pull a tram car along 400 lbs. are required, which we may assume constant at all speeds. The motors are supplied with a total current of 65 amperes at 500 volts; the over-all efficiency of motors and gearing is 52 per cent. Find the speed at which the car will travel. [1 K.W. = 1·34 H.P.]

8. What kind of dynamo would you use to charge a battery of storage cells. Give reasons for your answer. A storage battery was charged for 6 hours with a steady current of 60 amperes at a mean P.D. = 120 volts. The battery then supplied a current of 65 amperes for 5 hours. If the mean P.D. of discharge was 105 volts, find the efficiency of the battery in (1) ampere-hours, (2) Watt-hours.

9. Power is transmitted over a distance of 850 yards to a 500 volt motor having an efficiency 93 per cent. The out-put of the motor is 95 B.H.P., and the power given to the line by the generator is 85 K.W. Find (1) the generator voltage, (2) the weight of copper required for the line. [Sp.res. of copper = 0·7 × 10^6 per inch cube. One cubic inch of copper = 0·32 lb.].

10. State the various losses which occur in a dynamo working at full load.

The eddy current loss in a dynamo is 900 watts when the total magnetic flux per pole = 3·2 × 10^6 lines and speed = 600 r.p.m. Find the loss when the flux = 4·6 × 10^6 and the speed = 900 r.p.m.

INSTRUCTION-.

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*) *Six* questions only may be attempted, of which not more than *four* may be taken from Section A. 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.

SECTION A.

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

1. Find the value of P from the equation,

$$P\left(1+\frac{m}{100}\right)^{x}=315x$$

when $x=6{\cdot}8$ and $m=5$. Also find which of the following values of x will give the greatest value of P,

$x=10$, 20, or 30

2. Given that $P_1=80\cos(A+30^\circ)$ and $P_2=80\cos(A-30^\circ)$, find the sum of P_1 and P_2 when $\cos A=0{\cdot}8$. Also show that

$$\tan A=\frac{\sqrt{3}\,(P_2-P_1)}{P_2+P_1}$$

3. Express each of the values (cos A—cos 3A) and (cos 3A—cos 5A) in terms of the product of two sines. Then find the sum of the series sin 2A+sin 4A+sin 6A+ ... to n terms.

4. Explain why the slope at a point on the flux-time curve for a coil threaded by a changing magnetic flux represents the induced E.M.F. in the coil at a time corresponding to the position of the point on the curve. If the flux threading a coil of 2,000 turns at time t is $\Phi\sin at$, Φ being $2{\cdot}5\times10^5$ lines of magnetic force, estimate the E.M.F. induced in the coil when at is equal to (a) 0, (b) $\frac{\pi}{3}$ radians, and (c) $\frac{\pi}{2}$ radians; and $a=300$.

5. Graph each of the three values e^{x}, e^{-x}, and $\frac{e^{x}+e^{-x}}{2}$ against values of x equal to 0, 0·4, 0·8, 1·2, 1·6, and 2·0. Find the slope of each curve at the point for $x=0$. The value of e is equal to 2·7183.

6. Prove that the differentiation of ax^n with respect to x is anx^{n-1}.

Differentiate with respect to x the value

$6x^9-7x^{-9}$.

7. Differentiate with respect to x

$6\sin 4x+8\cos. 4x$,

and integrate

$6(\sin^2 x)\,dx$.

8. The insulation resistance of a length of cable is,

$$240\int_{r}^{R}\frac{dx}{x}\text{ megohms.}$$

Estimate its value supposing R=4 and $r=1{\cdot}3$.

SECTION B.

9. Draw *free-hand* sketches of *either*—

(*a*) Two views of an automatic circuit-breaker;

or,

(*b*) Two main views of a large commutator spider showing how the copper segments are held together and fixed to the spider.