UNIVERSITY OF LONDON

B.Sc. (ENGINEERING) EXAMINATION 1963

PART II

for Internal and External Students

(15) ELECTRICAL ENGINEERING

Monday 17 June: 10 to 1

Attempt FIVE questions only.

1. The fraction β of the output of an amplifier of gain A is fed back in series with the input of the amplifier. What will be the resultant gain of the amplifier?
Explain what advantages are to be obtained from the use of negative feedback.
Describe a practical application making use of positive feedback.

2. From first principles show for a d.c. motor how
(*a*) the speed of rotation, and (*b*) the electromagnetic torque developed, depend on the flux per pole, the armature current, the resistance of the armature circuit, and the terminal voltage applied.
A d.c. series motor, having an armature resistance of 0·5 Ω and a field resistance of 0·2 Ω rotates at 750 rev/min when taking 30 A from a 440-V supply. Calculate the gross torque developed by the motor under these conditions.
If the field winding is shunted by a 0·4 Ω resistor, and the motor is loaded to take 45 A from the 440-V supply, calculate the new speed and torque. Assume that the flux per pole is proportional to the field current.

3. Explain the relative advantages of distributing electrical power by (*a*) direct current, and (*b*) three-phase alternating current.
Briefly discuss the factors upon which charges for electrical energy are based. Describe one type of supply tariff designed to take account of the power factor of a consumer's load.

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Turn over

4. Explain how a 3-phase synchronous motor may be made to operate with a leading power factor.
The total power supplied to a factory is 1200 kW, of which 1000 kW is taken at a lagging power factor of 0·8, the remaining 200 kW being taken by a synchronous motor.
Determine the kVA rating and the power factor of the synchronous motor if the overall power factor of the total electrical load is to be
(*a*) 1·0; (*b*) 0·9 lagging.
Explain which of these alternatives is likely to be the more economic.

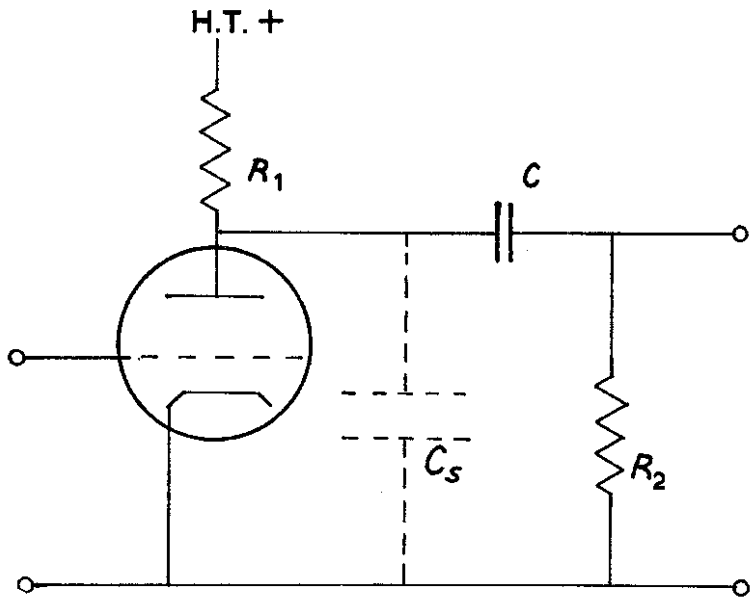
5. Explain how an autotransformer can be used for the starting of a 3-phase induction motor. Discuss the advantages and disadvantages of this method.
A 3-phase induction motor having a squirrel-cage rotor is to be started by means of a transformer giving 0·6 of normal voltage to the motor at starting. The transformer is star-connected and may be either
(*a*) an autotransformer, or
(*b*) a conventional 2-winding transformer.
If the two transformers have the same current density in all parts of the windings, and the same e.m.f. per turn and length per turn, compare the power loss in the windings for the two cases, stating any assumptions made.

6. Draw a vector diagram for a short single-phase transmission line loaded at the receiving end; the capacitance of the line is to be neglected.
Define the term *regulation* of the line.
Derive an expression for the regulation in terms of the current, the voltage and the phase angle of the load, and the constants of the line, stating any approximations made.
A load of 200 kW at 2 kV and power factor 0·707 lagging is supplied over a short line of total resistance 0·8 Ω and inductive reactance 4·0 Ω. Determine the sending end voltage of the line.

7. The effective series resistance and inductance of an electro-mechanical transducer are approximately 50 Ω and 10 mH at the operating frequency of 1 kc/s.
Draw a diagram of a bridge circuit for determining the resistance and the inductance of the transducer.
Derive the conditions for the bridge to be balanced. Suggest suitable values for the bridge components.

8. Define what is meant by a semi-conductor and explain carefully the difference between *n*-type and *p*-type semi-conductors.
Describe qualitatively the principle of operation of a junction diode and sketch the characteristic voltage/current curve.

9.



The figure shows an *RC* coupled amplifier using a triode with mutual conductance g_m and anode slope resistance r_a.

Draw (*a*) an equivalent circuit for the amplifier, and (*b*) approximate equivalent circuits for use at medium, high and low frequencies, justifying the approximations made. Hence derive an expression for the voltage gain of the amplifier at mid-frequency.

10. Discuss *two* of the following:

(*a*) a mechanical pressure transducer and its application;
(*b*) the modulation of an electrical signal;
(*c*) a simple integrating circuit and an example of its application;
(*d*) earth leakage protection.

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