

## SECTION A: ELECTRICAL MEASUREMENTS

Answer any **THREE** questions from this section.

1. (a) (i) State any **two** factors that affect equipment reliability.
- (ii) Sketch the curve of failure rate against time for an equipment and explain its shape.
- (8 marks)
- (b) Table 1 shows the mean time between failure (MTBF) for various units of an electronic equipment connected in series. For an operating period of 1,000 hours, determine the reliability of:
- (i) each unit;
- (ii) the equipment.
- (8 marks)

Table 1

Unit	MTBF (hrs)
Power supply	30,000
Pre-amplifier	100,000
Oscillator	60,000
Modulator	75,000
Power amplifier	40,000

- (c) A generator system designed for continuous operation fails three times in one year. If the total time to repair is 14 days, determine the:
- (i) mean time to repair (MTTR), in days;
- (ii) mean time between failure (MTBF), in days.
- (4 marks)

2. (a) (i) State any **two** advantages of MKS over CGS system of units.
- (ii) Show that one unit of charge (Q) in cgs electromagnetic units is equal to one unit of charge in MKS units.
- (8 marks)
- (b) Derive the dimensional expression for each of the following electrical quantities in the specified cgs units:
- (i) charge (Q) in e.s.u;
- (ii) magnetising force (H) in e.m.u.
- (12 marks)

3. (a) Describe the procedure of measuring the depth of modulation of an amplitude modulated (AM) wave using an oscilloscope with the internal timebase switched off and sketch the displayed waveform. (6 marks)
- (b) A spring controlled electrostatic voltmeter has a total capacitance of  $35.4\theta$  pF, where  $\theta$  is the angle of deflection of the movable plates. Determine the spring constant (in Nm/rad) of the voltmeter if 10 kV corresponds to a full-scale deflection of 100 degrees. (4 marks)
- (c) (i) State any **three** detectors used in a.c. bridges.
- (ii) Figure 1 shows a circuit diagram of an a.c. bridge.
- (I) Derive the bridge equation at balance.
- (II) Determine the value of  $R_1$  and  $L_1$ .

(10 marks)

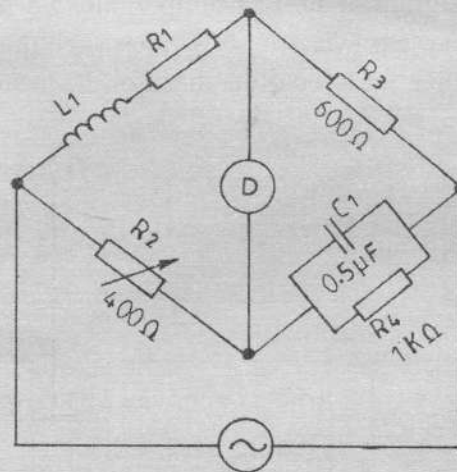


Fig. 1

- A. (a) State any **two**:
- (I) factors that may cause premature failure of capacitors;
- (II) precautions to be observed when handling and testing electronic components. (4 marks)
- (b) Figure 2 shows a circuit diagram of an amplifier.
- (i) Estimate the voltage at the test points  $TP_1$ ,  $TP_2$  and  $TP_3$  for each of the following faults:
- (I) resistor  $R_1$  open circuit;
- (II) transistor base-emitter junction short circuit.
- (ii) Explain the effect of an open circuit in capacitor  $C_3$ .

(10 marks)

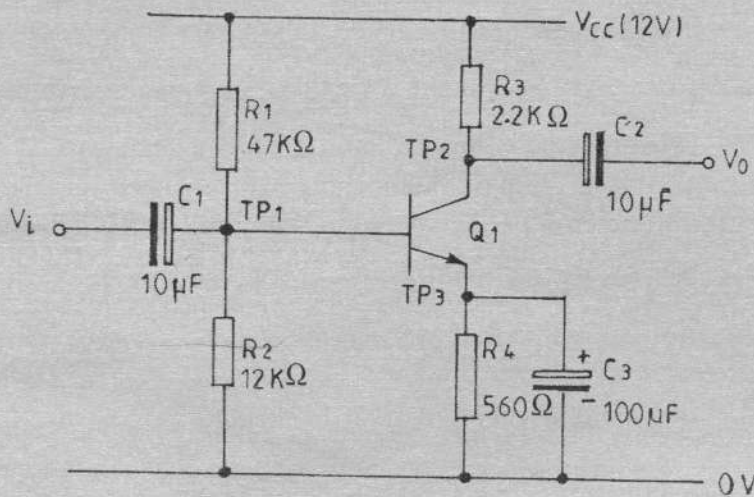


Fig. 2

- (c) Figure 3 shows a block diagram of an over-temperature alarm system. It is suspected that a fault has occurred in the power supply section such that there is no indication on the alarm outputs. Develop a fault location chart for the system. (6 marks)

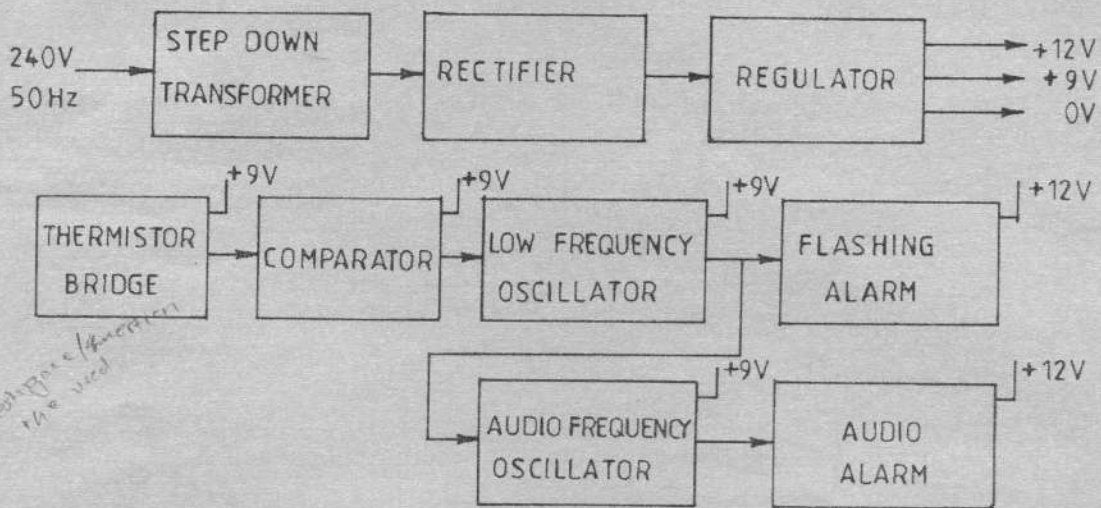


Fig. 3

5. (a) (i) State any **two** ways of minimising the effect of environmental errors in measurements.
- (ii) With the aid of a labelled diagram, describe the operation of a thermocouple ammeter.
- (iii) A thermocouple ammeter is assumed to have a perfect square law response. If it gives a full-scale deflection for a current of 10A, determine the current to give half-scale deflection.

(10 marks)

(b) In a magnetic test, a flux meter is connected to a search coil having 500 turns and a mean area of 500 mm<sup>2</sup>. The search coil is placed at the centre of a solenoid 1 m long, wound with 800 turns. When a current of 5A is reversed, there is a deflection of 25 scale divisions. Taking  $\mu_0 = 4\pi \times 10^{-7}$  H/m, determine the:

- (i) flux density in the solenoid;
- (ii) flux linkages per scale division for the meter.

*D = 600  
800 turns*

(10 marks)

*250 S / 5*

**SECTION B: ANALOGUE ELECTRONICS I**

Answer any **TWO** questions from this section.

6. (a) (i) Define each of the following with respect to atomic theory:

- (I) atomic number;
- (II) ionization potential.

(ii) Draw labelled energy-band structure for each of the following:

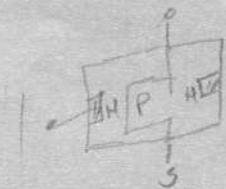
- (I) insulator;
- (II) semiconductor.

(6 marks)

(b) (i) Explain thermionic emission as applied to metals.

(ii) An electrostatic CRT has a final anode voltage of 2kV and parallel deflection plates 2 cm long and 5 mm apart. The screen is 30 cm from the centre of deflection plates. If a deflection voltage of 100V is applied across the plates, determine the:

- (I) maximum deflection, in cm;
- (II) sensitivity of CRT, in mm/V;
- (III) deflection factor, in V/mm.

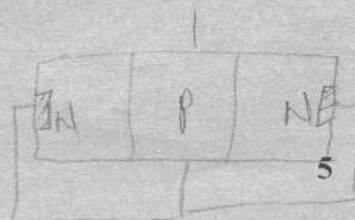


(10 marks)

(c) Sketch on the same axis the characteristic curve of a silicon diode at temperatures of 100°C and 200°C. (4 marks)

7. (a) (i) State any **two** advantages of FETs over BJTs.

(ii) With the aid of a labelled diagram, describe the operation of a bipolar NPN transistor.

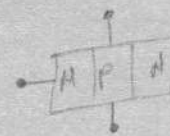


*GATE*

*Drain*

*SOURCE*

(9 marks)



Turn over

(b) Figure 4 shows a circuit diagram of a JFET amplifier while table 2 shows the variation of drain current ( $I_D$ ) with gate-source voltage ( $V_{GS}$ ) for the JFET.

- (i) Plot the transfer curve.
- (ii) Construct the dc loadline.

(11 marks)

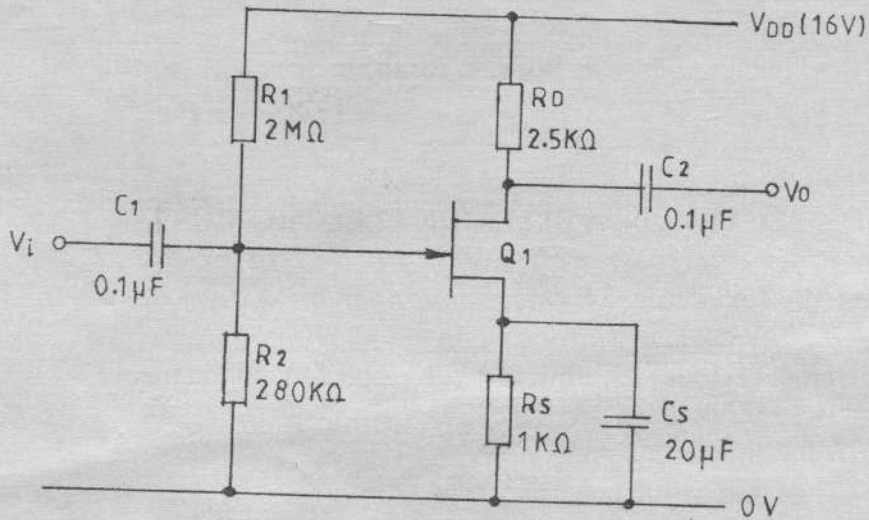


Fig. 4

Table 2

$V_{GS}$ (V)	$I_D$ (mA)
0	8
-1	4.5
-2	2
-3	0.5
-4	0

8. (a) (i) Define each of the following with respect to dc power supplies:

- (I) peak inverse voltage;
- (II) ripple factor.

(ii) A half-wave diode rectifier feeds a pure resistive load. Derive the expression for the dc output voltage.

(7 marks)

(b) With the aid of a circuit diagram, describe the operation of a full-wave voltage doubler. (6 marks)



- (c) Figure 5 shows a circuit diagram of a shunt regulator using a Zener diode. Determine the:
- minimum value of  $R_L$  that the Zener will tolerate in maintaining  $V_L$  constant;
  - minimum value of load current;
  - maximum value of load current.

(7 marks)

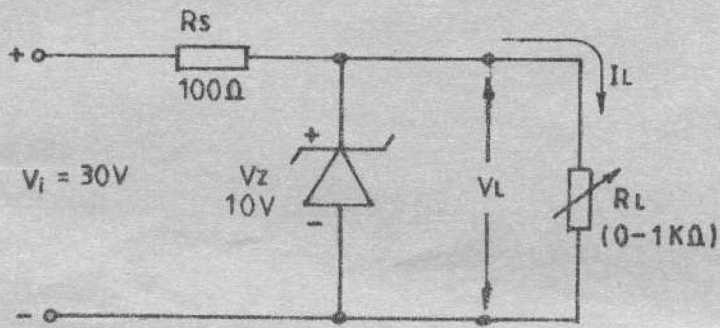


Fig. 5

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