



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRONIC ENGINEERING

ANALOGUE ELECTRONICS II

EEE 2215

Final Examination Paper

March 2025

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: N/A

Examiner's Name: MR J.KATEKWE

INSTRUCTIONS

1. Answer all questions.
2. Each question carries 20 marks
3. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
1.	20
2.	20
3.	20
4.	20
5.	20
TOTAL	100

Question 1

- a) Sketch the output (I_D/V_{DS}) and transconductance (I_D/V_{GS}) characteristics of a P-channel junction field effect transistor (JFET). [4 marks]
- b) The amplifier circuit in figure 1 employs an enhancement metal oxide semiconductor field effect transistor (MOSFET) with $K = 40\text{mA/V}^2$, $V_T = 2.7\text{V}$ and $V_{DD} = 15\text{V}$. Ignore the MOSFET output resistance in your calculations. All resistance values are in ohms unless when indicated otherwise.
- (i) Calculate the amplitude of the output voltage V_{out} . [6 marks]
- (ii) Determine the coupling capacitance values if the amplifier is required to have a lower cut-off frequency of 30Hz. [4 marks]

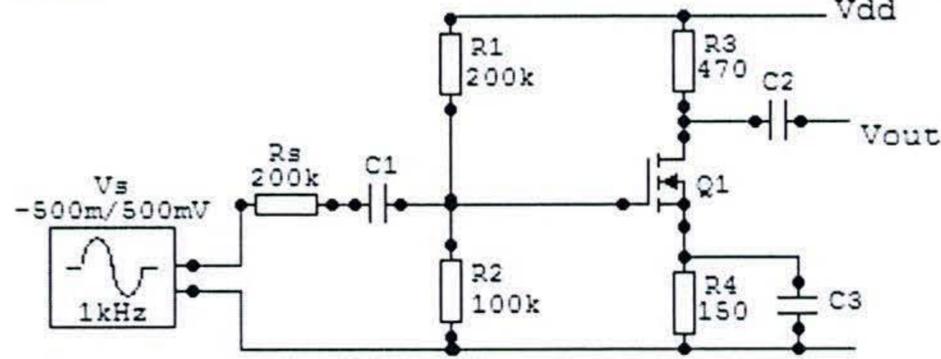


Figure 1

- c) A thermistor with a resistance of 2000 ohms at 25°C (see figure 2) is connected in series with a resistor of 1000 ohms across a supply of 10 volts. The voltage developed across the thermistor is applied to the input of an inverting operational amplifier, which has a gain of -20.

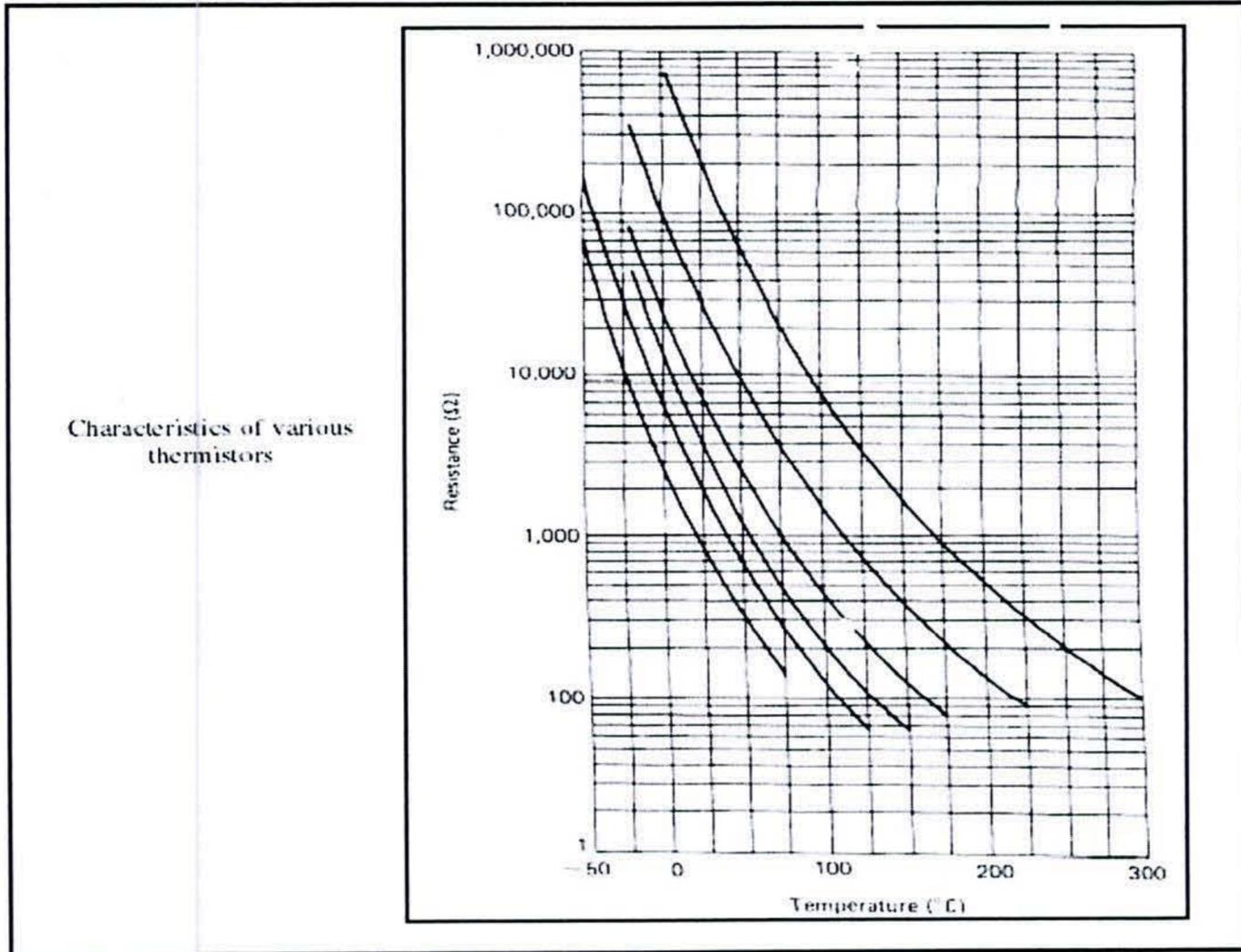


Figure 2

- (i) Draw the amplifier circuit, showing how it is connected to the thermistor circuit. Indicate all resistance values. [3 marks]
- (ii) Calculate the temperature value if the output voltage of the amplifier is -22.2V. [3 marks]

Question 2

- a) With the aid of diagrams, describe the operation of first order active low pass, high pass, band pass as well as band stop (notch) filters. State the expressions of their cutoff frequencies and illustrate them on separate block diagrams. [12 marks]
- b) An active first order low pass filter consists of a resistor $R = 4.7k$ and capacitor $C = 10\mu F$, Calculate the cutoff frequency and the output voltage at calculated cutoff frequency if the input voltage is 5V. [4 marks]
- c) Design an active first order high pass filter with a cutoff frequency of 5kHz using a resistor of 2.2k. [4 marks]

Question 3

- a.) With the aid of diagrams, describe the operation of a bipolar junction transistor (BJT) astable, monostable and bistable multivibrators. Derive expressions of their oscillation frequency where applicable. [15 marks]
- b) Design a BJT monostable multivibrator, which has a time delay of 1.54 seconds. [5 marks]

Question 4

- a) Design an amplifier, using an op-amp with a feedback resistor of 80 k, to take voltages V_1 , V_2 , V_3 , V_4 and to produce an output given by $V_o = -(V_1 + 2V_2 + 4V_3 + 8V_4)$. [4 marks]
- b) Design a non-inverting and inverting amplifier with a voltage gain of ± 20 respectively and feedback resistance of 2k, Calculate the output voltages in each case when the input voltage is 5V at $V_s = \pm 12V$. [6 marks]
- c) A Schmidt trigger circuit is used to modify the waveform of a sinewave of frequency 1 kHz and peak 12 volts. The trigger circuit has a supply voltage of 12 volts with the potentiometer set to produce a reference voltage of +4 volts. If $R_1 = R_2 = 1k$, what will be the length of the mark (positive pulse) and space (negative pulse) in the resulting waveform? [6 marks]
- d) Identify the circuit in figure 3 and describe its operation. [4 marks]

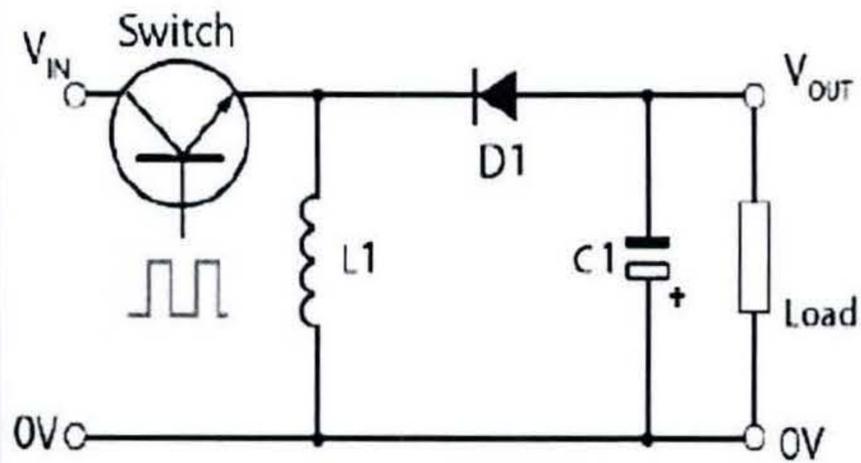


Figure 3

Question 5

- a) With the aid of diagrams, derive the expressions for the output voltage V_o for both the differentiator and integrator circuits hence evaluate V_o in each case when $R = 10k$, $C = 100\mu F$, and $V_{in} = 12\sin(10t)$ over the time interval 0 to 5ms. [12 marks]
- b) Figure 4 shows a simple diode circuit, calculate the labelled circuit currents, potential drops and power dissipations in each resistor. [6 marks]

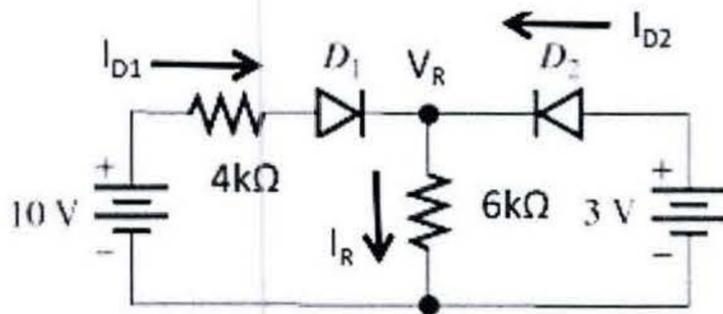


Figure 4

- c) State Shockley equation and explain the meaning of each symbol. [2 marks]