The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: DMX3574/MEX3274 Electronics, sensors and actuators**
Academic Year	: 2017/18
Date	: **25th January 2019**
Time	: **0930hrs-1230hrs**
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Eight (8)** pages.
3. Answer **five** questions only, selecting at least **two questions each from part A and part B**. only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. Answers should be in clear hand writing.
7. Do not use Red colour pen.

Part A

Q1.

(a) What are the characteristics of an ideal op-amp? List any three characteristics.

[03 marks]

(b) An operational amplifier is shown in Figure Q1-b. V1=2V, V2= 1V, R1= 10k, R2=5k.

i. Identify the type of operational amplifier

ii. Determine Vo of the operational amplifier

[04 marks]

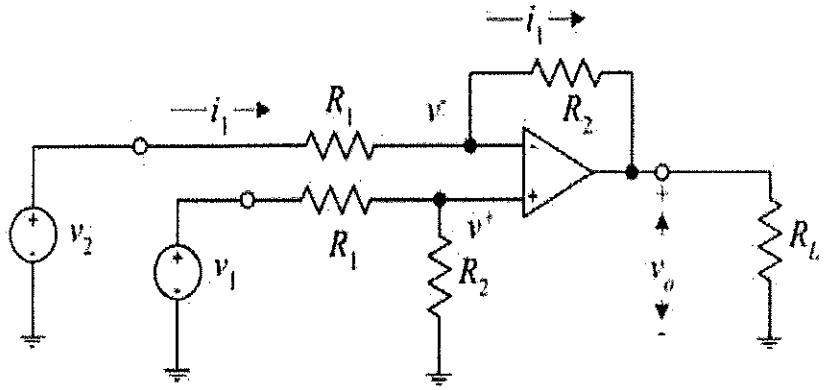

Figure Q1-b

(c) i. Identify the type of the operational amplifier shown in figure Q1-c.

ii. Determine the gain of the operational amplifier shown in figure Q1-c

iii. If the input of the circuit is connected to an AC source with Vp= 50mV, (Vpp=100mV), draw the input and output waveforms.

[09 marks]

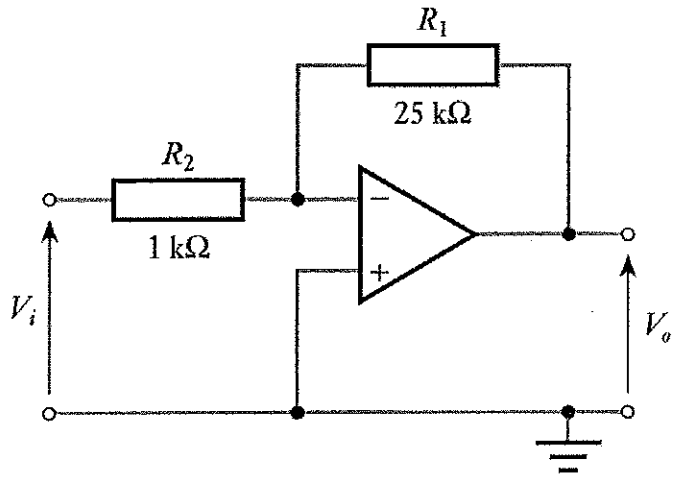

Figure Q1-c

(d) Determine the Vout of the operational amplifier shown in Figure Q1-d. V1=V2=3V, R1= 30k, R2=15k. [04 marks]

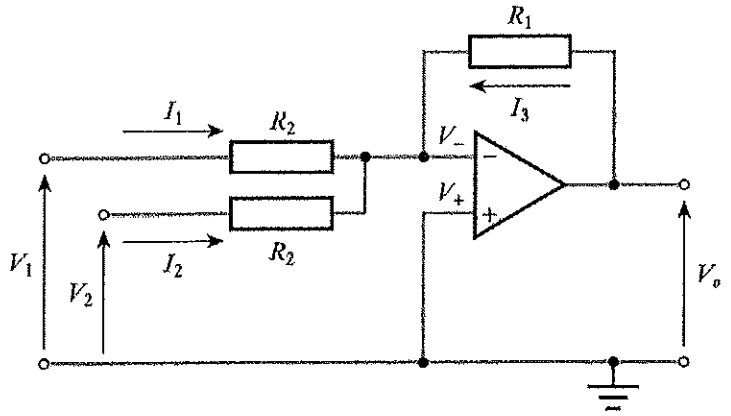

Figure Q1-d

Q2.

(a) Determine Thévenin and Norton equivalent circuits of the circuit illustrated in Figure Q2-a. [04 marks]

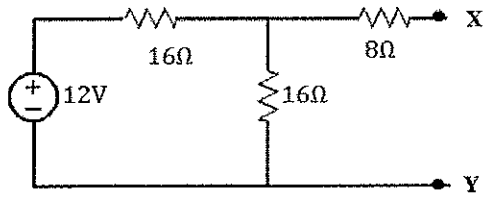

Figure Q2-a

(b) Determine Thévenin equivalent circuit of the circuit illustrated in Figure Q2-b. [04 marks]

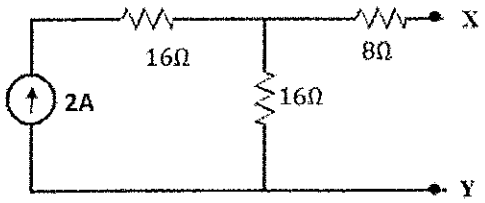

Figure Q2-b

(c) Suppose that R = 5000 Ω and C = 1 μF in the circuit of figure Q2-c. Find the time at which the voltage across the capacitor reaches 63.2% of its initial value.

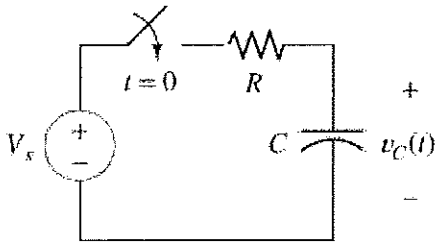

Figure Q2–c

(d) A Wheatstone bridge is illustrated in Figure Q2-d. $R1$ =12 k , $R3$ =240k , and $R2$ = 2k. If Ig=0, determine Rx. [04 marks]

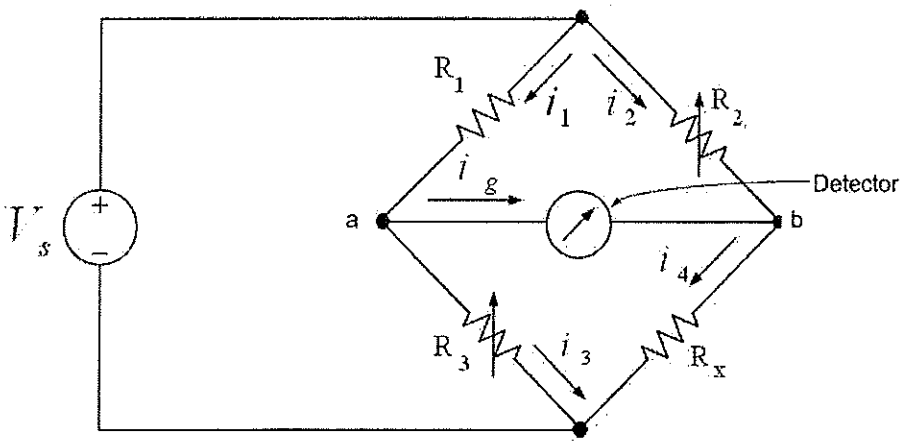

Figure Q2-d

Q3.

(a) Simplify the following Boolean expression using Boolean Theorems. [02 marks]

i. $A + \bar{A}$

ii. (A+1) • (A•A)

(b) 2's complement representation of an 8 bit binary number is given as 11111010. Determine the decimal value of the number. [03 marks]

(c) Sign magnitude representation of an 8 bit binary number is given as 10000101. Determine the decimal value of the number. [03 marks]

(d) Determine two's complement (8 bit) representations of the -16_{10}. [03 marks]

(e) Simplify the following Boolean function using K-maps.

f (A, B, C, D) = Σm (0, 2, 3, 4, 5, 7, 9, 13, 15)

[04 marks]

(f) Perform the following conversions between number systems with clearly showing the necessary steps.

i) 16.2_8 to decimal, binary and hexa-decimal

ii) 1100.1_2 to decimal and octal

[05 marks]

Q4.

(a) Determine V_B, V_E, I_E, I_C and Vo of the BJT amplifier circuit shown in figure Q4-a. [10 marks]

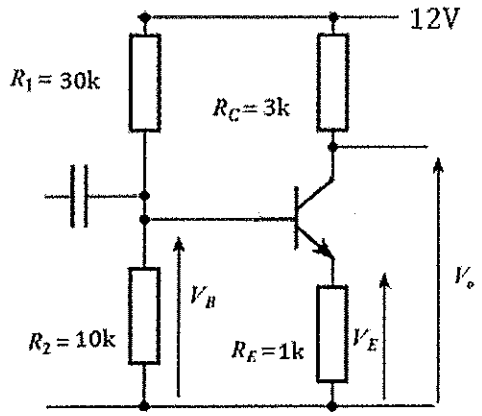

Figure Q4-a

(b) The dc current gain of the transistor of the circuit shown in Figure Q4-b is 100. Determine Q point and draw the dc load line. [05 marks]

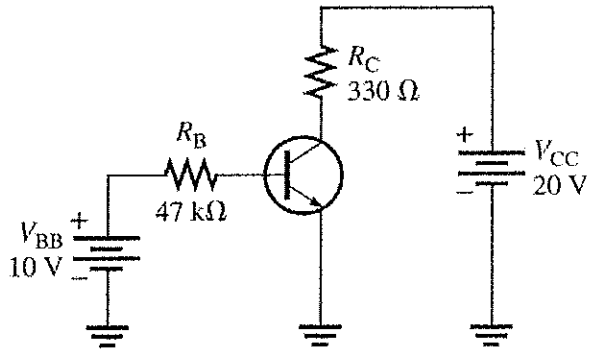

Figure Q4-b

(c) A double diode clipper circuit shown in Figure Q4-c can be used to limit the peaks of both half cycles of the 10V AC input signal. Sketch the output signal (You should indicate the magnitudes of the signal. [05 marks]

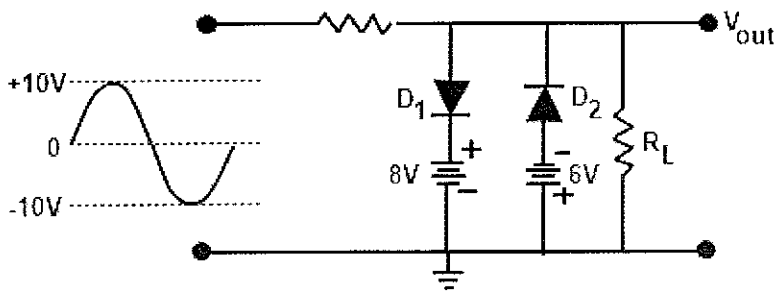

Figure Q4-c

Part B

Q5.

(a) Identify the type of optical encoder disk shown in the Figure Q5. [03 marks]

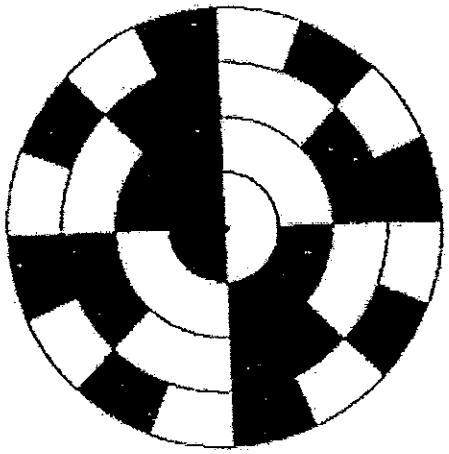

Figure Q5

(b) Determine the angular resolution of the encoder shown in the Figure Q5. [04 marks]

(c) How do you improve the resolution of this encoder to 5.625 degrees? Explain. [04 marks]

(d) Briefly explain following static characteristics of the sensors. [09 marks]

i. Resolution
ii. Accuracy
iii. Precision

Q6.

(a) Draw a simple schematic diagram of a linear variable differential transformer (LVDT) and explain the operation briefly. [07 marks]

(b) Name any three types of temperature sensors. [03 marks]

(c) A stepper motor is working in the full step mode and the step angle is 3.6°. Calculate the rotational speed of the stepper motor (in rpm) if stepping rate is 200 pulses/sec. [03 marks]

(d) What are the three common types of stepper motors? [03 marks]

(e) Single stack three phase variable reluctance stepper motor is illustrated in Figure Q6-e. Number of rotor teeth (n_r)=8 and number of stator teeth (n_s)=12. If the switching sequence of the phase winding is **1-2-3-1**. Determine the direction of rotation. [04 marks]

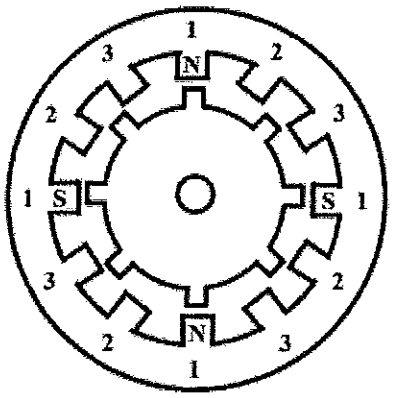

Figure Q6-e

Q7.

(a) Draw the symbols of following pneumatic components. [06 marks]

i. 2/2 way push button valve

ii. 5/2 push button valve

iii. Double acting cylinder

(b) What are the main three parts of an air service unit? [03 marks]

(c) An object has to move using a single acting cylinder. The piston rod is to extend when a push button is pressed and return to the start position when the push button is released.

i. Draw a pneumatic circuit to perform the operation. [07 marks]

ii. Draw a hydraulic circuit to perform the same operation. [04 marks]

Q8.

(a) A three-phase induction motor is wound for four poles and supplied from a 50Hz source. The slip is 2%. Determine the synchronous speed and the speed of the rotor. [04 marks]

(b) An induction motor (220Vrms, 60-Hz three phase Y-connected) draws 25A at a power factor of 80% lagging. The total stator copper loss is 300W, the total rotor copper loss is 100W. Determine the input power, the power crossing the air gap and the developed power.
[08 marks]

(c) The magnetization curve of a machine is shown as Figure Q8-c. It is operating as a motor at a speed of 800 rpm with I_A= 30 A and I_F = 2.5A. The armature resistance is 0.5 Ω and the field resistance R_F = 10 Ω. Determine the

i. voltage V_F applied to the field circuit,
ii. voltage V_T applied to the armature,
iii. developed torque, and
iv. developed power.

[08 marks]

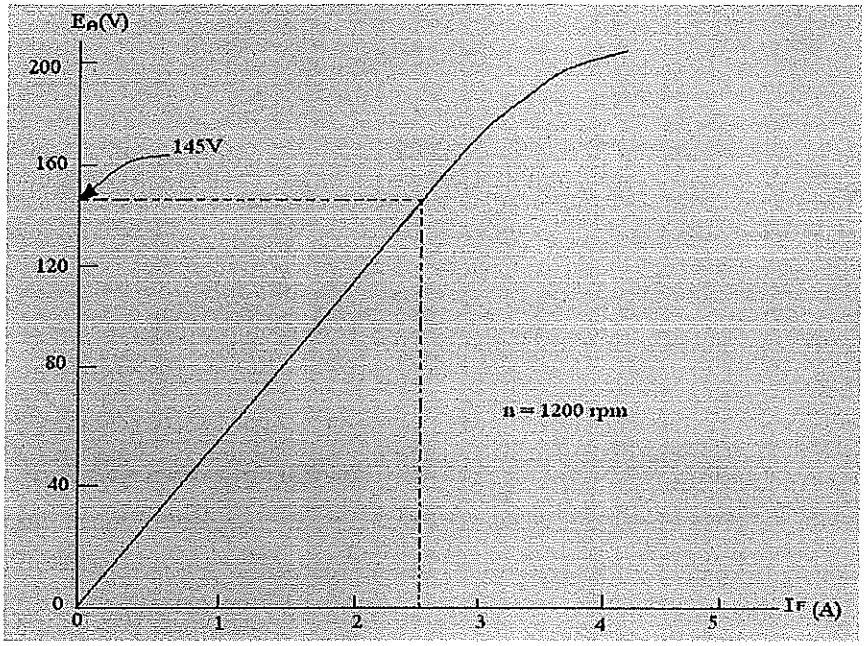

Figure Q8-c(i)

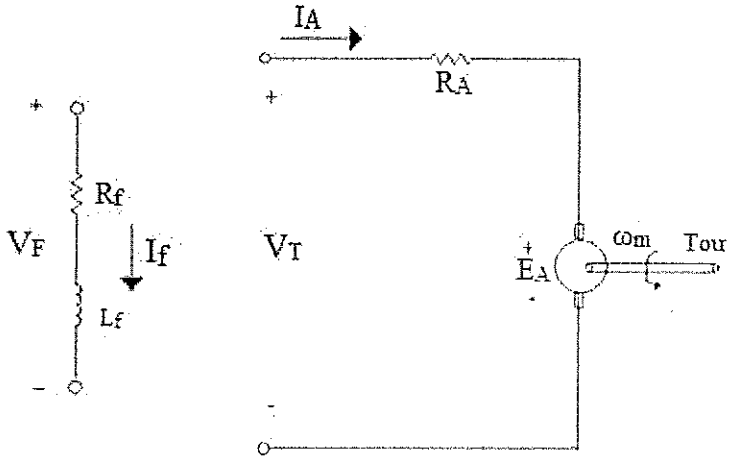

Figure Q8-c(ii)

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