# The Open University of Sri Lanka
# Faculty of Engineering Technology

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| Study Programme | : | Bachelor of Technology (Engineering) |
| Name of the Examination | : | Final Examination |
| **Course Code and Title** | : | **MEX3274 – Electronics, sensors and actuators** |
| Academic Year | : | 2014/15 |
| Date | : | 26th August 2015 |
| Time | : | 0930hr-1230hr |
| Duration | : | 3 hours |

**General instructions**

1. Read all instructions carefully before answering the questions.
2. This question paper has eight questions.
3. Answer **five questions** only selecting **at least two questions** each from **part A and part B**.

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## PART A

Question 01

(a) State Kirchhoff's voltage law and Kirchhoff's current law. [4 marks]

(b) Draw the circuit symbols of a diode and a zener diode and sketch V/I characteristic curve of a diode. [4 marks]

(c) Briefly explain the full wave bridge rectification method using a circuit diagram. [4 marks]

(d) Draw the output waveform of a half bridge rectifier, if input is sinusoidal. [3 marks]

(e) Most of digital electronic circuits use Light Emitting Diode (LED) as a visual indicator. If you have to use a LED as a visual indicator of a circuit as shown in Figure Q1, explain how you would choose a suitable resistor. (Clearly show the necessary calculations and make any reasonable assumptions ) [5 marks]

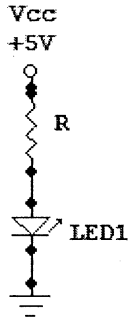



Figure Q1

Question 02

(a) What are the two common types of bipolar junction transistors (BJT)? Draw the symbols of those transistor types. [3 marks]

(b) Write down the main three operating regions of a transistor. [3 marks]

(c) If a transistor operates as an amplifier, what is the relevant operating region? [2 marks]

(d) Calculate the voltages which should be at the test points TP1, TP2, TP3 and TP4 of the BJT amplifier shown in Figure Q2. [8 marks]

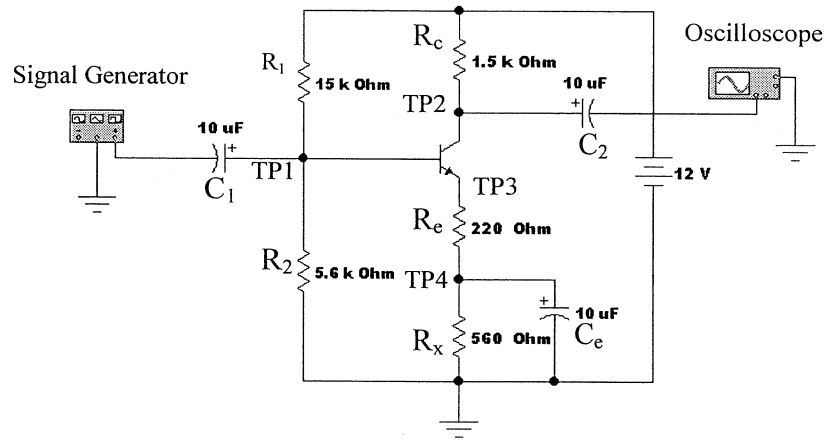



Figure Q2

(e) What is the function of $R_1$ and $R_2$ of the BJT amplifier shown in Figure Q2 ? [2 marks]

(f) What is the function of $C_2$ of the BJT amplifier shown in Figure Q2 ? [2 marks]

Question 03

(a) Identify the types of the operational amplifiers shown in Figures Q3(a) and Q3(b). [2 marks]

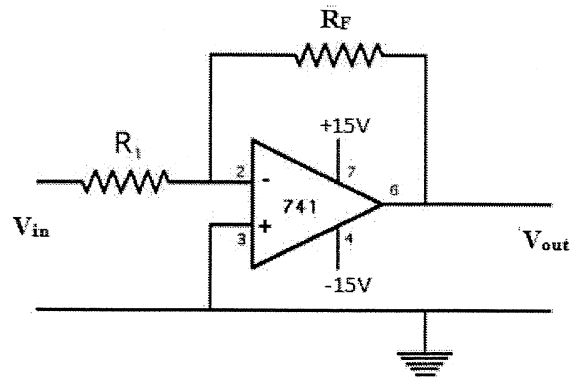



Figure Q3(a)

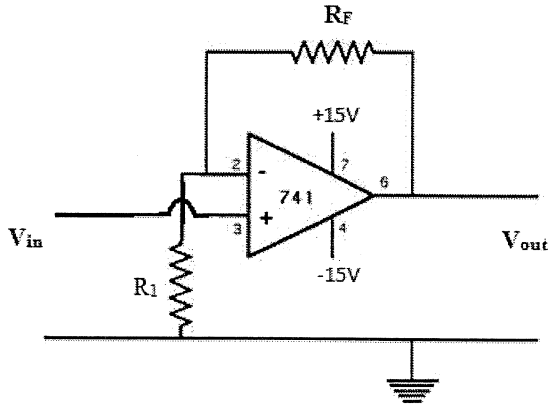



Figure Q3(b)

(b) Determine the gain of the operational amplifier shown in Figure Q3(a), if $R_I$= 1kΩ and $R_F$ =3kΩ. Also calculate $V_{out}$, if $V_{in}$ = 2V DC . [4 marks]

(c) If the input signal, shown is Figure Q3(c), is given to the operational amplifiers shown in Figure Q3(a) and Q3(b), draw the output wave-forms (indicate the values) of each operational amplifier. (Assume gain of the operational amplifier shown in Figure Q3(b) is equal to 2 ). [6 marks]

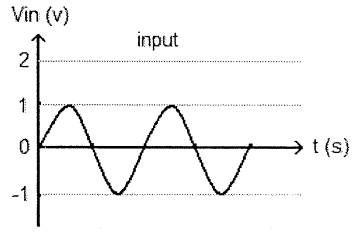



Figure Q3(c)

(d) Perform the following conversions between number systems indicating the necessary steps clearly. (Do not write the final answer directly).

i. $10001111_2$ to decimal and hexadecimal.

ii. $35_{10}$ to binary and octal.

iii. $3E_{16}$ to binary and octal. [6 marks]

(e) Determine two's complement (8 bit) representation of the $-37_{10}$ [2 marks]

Question 04

(a) If a two bit encoder is used to detect the position of a rotating body, what will be the relevant gray code given by the encoder.(Hint: reorder the binary values 00,01,10,11 according to the gray code). [3 marks]

(b) Draw the symbol and truth table of a two input XOR gate. [3 marks]

(c) Simplify the following Boolean expression using De-Morgan's theorem and draw the logic circuit using AND and NOT gates only. [6 marks]

$$Q = A'B + (C' + D)$$

(d) Implement the XOR gate using NAND gates. [8 marks]

**PART B**

Question 05

(a) Distinguish between a sensor and an actuator. Elaborate with suitable examples. [4 marks]

(b) Briefly explain following characteristics of a sensor.

i. Accuracy
ii. Resolution
iii. Linearity
iv. Hysteresis error [8 marks]

(c) Identify the two types of encoders shown in the Figures Q5(a) and Q5(b). [4 marks]

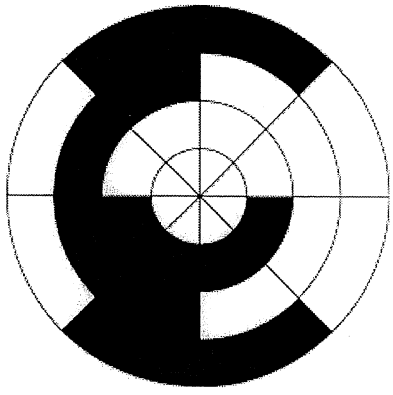


Figure Q5(a)

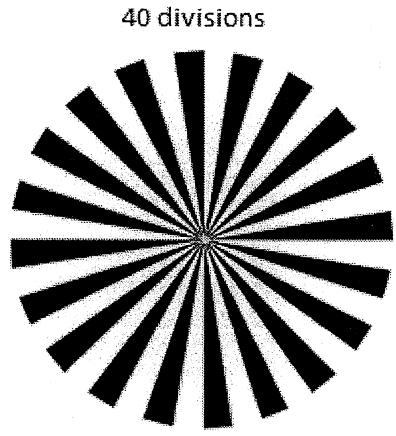



Figure Q5(b)

(d) Find the angular resolutions of the encoders shown in the Figures Q5(a) and Q5(b). [4 marks]

Question 06

(a) Explain the operation of a strain gauge transducer using a suitable example. [4 marks]

(b) Draw a simple schematic diagram of a linear variable differential transformer (LVDT) and explain the operation briefly. [6 marks]

(c) Assume you have to design a 'line following robot'. You can select LDR or IR sensors to detect the white/black lines. What will be the most suitable sensor among LDR and IR sensors? State reason/reasons for your selection. [5 marks]

(d) A production line of a toy manufacturing plant produces a toy with same size using different materials. If they want to detect the toy when moving it on a conveyor belt, suggest a suitable sensor giving reasons for your selection. [5 marks]

Question 07

(a) State two advantages and two disadvantages of pneumatics when compared with other power sources used in the industry. [4 marks]

(b) Write four differences between pneumatic and hydraulic systems. [4 marks]

(c) Complete the pneumatics circuit shown in Figure Q7 and name each component properly (copy the diagram to your answer sheet). When the push button of 1S1 valve is pressed, the actuator 1A should be extended and after releasing the push button the actuator should retract to its initial position. [12 marks]

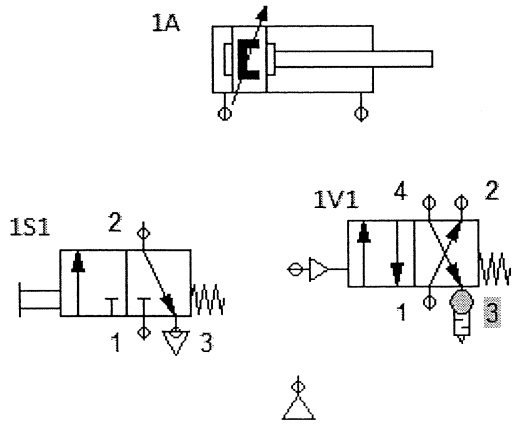



Figure Q7

Question 08

(a) What are the three common types of stepper motors? [3 marks]

(b) Determine how many pulses are needed for a stepper motor to rotate three revolutions, if step angle of the stepper motor is equal to 7.2°. [4 marks]

(c) When power is transferred from a three-phase electrical source to a mechanical load using an induction motor, what are the losses occurred between input and output. [5 marks]

(d) The equivalent circuit of a dc motor is shown in Figure Q8. If induced armature voltage $E_A = 116V$, armature current $I_A = 2A$ and motor speed is 1200 rpm, find the developed torque and developed power. [8 marks]

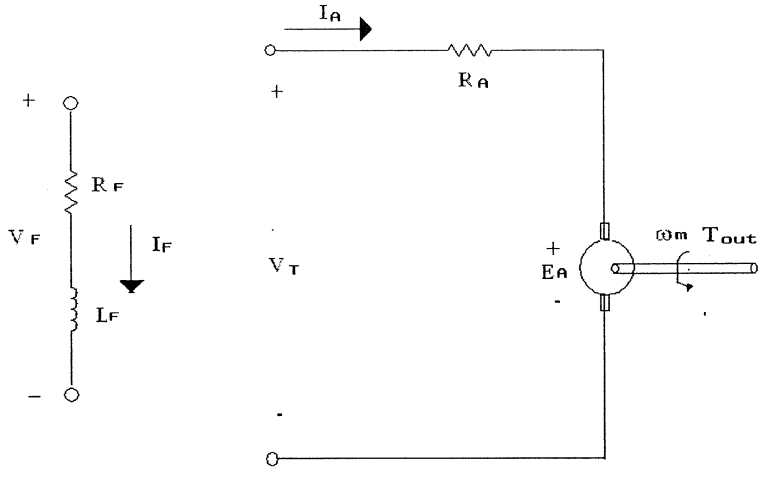



Figure Q8

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