F E D E R A L U N I V E R S I T Y O F T E C H N O L O G Y , M I N N A
SCHOOL OF ELECTRICAL ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MECHATRONICS ENGINEERING
FIRST SEMESTER 2019/2020 ACADEMIC SESSION

COURSE: MCE 411 Mechatronics Systems Design II		
TIME ALLOWED: 3 HOURS	**CREDIT UNIT:** 3	**LEVEL:** 400

Instruction: Attempt All Questions

Question One [20 Marks]

a) Kindly, provide a brief description of your MCE 411 Project, stating the problem you are solving, the methodology adopted, the implementation and the results obtained. (Use appropriate diagrams and illustrations where necessary).
[15Marks]

b) Using an analogue-to-digital converter, a continuous voltage signal is to be converted into its digital form. The maximum voltage range is ±25 V. The ADC has a 16-bit capacity, and full-scale range of 60 V.
Determine:
   (i)   number of quantization levels,
   (ii)   resolution,
   (iii)   the spacing of each quantisation level,
   (iv)   the quantisation error for this ADC.   **[5 Marks]**

Question Two [20 Marks]

a) As a mechatronics engineering student that needs to design a mechatronics system using some transducers, enumerate the ten (10) factors to be considered in the selection of your transducers.   **[5 Marks]**

b) Explain the principles of operation of a DC motor, back your explanation up with the aid of diagram and equations.   **[5 Marks]**

c) A DC Motor has six (6) parts, list and explain the function of each part. **[6 Marks]**

d) A stepper motor has a step angle of 3.6°. (i) How many pulses are required for the motor to rotate through ten complete revolutions? (ii) What pulse frequency is required for the motor to rotate at a speed of 100 rev/min?   **[4 Marks]**

Question Three [20 Marks]

a) The output voltage of a particular thermocouple sensor is registered to be 42.3 mV at temperature 105°C. It had previously been set to emit a zero voltage at 0°C. Since an output/input relationship exists between the two temperatures, determine the transfer function of the thermocouple, and the temperature corresponding to a voltage output of 15.8 mV**.**   **[5 Marks]**

b) Enumerate the factors that affect the speed of a synchronous AC Motor. **[5 Marks]**

c) Explain this concept of active and passive transducer with respect to photovoltaic cells and a loudspeaker.   **[5 Marks]**

d) State source/channel separation theorem, with detailed explanation.   **[5 Marks]**

Question Four [20 Marks]

a) As a mechatronics engineering student, explain in details digital communication systems using a well-drawn block diagram. **[8 Marks]**

b) Enumerate the four reasons why communication systems contain binary interface between source and channel. **[5 Marks]**

c) Explain what you understand by modulation in terms of analog communication and digital communication. **[4 Marks]**

d) Explain the following in terms of digital interface;
   i. Unequal rate
   ii. Errors
   iii. Network **[3 Marks]**

Question Five [20 Marks]

a) Hundred level students of the department of mechatronics engineering during their practical class experiment discovered a box with a label Component A containing two devices suspected to be sensors. It is believed that the two devices are of same type. In the quest to identify these devices, they found out that: one of the device resistances increases with decrease in temperature and for the other device the resistance increases as the temperature increases.
   i. As a Mechatronics student, please help these students identify what type of devices are these. **[5 Marks]**
   ii. Also, give them some applications of these devices as well as some advantages and disadvantages of using these devices. **[5 Marks]**

b) Compare and Contrast RTD, Thermocouple and Thermistor. **[5 Marks]**

c) Explain in details Channel Capacity. **[5 Marks]**