FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGERIA
SCHOOL OF ELECTRICAL ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MECHATRONICS ENGINEERING
FIRST SEMESTER 2018/2019 B.Eng. DEGREE EXAMINATION
COURSE: MCE 411(Mechatronics Systems Design II)
INSTRUCTION: Answer Question One and Any Other Two Questions
TIME ALLOWED: 3 Hours.

Question 1 (50 Marks)

a) The Advanced Engineering and Innovation Research Group (AEIRG) of the department recently won a grant to develop an Intelligent Wireless Battery Charger (IWBC) for mobile Phone. As a potential Mechatronic Engineer, you are required to develop the Product design life cycle for the IWBC, stating all the stages that may be involved in the design as well as the description of these stages. [Use applicable diagram (s) to justify your design where necessary] (15 Marks)

b) The department has concluded plans to host the 2019 edition of the Nigerian Robotics Championship (NIROC). As a member of one of the participating teams, you are required to design a chameleon Robot, such that whenever a coloured object is brought in contact with it the colour changes correspondingly to that which was brought close.
   i. Develop a suitable block diagram and flowchart for the design. (7 Marks)
   ii. State all components that may be required to actualize your design. (4 Marks)
   iii. State the functions of the components identified. (4 Marks)

c) The Management has recently approved the installation of Air-Condition (AC) units in all lecture theatres within the University. The AC's are required to operate automatically based on the internal temperature of the lecture theatres with the assumption that there is constant electricity supply, hence the need a sensor-based switching system. You are required to identify a suitable temperature sensor for the switching system, stating the reasons for selection, the operation of the sensor as well as the advantages and disadvantages over other applicable sensors. (10 Marks)

d) A synchronous motor is required to drive the alternator of the fuelless generator to a speed of 1500rpm at frequency of 50Hz, what is the number of poles that would be required on the motor. (5 Marks)

e) If the speed of the motor in (d) is increased to 1800rpm what frequency would be required to drive the motor. (5 Marks)

Question 2 (25 Marks)

a) Recently, AD Bakery Minna recorded some losses owing to burnt bread due to inability of the operators to measure the oven temperature. The manager of the venture has consulted you to help recommend a sensor/ transducer to adequately measure the oven temperature. You are required to recommend the most appropriate sensor for the operation, state the reasons why and also the advantages as well as the principle of operation of the sensor you recommended putting into consideration that the bakery temperature requirement can be up to 1000^{o}C and there are lots of contaminants in the oven. (15 Marks)

b) Describe in details the operating principle of a DC motor. (5 Marks)

c) Compare and Contrast the following:

i. Precision and Accuracy. (2.5 Marks)

ii. Response Time and Sensitivity. (2.5 Marks)

Question 3 (25 Marks)

a) Following the peace deal reached with the US government, the Democratic People's Republic of North Korea as started dismantling all the Nuclear Weapon Stations in the country. Thus, in quest to complete the task effectively it is required to design a power actuating system to help lift dismembered components within each facility. Putting into consideration, that the temperature of the environment is -2^{O}C. Task, you are to propose a suitable actuation system to be used for this operation, stating the advantages and disadvantages that may be applicable. (15 Marks)

b) Identify the components of a typical pneumatic system and state their functions. (5 Marks)

c) What is the largest value of output voltage from an 8-bit DAC that produces 1.0V for a digital input of 00110010? (5 Marks)

Question 4 (25 Marks)

a) In the investigation report submitted to the Governor by the panel of inquiry into the Plateau water cooperation chlorine explosion, it was discovered that a wrong type of sensor had been used in the chlorine tank, hence there was no way it could detect the level of the gas in the tank, thus resulting into the explosion that claimed many lives. However, in the quest to reduce the sufferings of the people with respect to water shortage the government has decided to re-fix the plant, in doing so the Governor has strongly emphasized on the need for a suitable and effective sensor to be in place this time to forestall recurrence. To this end, the Chairman of the Committee has contacted you to guide appropriately on how to select a suitable sensor. (15 Marks)

b) A 50 mm diameter piston of the pneumatic cylinder of Figure 1 retracts 130 mm from its present position. ($P_1 = 2bar$ (gauge) and $V_1 = 300cm^3$) due to the external load on the rod. If the part at the blind end of the cylinder is blocked, find the new pressure, assuming temperature remains constant. (5 Marks)

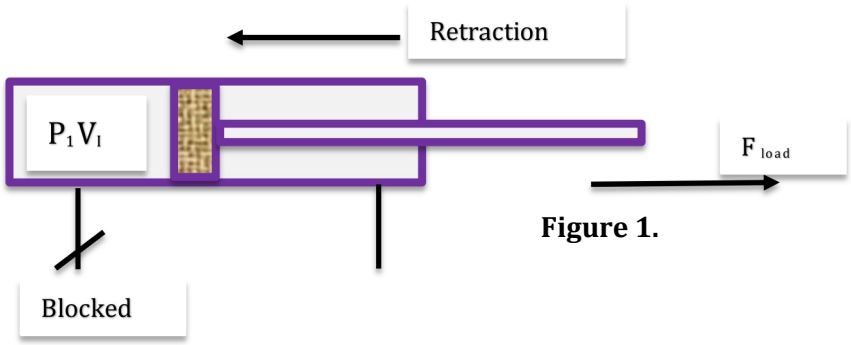

Figure 1.

c) Compare and Contrast RTD, Thermocouple and Thermistor. (5 Marks)