Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	DIGITAL MANUFACTURING
COURSE CODE	:	BDX 31503
PROGRAMME	:	BDX
EXAMINATION DATE	:	JULY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER ANY **FIVE (5)** FROM SIX (6) QUESTIONS PROVIDED 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) As a production engineer, you are assigned to setup a new manufacturing process plan for machining metal-based components using CNC Milling. Surface roughness of the component being machined is an important outcome. Suggest a systematic approach for conducting data analysis. Support your answer with a simple data analysis example.

(5 marks)

(b) Control Centred is an important concept in digital manufacturing. Describe the technologies involved under this concept and its advance.

(6 marks)

(c) Digital Threat and Digital Twin is applied in an aircraft manufacturing. Describe this technology based on an appropriate example and sketch.

(5 marks)

(d) State **FOUR (4)** advantages when applying Digital Manufacturing technology in manufacturing.

(4 marks)

Q2 (a) **Figure Q2** shows a cylindrical shape workpiece is manufactured using turning process. The flange of the workpiece is clamped at the machine chuck using an automation device. Using schematic diagram, propose graphical simulation for the following process error or disturbance. Support your answer with the graphical data streams for diameters ID1 and ID2.

(i) Cutting tool bluntness.

(5 marks)

(ii) Loading error of an automation device due to dusts or metal chips stuck around the flange surface.

(5 marks)

(b) Rescale of manufacturing process variable or sample data streams into a standardize range within [−3, +3] can be performed using mathematical modeling approach.

(i) Write an equation for data standardization and the meaning of each symbol. Assume that the manufacturing process samples the standardized samples are represented by parameters X and Z respectively

(4 marks)

(ii) Propose a MATLAB program to generate the data standardization.

(6 marks)

Q3 (a) Premach-100 company manufactures flat head screw (**Figure Q3(a)**) in mass production. A new engineer attempts to explore an artificial intelligence (AI) technology to classify **THREE (3)** size of screw: M2, M3 and M4. Analyze the available information to develop the AI classifier. Support your answer with the AI classifier model, number of training data, and training algorithm.

(10 marks)

(b) **Figure Q3(b)** shows a schematic diagram for an automated feeding and cutting mechanism. Assume that the cutter is moving downward for cutting materials. The materials is moving forward (horizontally) based on intermittent feeder. The cutting process starts when a sensor detect the incoming pre-cut materials and running automatically until N number of **cut**. Propose a control system using Electro Pneumatic technology. Support your answer with the step-displacement, pneumatic circuit and electrical circuit diagrams.

(10 marks)

Q4 In Virtual Manufacturing Aircraft production line, a photo electric sensor is used to ensure the turbine blade parts has uniform size in an automatic quality inspection process as shown in **Figure Q4**. If the sensor detects the part, that's mean the part has unacceptable height and must be rejected. Once the rejected part is being detected, a double acting pneumatic cylinder which is attached near the sensor push the rejected part off the conveyor into rejected box. Otherwise the turbine blade parts continue moving on the conveyor and the cylinder remain inactive. If the cylinder rejects more than 10 parts, an emergency indicator emits red light to show that the rejected parts has reached the limit so the system could stop the entire system for 5 minutes and before continuing. Select the Programmable Logic Controller (PLC) system including pneumatic diagram, motion diagram, electrical diagram and ladder diagram for this automation system according to ISO 1219 standard respectively. All components require 12VDC supply voltage.

(20 marks)

Q5 (a) In Digital Manufacturing, there are two type of Radio Frequency Identification (RFID) which are active and passive system. Differentiate the technological principle between both RFID systems.

(8 marks)

(b) The output voltage of a particular thermocouple sensor is registered to be 45.5 mV at temperature 120°C. It had previously been set to emit a zero voltage at 0°C. Since an output/input relationship exists between the two temperatures, by using the given formula:

$$S = C + ms$$

where C = output value at a stimulus value of zero

m = constant of proportionality (sensitivity)

s = *stimulus*

(i) Determine the transfer function of the thermocouple.

(6 marks)

(ii) Find the temperature corresponding to a voltage output of 18.5 mV

(6 marks)

Q6 (a) Industrial revolution 4.0 (IR 4.0) also sometimes referred to as internet of thing (IOT) or smart manufacturing system to create a more holistic and better connected ecosystem for companies that focus on aircraft manufacturing and technologies. Analyze **THREE (3)** core technologies that play important roles in IoT that can benefit the aircraft manufacturing industry to understand the value of IR4.0 in manufacturing cases with example of application.

(10 marks)

(b) The internet of things (IoT) operates around a vast network. Various components are involved which work together to form a cohesive system. The IoT is seen as the key ingredient for the development of smart environments. The situation presents a challenge to identify the most suitable IoT communication solutions for a particular smart environment. Propose **FOUR (4)** major of smart environment in IoT and sketch the example of application to represent the IR 4.0 concept.

(10 marks)

- END OF QUESTION -

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER II /2021/2022
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FIGURE

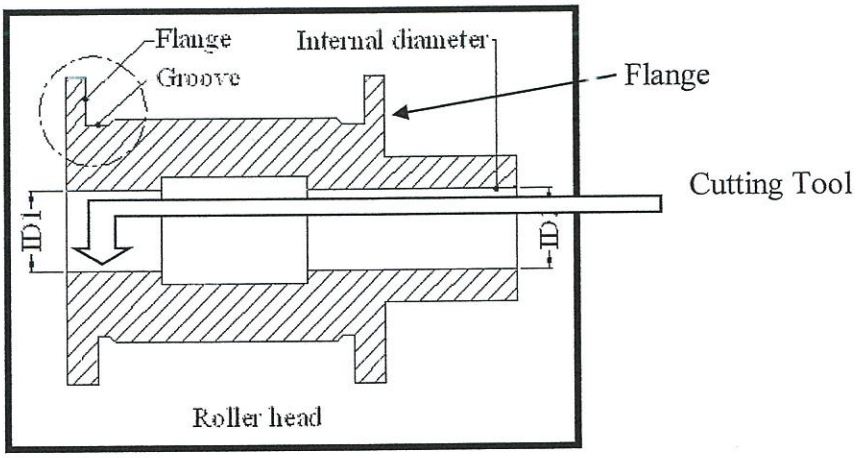

FIGURE Q2 Turning process

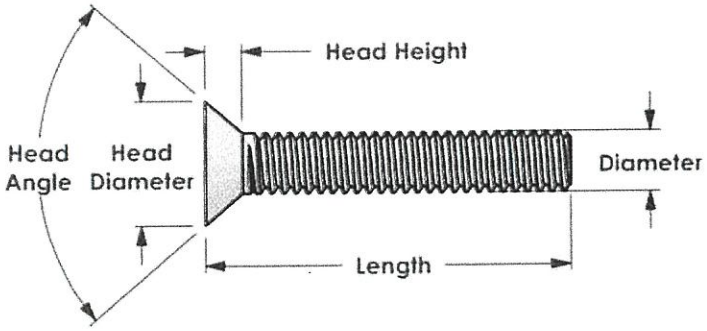

FIGURE Q3(a) Dimension features for flat head screw

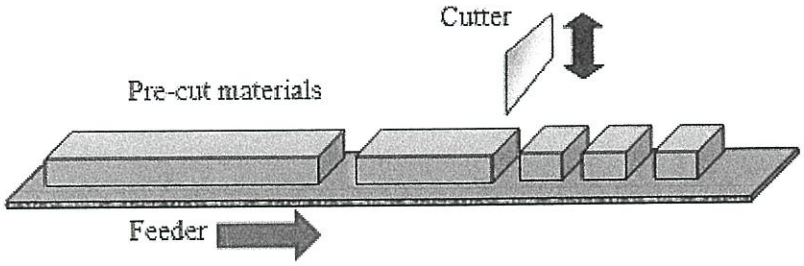

FIGURE Q3(b) Automated feeding and cutting mechanism

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FIGURE

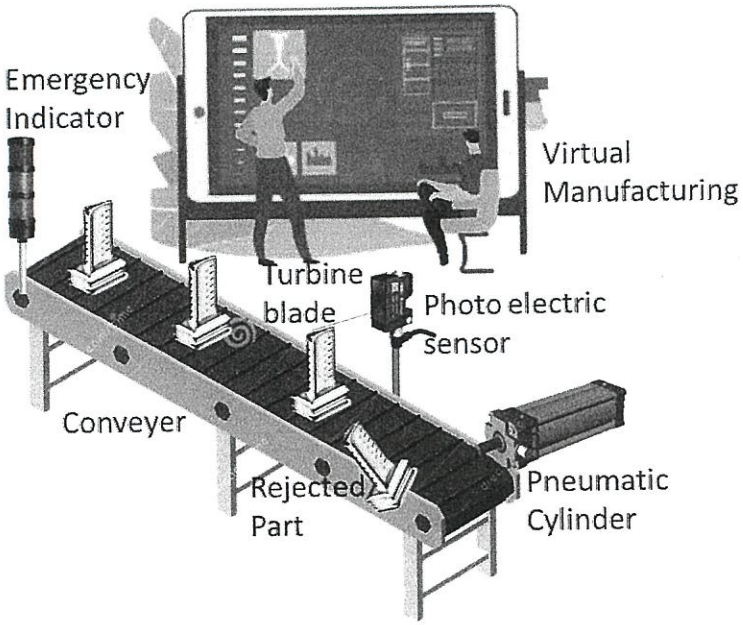

FIGURE Q4 Virtual manufacturing