KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year 1st Term Online Examination, 2020

ME 4083

(Robotics)

Time: 1 Hour and 30 Minutes | Total Marks: 120

N.B.: i) Answer any TWO questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1(a)	Write short note on the historical evolution of robot and forecast the future direction based on the market analysis.	10
1(b)	Compare robot with human labor and describe the importance of robot in this regards.	09
1(c)	Design a robot to serve in this COVID pandemic situation. Mention its important features and necessary components.	11
2(a)	Define and differentiate forward and inverse kinematics.	05
2(b)	Why frame to frame transformation is important in robotics? Assume, frame {C} is the universal coordinate frame. Frame {D} is translated 20 m in $\hat{X}_C$ and 25 m in $\hat{Y}_C$ directions. In addition, frame {D} is rotated relative to frame {C} about $\hat{Z}_C$ by 45 degrees. Draw the frames and calculate C_P, where $D_P = [8, \quad 13 \quad 0]^T$.	12
2(c)	What are the D–H parameters? Draw a link-frame arrangement, denote the D–H parameters in the figure and briefly explain the physical meaning of the four matrices generated from the four D–H parameters.	13
3(a)	Write short notes on "Jacobians" and "Singularities". Also mention the relationship between Jacobian and Singularity.	07
3(b)	Draw a PRP manipulator, assign link-frames with D–H parameters and find the end-effector position and orientation in respect to the base.	15
3(c)	Draw the following Robotic manipulator: (i) SCARA Robot, and (ii) Articulated Robot.	08

SECTION-B

4(a)	Analyze the application of sensors in industrial robots and medical robots with the explanation of sensor characteristics.	15
4(b)	What are the importance of sensors and actuators in the field of robotics?	07
4(c)	Explain actuators in robot with their important properties.	08
5(a)	What are the cases when path generation with via points are required? Compare the path generation methods of robots with linear interpolation in joint space and Cartesian space.	15
5(b)	Derive a robot path generation method in joint space to ensure minimum jerk in the starting and ending, and maximum velocity at the mid-way.	15
6(a)	What are the popular control systems used in robotics? Analyze the time response of a second order system with the varying effect of ω_n and ξ.	13
6(b)	Design a robot control system with necessary block diagram.	12
6(c)	What is the transfer function? Define the open-loop control and closed-loop control.	05

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ME 4019

(Aerodynamics)

Time: 1 Hour and 30 Minutes | Total Marks: 120

N.B.: i) Answer any TWO questions from each section in separate scripts.
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iii) Assume reasonable data if any missing.

SECTION-A

1(a) Describe the physical significance of Kutta-Joukowski theorem, surface pressure distribution and circulation on generation of lift. 10

1(b) Find the theoretical location of centre of pressure and aerodynamic centre for thin symmetrical airfoil. 20

2(a) Discuss the Kutta condition and illustrate the starting vortex. Explain how the starting vortex creates the unique value of circulation that satisfy the Kutta condition? 12

2(b) The NACA 4412 airfoil has a mean camber line given by– 18

$$\frac{z}{c}=\begin{cases}0.25\left[0.8\frac{x}{c}-\left(\frac{x}{c}\right)^2\right] & for\ 0\le\frac{x}{c}\le 0.4\\ 0.111\left[0.2+0.8\frac{x}{c}-\left(\frac{x}{c}\right)^2\right] & for\ 0.4\le\frac{x}{c}\le 1\end{cases}$$

Using thin-airfoil theory, calculate –(i) zero lift angle of attack, $\alpha_{L=0}$ (ii) lift coefficient when $\alpha = 3°$.

3(a) How the lifting-line theory for finite wing is developed combining the bound and the trailing vortices and applying the Helmholtz's theorem and Biot-Savart law? Explain with sketches. 14

3(b) Explain why the general arbitrary series distribution of lift is analyzed for finite wing. Show that the lift coefficient for series distribution depends only on the first coefficient of the series. 16

SECTION-B

4(a) Explain how the load distribution along the span of the wing is determined using the fundamental equation of Prandtl lifting-line theory? 15

4(b) The spanwise distribution of circulation along an untwisted rectangular wing of aspect ratio 5 can be written in the form– 15

$$\Gamma(\theta)=2bv_\infty\alpha(0.0234\sin\theta+0.00268\sin3\theta+0.00072\sin5\theta+0.00010\sin7\theta).$$

Calculate the lift and induced drag when the incidence, α measured to no lift is 10°. Assume ρ = 1.225 kg/m^3, v_∞= 90 m/sec, and b = 12 m.

5(a) What is compressibility correction and when the compressibility correction must be considered for subsonic flow? 10

5(b) Why the linearized perturbation potential equation is transformed to Laplace equation rather than solving it analytically? 07

5(c) For NACA 4-degit series, the lift coefficient for three airfoil sections in incompressible flow are given in the table below: 13

Airfoil section	$\alpha = 4°$	$\alpha = 5°$
NACA 3412	c_l = 0.84	c_l = 0.96
NACA 4412	c_l = 0.96	c_l = 1.08
NACA 4415	c_l = 0.99	c_l = 1.11

Consider NACA 3412 airfoil is set to 4° incidence flying at M_∞ =0.6. What is the airfoil section for the equivalent wing in an incompressible flow? Also determine the lift coefficient in actual compressible flow at 0.6. Now verify the lift coefficient for the same NACA airfoil using the data table provided above.

6(a) Explain the significance of viscous interaction phenomena and aerodynamic heating in hypersonic flight. 10

6(b) Explain the differences between the physics of supersonic and subsonic flow? 08

6(c) Show that the lift coefficient of supersonic airfoils are independent of shape and thickness of the airfoil but depend on incidence at given Mach number. 12

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ME 4127

(Operation Management)

Time: 1 Hour and 30 Minutes | Total Marks: 120

N.B.: i) Answer any TWO questions from each section in separate scripts.
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SECTION-A

1(a) What is meant by operations? Identify five production processes from real life and state why these are called production process. Justify your answer. 10

1(b) What is organizational value system? One of the most important function of operations manager to transform organizational value system into operational objectives? Explain. 10

1(c) Discuss the criteria for classifying operations systems and give an example for each category. 10

2(a) What is meant by depreciation of an asset? When to use double declining-balance method for calculating depreciation of an asset? What are its advantages? Explain. 10

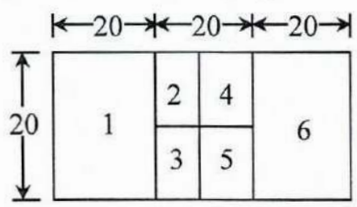
2(b) What is meant by IRR? Explain how to take decision for selecting a project using IRR. 10

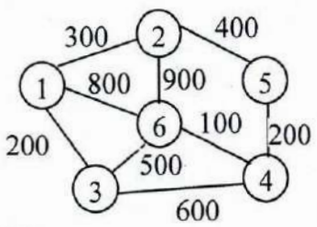
2(c) Mr. X decided to deposit TK 50,000/- each year at a deposit pension scheme for the next 10 years with an initial deposit of TK 100,000/-. After completion of 10 years, how much he can withdraw each year for the next 10 years. 10

3(a) What are the common graphic aids used for process design? What are the information contained in an operations sheet? Explain. 10

3(b) What are the factors that lead to consideration of a plant relocation? Explain with example. 10

3(c) The figure shows the present layout and load movements for the six work centers of a machine shop. Suggest how the current layout can be revised to minimize materials handling. What is the improvement for the proposed design? 10





SECTION-B

4(a) What are the elements of inventory ordering costs and setup costs? 05

4(b) Compare and contrast between EOQ and EPQ models. 10

4(c) Draw a decision flow diagram for two price break. The maintenance department of KUET requires 6000 gallons of paint annually for schedule maintenance of its buildings. It has been estimated that the cost of holding inventory is 25 percent of the investment in inventories and the cost of placing an order is TK 16. The pricing policy of the vender is as follows: 15

$$b(Q)=\begin{cases} b_1 = TK8 \ \ per\ gallon & if\ Q<300 \text{ gallon} \\ b_2 = TK6 \ \ per\ gallon & if\ 300 \le Q<500 \text{ gallon} \\ b_3 = TK4 \ \ per\ gallon & if\ Q \ge 500 \text{ gallon} \end{cases}$$

Determine the optional ordering policy.

5(a) Briefly explain and compare the loading and sequencing process. 15

5(b) Suppose that five jobs are waiting at the beginning of a shift to be processed on two machines. Their operation times in hours have been estimated as follows: 15

Job	J_1	J_2	J_3	J_4	J_5
Machine A	5	3	6	1	4
Machine B	2	7	5	2	5

(i) What job sequence will minimize the total elapsed time?
(ii) What is percentage of idle time for each machine over the total elapsed time?

6(a) Define project, its life cycle and ethical issues. 10

6(b) As an engineer, make a technical project to support our health system in this corona pandemic, and briefly explain its management plan. 20