KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year 1st Term Examination, 2021

ME 4083
(Robotics)

Time: 3 Hours   Total Marks: 210

N.B.: i) Answer any THREE 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) What does the term "Robot" mean? How does the robot industry lead toward fourth generation robots? — 12

1(b) Why robot is diversified than automation and why the robot is becoming preferable than human worker day by day? — 08

1(c) Briefly explain the future direction of robot application. Design your dream robot with important features. — 15

2(a) Write short note on mappings involving general drones. Frame {B} is rotated relative to frame {A} about $\hat{z}$ by 60°, translated 28 units in $\hat{X}_A$, and translated 13 units $\hat{Y}_A$. Find A_P, where $B_P = [9\ 17\ 0]^T$, and frame {A} is the universal coordinate system. — 15

2(b) Draw a 5DOF robot manipulator. Denote its major components and briefly explain the singularity with Jacobian. — 12

2(c) Write short note on forward and inverse kinematics in robotics. — 08

3(a) Draw a link-frame arrangement and denote the D-H parameters. Briefly explain the physical meaning of the matrices generated from the D-H parameters. — 12

3(b) Draw a wrist joint and find the D-H parameters. — 08

3(c) Find 2 joint angles from a RR manipulator using given end effector position. — 15

4(a) Calculate the velocity of the end-effector of a RR manipulator as a function of joint rates. Compute the Jacobian matrix and find the points of singularity. — 18

4(b) Derive the expressions of joint torques of a two link planner manipulator by using either Newton-Euler method or Lagrangian method. — 17

SECTION-B

5(a) Write short note on the hierarchy of motion planning of a robot. Why trajectory planning is important for manipulator? — 10

5(b) Briefly explain and differentiate the trajectory planning in the Cartesian and Joint space. — 10

5(c) Derive the equation of robot trajectory by using the cubic polynomial method.
A single link robot with a revolute joint is motionless at $\theta = 10°$. It is desired to move the joint in a smooth manner to $\theta = 80°$ in 4 sec. Find the equation of position, velocity and acceleration of the joint as a function of time. — 15

6(a) Explain the feed-forward control and feedback control of robotic systems. — 08

6(b) Show the variation of time response in a typical mass-spring system during force control. — 15

6(c) What are the properties typically required to characterize a signal? Also express the effect of signal properties when the gain parameters increase in tabular form. — 12

7(a) What are the major differences between eddy current proximity sensors and piezoelectric sensors?   10

7(b) "Ultrasonic sensors are superior to infrared sensors in terms of reliability"- Justify the statement.   10

7(c) Suppose a robot is designed to supply medicine to a corona patient in a hospital ward from doctor's chamber. What types of sensors are required to accomplish its tasks and what should be their characteristics? Briefly explain the working principle of a sensor used to avoid collision?   15

8(a) Differentiate electric actuators from pneumatic and hydraulic actuators according to application, operation and power consumption.   10

8(b) A surgery robot should have good accuracy and precision in its movement. Which actuator should be used to ensure those with a good feedback? Briefly explain its working principle.   13

8(c) A manipulator can be programmed by programming languages and teach by showing or demonstration. Write short note on different robot programming methods.   12

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year 1st Term Examination, 2021
ME 4019
(Aerodynamics)

Time: 3 Hours   Total Marks: 210

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

SECTION-A

1   Pressure and shear-stress distribution over the wings of airplane are the natural sources for the creation of aerodynamic forces and moments, when air flows. Now answer:

    (a) Explain with neat sketch how lift is generated on airfoil based on the continuity equation and Newton's second law of motion principal.   10

    (b) Derive expressions for the estimation of lift, drag and moment coefficients from pressure distribution over the airfoil surface.   15

    (c) Explain the characteristics of lift, drag and moment coefficient curves which were systematically measured for different airfoil shapes in low-speed wind tunnels. Mention the reasons for their notable variations.   10

2(a) What is circulation? How lift can be calculated using the value of circulation around an object?   08

2(b) Why does the starting vortex create when the angle of attack or the flow velocity increases of an airfoil?   11

2(c) Describe the Kelvin's circulation theorem.   06

2(d) An experimental data of NACA 4412 airfoil section at an angle of attack of $5°$; $C_l = 0.85$ and $C_{m,c/4} = 0.09$. Calculate the location of center of pressure.   10

3   Thin airfoil theory is used to determine the aerodynamic characteristics of airfoil. Starting from the fundamental equation of the theory, derive the expressions for the coefficient of lift and zero-lift angle of attack for cambered airfoil.   35

4(a) "Aerodynamic characteristics of wing are different from its airfoil section"- What are the differences and why these differences arise? Explain with sketches.   08

4(b) For the following flight conditions, explain the significant feature of the flow field and different drag that arise-   09
    (i) A wing in subsonic incompressible flow,
    (ii) An airfoil in supersonic flow,
    (iii)An airfoil in hypersonic flow.

4(c) A rectangular, untwisted wing of aspect ratio 3 and span length of 12 m has an airfoil section with the lift-curve slope of 6. The flight velocity is 90 m/sec and angle of attack is $5°$. Determine the circulation distribution by retaining only two terms of the Fourier sine series in the expression of circulation and satisfying at $\theta = \pi/4$ and $\pi/2$. Calculate the lift at the mid-section of the wing.   18

SECTION-B

5(a) Explain why the induced drag depends on lift. Show that the highest possible aspect ratio of the wing is required to reduce the induced angle of attack and the induced drag coefficient for elliptic distribution of circulation.   20

5(b) Why elliptical planform wing are rarely use in airplanes albeit being most efficient aerodynamically?   05

5(c) The measured lift slope for NACA 23012 airfoil is 0.11 per degree and $\alpha_{L=0} = -1.3°$. 10
Consider a finite wing made of this airfoil section, with AR = 8 and taper ratio = 0.6.
Calculate the lift and induced drag coefficient for this wing at a geometric angle of attack
of 7°. Assume $\delta = \tau$.

6(a) Explain Prandtl-Glauert rule with necessary figure. 10

6(b) Derive the velocity potential equation for an inviscid, compressible and subsonic flow over 15
an airfoil.

6(c) For an airfoil, the low speed incompressible wind tunnel test results are given by- 10

$$(t/c)' = 0.05, \qquad \alpha' = 4°, \qquad C_l' = 0.8.$$

Determine the lift coefficient of the same airfoil at $M\infty = 0.6$. What should be the
thickness-to-chord ratio and the angle of attack of the same airfoil for compressible flows?

7(a) Explain with sketches, why subsonic airfoils should not be used in supersonic flight? 05

7(b) "Supersonic flow field is dominated by the creation of different waves unlike of subsonic 10
flow"- Justify the statement. Explain how the different waves are created?

7(c) "Shock-expansion wave theory provides the exact analytical solution of supersonic flow 05
over a body"- What are the conditions that must be fulfilled to employ the theory?

7(d) Derive the lift and wave drag coefficients using linear theory for flow over a symmetrical 15
double-wedge, 10% thick supersonic airfoil when the Mach 2.2 flow meets the upper
surface-1 as shown in the figure. If thickness-to-chord increased to 15%, compare and
comment on the lift-to-drag ratio.
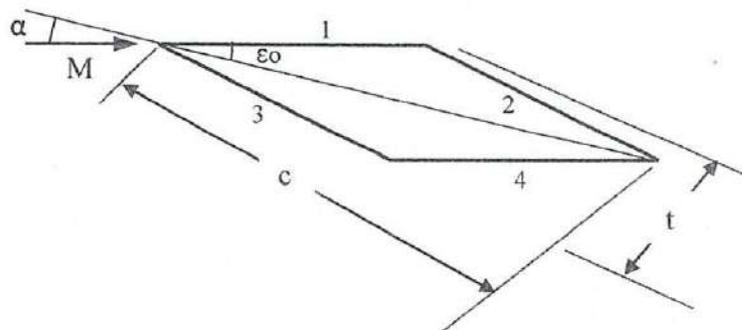
8(a) Explain how the following techniques help to reduce the large wave drag in transonic 15
flight-
    (i) Wing sweep, (ii) Supercritical airfoil, and (iii) Area rule.

8(b) Explain viscous interaction phenomena for hypersonic flow. 08

8(c) Derive the lift and wave drag coefficients for a flat plate in hypersonic flow. 12

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year 1st Term Examination, 2021

ME 4015
(Automobile Engineering)

Time: 3 Hours   Total Marks: 210

N.B.: i) Answer any THREE 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) What is meant by automobile? Briefly explain the classification of automobile.   10

1(b) Why engine is used in an automobile? Draw a schematic diagram of an automobile engine and explain its working procedure.   15

1(c) Draw a piston and piston rings of an IC engine and describe the functions of different types of piston rings.   10

2(a) What is firing order? Mention the firing order of a six cylinder inline engine and a Ford V-6 engine.   06

2(b) What are the basic systems require running a SI engine? Explain the exhaust system with neat sketch.   10

2(c) What is meant by octane rating? List out the characteristics of a good quality gasoline.   07

2(d) What are the various circuits of a carburetor? Explain the working principles of the accelerator circuit system of carburetor with neat sketch.   12

3(a) Mention the basic purpose of antifreeze in the cooling system.   06

3(b) What is sludge? How and why does it form? How can it be prevented?   10

3(c) Mention the purposes and types of cooling system. Describe the construction of a radiator and explain how it operates.   12

3(d) Mention the causes of knocking in SI and CI engines.   07

4(a) Why electrical system is important in an automobile? Draw a typical automotive electrical system showing the major electrical units.   10

4(b) 'Battery is the heart of the electrical system in an automobile'- Explain. Analyze the charging and discharging system of a lead acid battery.   10

4(c) What are the types of electronic ignition system? Compare between each of them.   10

4(d) What are the advantages of using alternator over dynamo?   05

SECTION-B

5(a) Describe the construction of a clutch plate.   09

5(b) What are the functions of torsion spring and cushion spring of a clutch plate.   06

5(c) Why synchronizer is used in a gear box and how does it works? Explain briefly.   10

5(d) What are the purposes of differential? Describe the operation of a differential with neat sketch.   10

6(a) Explain the power flow system in reverse gear with a neat sketch. 08

6(b) Describe the working principle of hydraulic brake system used in a modern car with necessary diagram. 12

6(c) Why power brake is used? Describe the operating principle of a power brake. 07

6(d) Describe the functions of a master cylinder of hydraulic brake system with neat sketch. 08

7(a) What is meant by front wheel geometry of a car? Draw and explain the different front wheel geometry of a modern car. 12

7(b) Compare the function and operation between the supercharger and turbocharger used in an automobile. 08

7(c) Explain why spring and shock absorber both are used in suspension system? 07

7(d) Show different types of tyre inflation. Mention the causes and remedies of excessive tyre wear. 08

8(a) What is Hybrid car? Compare its construction and operation with EV and normal car. 10

8(b) What is catalytic converter? How does it work in the car exhaust system? 08

8(c) Mention the purposes of tyre in automobile. Discuss the merits and demerits of radial ply tyre over bias ply tyre. 08

8(d) What are meant by IC engine pollution and emission? Describe any one pollution control system. 09

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year 1st Term Examination, 2021
ME 4127
(Operations Management)
Time: 3 Hours   Total Marks: 210

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

1   Khulna shipyard is an autonomous organization. It builds new ships as well as repair old ships. It also makes to order spare parts. More than 500 employees (engineers, technicians, helpers etc.) are working in the organization. It has various types of small and large machine tools to support its production processes. The yearly turnover is Tk. 1 billion. You are asked to answer the following questions with respect to this organization.

(a) Define production process.   05
(b) Does Khulna shipyard represent a production system? If so, identify the input,   10
     output and processes of it.
(c) Describe the role of operations manager for this organization.   10
(d) Suggest an appropriate layout for this organization and justify your answer.   10

2   The xyz publisher wants to introduce a new magazine for university students. The success of the proposed venture will depend on the future circulation. The data collected for a monthly capacity of 1 million copies are as follows:
Fixed monthly cost is $300,000, variable unit cost per copy is $0.8 and selling price is $2.00   10
per copy. Answer the following questions for this situation.

(a) What is meant by break-even analysis? Is it possible to have more than one break-   15
     even points? If yes, explain with example.
(b) Plot a break-even chart and identify the break-even point and monthly circulation   10
     needed to break-even point?
(c) What is the loss or total profit before taxes for a monthly circulation of 500,000
     copies?

3   Mr. X has business proposal from his friend Mr. Y. If Mr. X invests Tk. 10,00,000/- today, he will receive annual cash flow as profit is as follows:
at the end of 1st year Tk. 50,000/=
at the end of 2nd year Tk. 1,00,000/-
at the end of 3rd year Tk. 2,00,000/-
at the end of 4th year Tk. 3,50,000/-
at the end of 5th year Tk. 2,50,000/-
at the end of 6th year Tk. 1,50,000/-
at the end of 7th year Tk. 1,25,000/- and
8th year is the closing year and he will receive Tk. 75,000/- as salvage value. In this context, answer the following questions.

(a) What is meant by discounted cash flow? Why cash flow is discounted? Explain.   10
(b) Write down the names of different methods to evaluate business proposal and   10
     explain under what circumstances they are used.
(c) Evaluate whether the given business proposal for Mr. X is profitable or not if the   15
     cost of capital is 10%.

4   Mr. Karim has a workshop to make products for customers according to their requirement. At the beginning of each day, he performs the loading and sequencing of the awaiting jobs. Sunday he has 5 jobs to be processed on Monday. All these jobs are to be processed first in m/c-1 and then in m/c-2. The required times in m/c-1 and in m/c-2 are as follows:

Jobs	A	B	C	D	E
m/c-1	15	5	8	9	12
m/c-2	7	10	16	3	5

Answer the following questions for this situation.
(a) What are meant by loading and sequencing?   05

(b) What are the information required for loading and sequencing? Explain. 05
(c) Sequence the jobs to minimize total processing time. 10
(d) Draw a Gantt chart and determine the percentage of idle time for each machine. 15

SECTION-B

5(a) Define method study. Justify why method study should proceed before work measurement. 10

5(b) Why time estimate is needed? Explain. 10

5(c) What is meant by THERBLIG? A boy wants to take a pencil from the pen stand to write his home works. Identify the THERBLIG's for this task. 10

5(d) Why work measurement is necessary? Explain with example. 05

6 Mr. Arif decided to setup a workshop for make to order. He appointed you as a project manager for this purpose. In this context, answer the following question:
(a) What is meant by project? Is this a project? Justify your answer. 05
(b) Identify the tasks to be done and their technological sequence. 10
(c) Draw the network for this project and 10
(d) Identify the critical path and completion time of the project. 10

7(a) What is meant by forecasting? What factors are to be considered for selecting forecasting method? Discuss. 10

7(b) A manufacturer of a toy requires the parts as shown in the accompanying product tree. 20
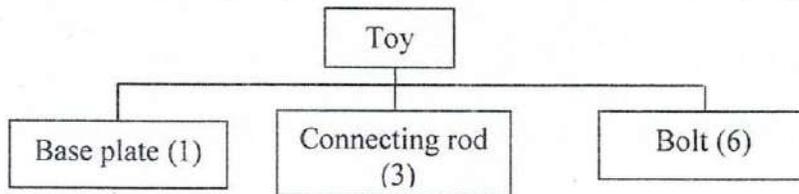
The master production schedule for the next 8 weeks calls for 150 toys in week 3, 250 in week 5, 200 in week 6 and 500 in week 8. The lot size, lead times and initial inventory are shown below:

Part name	Lot size	Lead time; week	Initial inventory
Base plate	500	2	400
Connecting rod	1000	2	700
Bolt	2000	1	1100

Determine the material requirements planning schedule for the parts.

7(c) Describe a forecasting method for new product? 05

8(a) What is CPM and PERT? Differentiate those methods. 05

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

8(c) The demand for certain item is 60,000 units/year. The setup cost for each production run has been estimated at $240 and inventory carrying charges at $15 per unit per year. The production rate is 768 units/day and there are 250 working days per year. Determine: 20
(i) The optimum production lot.
(ii) The time between production runs.
(iii)The duration of each production run.
(iv)The number of production runs/year and
(v) The minimum incremental cost.