KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year 1st Term Examination, 2022

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)	Briefly explain the main components of an automobile with a schematic diagram.	10
1(b)	Classify engine valves. Which type of valve is suitable for bulky engines? Explain the working mechanism with proper diagram.	09
1(c)	Why is a suction valve larger than an exhaust valve? Mention the firing order for a 6-cylinder engine.	08
1(d)	What are the two basic types of piston ring? How many of them are used in modern engines and why?	08
2(a)	What is the function of a venture tube in a Carburetor? Explain.	05
2(b)	Write down different circuits of a Carburetor.	07
2(c)	Explain the working principle of chock circuit.	07
2(d)	Why is float used in a Carburetor? Explain its operation principle.	06
2(e)	Why is rich mixture necessary during starting?	10
3(a)	Classify different types of safety devices for automobile? Demonstrate the importance of ECU in deploying air bag when accident occurs.	10
3(b)	Mention the basic purpose of antifreeze in the cooling system.	06
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)	What are the differences between turbocharger and supercharger? Design a light weight vehicle with a suitable supercharger.	09
4(b)	What are the faults of a lead-acid battery? Describe the causes and remedies of sulfation.	08
4(c)	Analyze the charging and discharging system for lead acid battery. Propose a solution for higher density charging battery that is suitable for Electric Vehicle (EV).	10
4(d)	Describe the operating principles of over-running clutch in a starting motor.	08

SECTION-B

5(a)	State the function of a clutch in an automobile. Explain the operation of a diaphragm spring clutch with neat sketch.	12
5(b)	Draw and explain the functions of a differential, universal joint and CV joint in automobile power transmission systems.	09

5(c)	How can the drive wheels be identified? State the advantages of four wheel drives.	09
5(d)	Describe the necessity of using gear box in a vehicle.	05
6(a)	Why is synchronization necessary for shifting gears? Describe how it works.	07
6(b)	Explain the power transmission in reverse gear for four speed transmission with all forward speed gears in constant mesh.	10
6(c)	Why is power brake used? Describe the operating principle of a power brake.	08
6(d)	Why is master cylinder used in automobiles? Describe the working principle of hydraulic brake system used in automobiles.	10
7(a)	Why is differential gear box used?	10
7(b)	What is meant by front wheel geometry of a car? Explain the different front wheel geometries of a car.	10
7(c)	Why are springs used in suspension systems? Describe the operation principle of a telescope type shock absorber.	08
7(d)	What is muffler? Show that the construction of a muffler with a diagram and label it properly.	07
8(a)	What is catalytic converter? How does it work in the car exhaust system?	09
8(b)	Discuss the merits and demerits of radial tyre over a bias ply tyre.	08
8(c)	Mention the merits and demerits of a disc brake over drum brake.	08
8(d)	What are meant by IC engine pollution and emission? Describe any pollution control system.	10

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B. Sc. Engineering 4th Year 1st Term Examination, 2022

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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iii) Assume reasonable data if any missing.

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. 12

1(b) Define production system. Also describe different types of production system. 12

1(c) Describe the role of operation management in an organization. 11

2(a) Define and explain the following terms: 10
(a) Marginal cost, (ii) Opportunity cost, (iii) Sunk cost, and (iv) Depreciation.

2(b) What is meant by time value of money? Describe the declining balance method for calculating depreciation cost. 10

2(c) KUET authority wants to purchase a milling machine and advertises in a newspaper. Two companies bid for the proposal and these are follows. 15

	Company A	Company B
Initial cost of the machine	$ 12000	$ 11000
Yearly operating cost	$ 1100	$ 900
Economic life of the machine	6 years	8 years
Salvage value after economic life	$ 1000	$ 800

Considering the rate of annual interest 10 percent, which milling machine should be purchased by KUET authority?

3(a) Define project. How is it different from program? Why is it used? 08

3(b) Write down the responsibilities of a project manager. 07

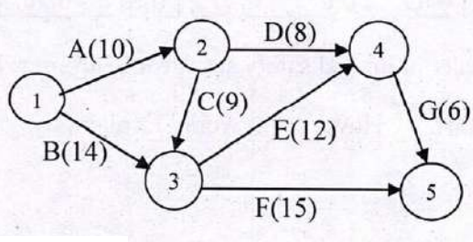
3(c) What are meant by redundant activity? The following activities listed below are for a construction work. Eliminate the redundant activities and draw a network diagram. 20

Activity	Immediate Predecessors
A	-
B	-
C	A
D	A, B, C
E	A, B, C
F	A
G	C, E, F
H	D, E, F, G

4(a) Write down the ethical issues of a project. 06

4(b) Explain the advantages and disadvantages of network techniques. 09

4(c) Calculate ES, EF, LS, LF and total float for each activity and critical path for the following network. 20



SECTION-B

5(a) "The whole is greater than the sum of the parts"- To what extent do you agree or disagree with this statement and why. 15

5(b) Why popularity of place is considered as subjective factor and cost of land is considered as objective factor? 08

5(c) Distinguish between process and product layout. Give an example of each. 12

6(a) How productivity can be increased with the same machine efficiency? 10

6(b) Why location analysis is important for a company? List the reasons for relocation of an organization. 08

6(c) The City Bank decided to relocate its Khulna branch to another city. Three alternative sites: Barishal, Jashore and Kushtia are being considered. The total annual costs are estimated as: Barishal Tk. 6.7 million, Jashore Tk. 6.2 million and Kushtia Tk. 6.3 million. The most important subjective factors are (i) Govt. bureaucracy, (ii) political stability and (iii) service availability. All these are viewed as equally important. It is also considered objective factors equally important as subjective factors. The following results were obtained by pair wise comparison. 17

Sites	Govt. Bureaucracy			Political stability			Service availability		
	1	2	3	1	2	3	1	2	3
Barishal	0	1	-	1	1	0	1	0	-
Jashore	1	-	1	1	-	0	1	-	1
Kushtia	-	0	1	-	0	1	-	1	0

7(a) Enumerate steps of forecasting process. 10

7(b) The number of housing units built quarterly in Khulna city is as shown below: 25

	Quarter			
Year	Q_1	Q_2	Q_3	Q_4
2011	50	95	80	60
2012	55	90	85	70
2013	60	105	100	85
2014	55	110	95	100
2015	65	120	110	90

(i) Obtain a least square trend line and calculate the standard error of the estimate.
(ii) Using the regression line above, obtain a forecast for the year 2016 and specify a 95% confidence level.

8(a) What is meant by inventory? What are the different types of inventory? Explain. 10

8(b) Compare between job shop and flow shop scheduling. 08

8(c) The lead time demand distribution for a spare part used by service department of an imported car dealer is as follows: 12

The lead time demand	20	21	22	23	24	25	26
Probability	0.05	0.05	0.25	0.25	0.30	0.25	0.05

Determine the appropriate reorder point and safety stock for a 90% service level.

8(d) What is the purpose of ABC analysis? How does it work? Explain. 05

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B. Sc. Engineering 4th Year 1st Term Examination, 2022

ME 4083

(Robotics)

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(a)	Describe the historical evolution of robot. Discuss the law of robotics proposed by Asimov.	15
1(b)	What are the special features and challenges to build a humanoid robot and a medical robot.	10
1(c)	"Robotic Automation is considered as the future of modern manufacturing"- justify the statement.	10
2(a)	Derive the transformation matrix for mappings involving rotation and translation. Frame {B} is rotated relative to frame {A} about $\hat{Z}$ by 45°, translated 50 units in $\hat{X}_A$, and 35 units in $\hat{Y}_A$. Find A_P, where $B_P = [15\ 27\ 0]^T$.	15
2(b)	Draw a robot manipulator for cylindrical workspace. Mention its components, draw the frames and find the position and orientation of the EE with respect to base.	15
2(c)	What are the significance of D-H parameters in robot kinematics?	05
3(a)	Explain the role of inverse kinematics in an industrial pick and place robot. How to confirm about the existence of solution and multiple solutions in inverse kinematics?	10
3(b)	For a 2-link manipulator of length l_1 and l_2, find the joint angles θ_1 and θ_2. (End effector position is arbitrary in space).	15
3(c)	Draw a link frame arrangement and derive the equations for linear and angular velocity.	10
4(a)	What are the relationship between Jacobian and singularity with necessary equations and sketches.	08
4(b)	What is the significance of dynamic modeling in robot manipulator? Briefly explain the difference between Newton-Euler and Lagrangian method of dynamic modeling.	09
4(c)	Derive the expressions of joint torques of a two link planner manipulator.	18

SECTION-B

5(a)	Write short note on path planning and trajectory planning. Why are via points important in robot path generation?	07
5(b)	Explain the significant difference between path generation in task space and joint space with examples.	10
5(c)	Derive the equation of robot trajectory by using the cubic polynomial with via points. A revolute joint of a robot is motionless at 5°. It is desired to move the joint to 90° in 5 sec. Find the equation of position, velocity and acceleration using cubic polynomial method and draw the graphs.	18
6(a)	What are the popular control systems used in robotics? Explain briefly.	08
6(b)	Analyze the time response of a second order system with varying effect of ω_n and ξ.	08

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.	09
6(d)	Draw a block diagram of trajectory following control system for a robot with disturbance force.	10
7(a)	What does it mean by Robot Architecture? Briefly discuss the sense-plan-act (SPA) paradigm.	10
7(b)	What are the sensors that should be engaged in autonomous vehicle for its safe driving? Which characteristics of those sensors must be maintained? Explain in brief.	12
7(c)	Suppose you work in the production section at a renowned pharmaceutical company. As an inspection manager, which type of sensors you can implement to monitor the weight and thickness of tablets and why?	13
8(a)	Why do electric actuators are more preferable in robotics than hydraulic and pneumatic actuators? Discuss with proper justification.	12
8(b)	Describe the working principle of a solenoid valve. How does a stepper motor works?	12
8(c)	What are the typical robot programming methods? Discuss the present scenario of offline programming in the context of robotics.	11

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ME 4105

(Applied Thermodynamics)

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(a) What is meant by "thermal refinement" in relation to gas turbine plant? Discuss the three thermal refinement strategies with appropriate diagrams. 10

1(b) Show that the efficiency of ideal gas turbine cycle with regenerator (Heat exchanger) depends on both maximum cycle temperature and pressure ratio. 11

1(c) A gas turbine plant operates on Brayton cycle with lower and upper temperature limits being 30°C and 910°C. The efficiencies of turbine and compressors are 80% and 85% respectively for actual cycle. What would be the optimum value of pressure ratio if the turbine is to be operated for maximum power output? Also determine the plant efficiency for that calculated pressure ratio. 14

2(a) What are the essential differences between turbo-jet and turbo-prop engines? With neat sketch, describe the working principle of Ramjet engine. 10

2(b) Show that the efficiency of rocket propulsion can be expressed as $\eta_{rocket} = \frac{2q}{1+q^2}$, where the symbols have their usual meanings. 11

2(c) A turbo-jet engine flying at a speed of 780 km/hr consumes air at the rate of 38 kg/sec. Given the enthalpy change for the nozzle is 200 kJ/kg, velocity coefficient is 0.96, air-fuel ratio is 73, heating value of the fuel is 45 MJ/kg and combustion efficiency is 95%; calculate: (i) Thrust specific fuel consumption, (ii) Thermal efficiency of the plant, (iii) Propulsive power, and (iv) Overall efficiency. 14

3(a) Why is staging done in steam turbine? Describe the principal features of pressure staging. 10

3(b) Show that for frictionless and symmetrical blading, the maximum diagram efficiency of an impulse turbine can be expressed as, $\eta_{d\max} = \cos^2\alpha$, where α is the nozzle angle. 10

3(c) Steam issues from the nozzles of a de Laval turbine with a velocity of 920 m/sec. The nozzle angle is 20°, the mean diameter of the blade is 26 cm and speed of rotation is 20,000 rpm. The mass flow through the turbine nozzles and blading is 0.2 kg of steam per second. If the friction loss in the blade channels is 34% of the kinetic energy corresponding to the relative velocity at inlet to the blades, draw the velocity diagram and calculate the followings: 15
(i) Velocity of whirl, (ii) Tangential and axial forces on blades,
(iii) Work done on the blades, and (iv) Blade efficiency.

4(a) What is meant by degree of reaction? Draw and explain the condition curves in h-s diagram for a multi-stage turbine. 11

4(b) What are the different internal losses encountered in steam turbine? How disc friction losses are estimated? 11

4(c) From the expression of blade outlet angle, show that in reaction turbine both impulse and reaction part contribute to the final absolute velocity. 08

4(d) What are the different types of plate blade sections? 05

SECTION-B

5(a) What is the physical significance of volumetric efficiency? How inlet valve timing and engine speed affect volumetric efficiency? 09

5(b) With the help of indicator diagram, explain (i) Indicated work/cycle, and (ii) Pumping work/cycle. 10

5(c) The air flow to the four cylinder four stroke petrol engine is measured by means of 7 cm diameter sharp-edged orifice with $C_d = 0.65$. During the engine test on the test bed, the following data were recorded: 16
bore = 11 cm, stroke = 13 cm, engine speed = 2200 rpm, brake power = 38 kW, fuel consumption = 7 kg/hr, heating value of fuel = 42.5 MJ/kg. The pressure across the orifice is 5 cm of water, atmospheric temperature and pressure = 22°C and 1 bar, respectively. Calculate- (i) Thermal efficiency on the basis of brake power, (ii) Brake mean effective pressure, (iii) Volumetric efficiency based on free air condition.

6(a) What are the engine variables that control the flame speed of an IC engine? 11

6(b) How spark timing influences MBT? Discuss the factors that increase the tendency to knock in SI engine. 12

6(c) Define the following terms: 12
(i) Squish, (ii) Tumble, (iii) Swirl, and (iv) Blow-by.

7(a) What is meant by "scavenging"? "2-stroke CI engine is more common than 2-stroke SI engine." – Explain the statement. 10

7(b) "A good SI engine fuel is a bad CI engine fuel." – Explain with appropriate figures. 12

7(c) What are the different methods of generating swirl in CI engine? Describe compression swirl and induction swirl with their advantages and disadvantages. 13

8(a) How chemical structure of fuel determines the ignition quality? Explain fractional distillation and chemical conversion processes in brief. 12

8(b) What is meant by supercharging? Describe the principle of operation of a turbo-charger and its advantages. 11

8(c) Explain the following terms: 12
(i) Anti-knock, (ii) Pro-knock, (iii) Sensitivity of fuel, and (iv) Cetane number.