

National Institute of Technology Patna

Department of Mechanical Engineering

End Semester Examination, January-June, 2024

Program Name: B. Tech.

Course Title: Fluid Mechanics and Machinery

Section: A

Time: 3 hours

Course Code: Semester: 4th
Ma2102
60

Instructions:

Answer all questions. All notations carry their usual meanings. Make suitable assumptions if necessary.

- Q. 1** (i) Consider a device with one inlet and one outlet. If the volume flow rates at the inlet and at the outlet are the same, is the flow through this device necessarily steady? Why? (5×2=10)
- (ii) What is significant about curves of constant stream function? Explain why the stream function is useful in fluid mechanics.
- (iii) Discuss how the Bernoulli equation differs between an inviscid, rotational region of flow and a viscous, irrotational region of flow. Which case is more restrictive?
- (iv) Which has a greater minor loss coefficient during pipe flow: gradual expansion or gradual contraction? Why?
- (v) What is a draft tube, and what is its purpose? Describe what would happen if turbomachinery designers did not pay attention to the design of the draft tube.
- Q. 2(a)** The velocity along the centerline of a nozzle of length L is given by $V = 2t \left(1 - \frac{x}{2L}\right)^2$ (5) where velocity V in m/s , time t in seconds from the commencement of the flow, x is the distance from the inlet to the nozzle. Find the convective acceleration, local acceleration, and the total acceleration when $t = 3 s$, $x = 0.5 m$, and $L = 0.8 m$.
- Q. 2(b)** Consider fully developed Couette flow—flow between two infinite parallel plates separated by distance h , with the top plate moving and the bottom plate stationary as

illustrated in Fig. 1. The flow is steady, incompressible, and two dimensional in the xy -plane. The velocity field is given by $\vec{V} = V \frac{y}{h} \hat{i} + 0 \hat{j}$.

- Is this flow rotational or irrotational?
- If it is rotational, calculate the vorticity component in the z direction.
- Do fluid particles in this flow rotate clockwise or counterclockwise?

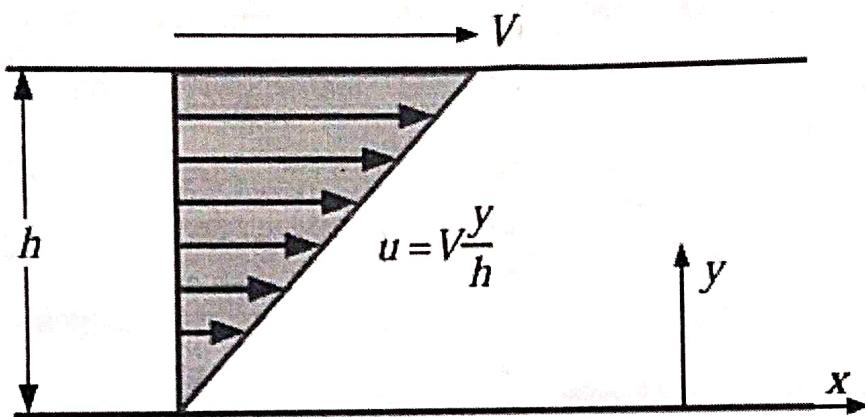


Fig. 1

- Q. 3(a) Air flows through a pipe at a rate of 200 L/s in Fig. 2. The pipe consists of two sections of diameters 20 cm and 10 cm with a smooth reducing section that connects them. The pressure difference between the two pipe sections is measured by a water manometer. Neglecting frictional effects, determine the differential height of water between the two pipe sections. Take the air density to be 1.20 kg/m^3 . (7)

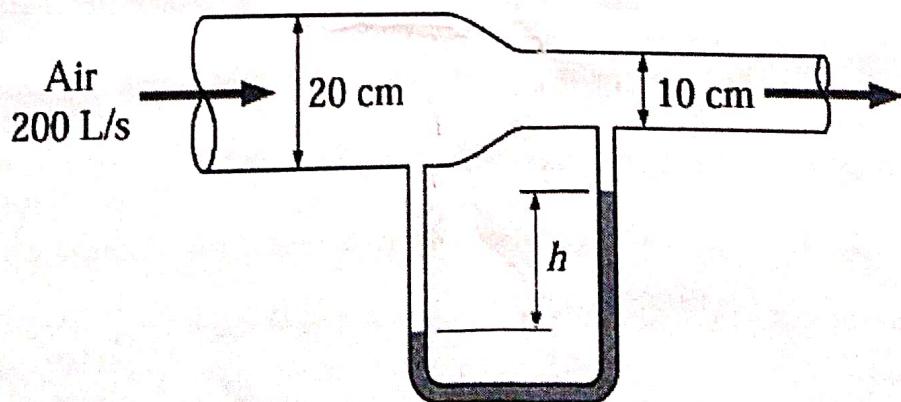


Fig. 2

- Q. 3(b) The water jet in Fig. 3 strikes normal to a fixed plate. Neglect gravity and friction, and compute the force F required to hold the plate fixed. (3)

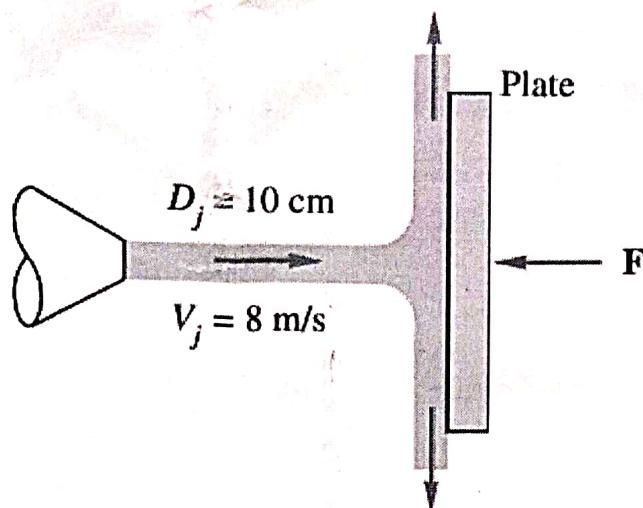


Fig. 3

- Q. 4(a) In a fuel injection system, small droplets are formed due to the breakup of the liquid jet. Assume the droplet diameter d is a function of the liquid density ρ , viscosity μ , surface tension σ , the jet velocity V , and jet diameter D . Form an appropriate set of dimensionless parameters using μ , V , and D as repeating variables. (6)

- Q. 4(b) Glycerin at 40°C with $\rho = 1252 \text{ kg/m}^3$ and $\mu = 0.27 \text{ kg/m.s}$ is flowing through a 5-cm-diameter horizontal smooth pipe with an average velocity of 3.5 m/s. Determine the pressure drop per 10 m of the pipe. (4)

- Q. 5(a) A smooth flat rectangular plate is placed longitudinally in a stream of fluid. At what fraction of the length from the leading edge will the drag force on the front portion be equal to half of the total drag force? Assume the boundary layer to be laminar. (4)

Q. 5(b) In a certain viscous, incompressible flow field with zero body forces the velocity components are $u = ay - b(cy - y^2)$ and $v = w = 0$, where a, b , and c are constants.

(6)

(i) Use the Navier-Stokes equations to determine an expression for pressure gradient in the x direction.

(ii) For what combination of the constants a, b , and c (if any) will the shear stress τ_{yx} be zero at $y = 0$ where the velocity is zero.

Q. 6(a) The minimum value of net positive suction head ($NPSH_{min}$) for a pump is given by the manufacturer as 6.3 m . The pump is proposed to be installed in a reservoir to lift water at the rate of $0.30\text{ m}^3/\text{s}$, with the water level in the reservoir being 1.50 m below the axis of the pump. The atmospheric pressure and the vapor pressure can be taken as 98.00 kN/m^2 and 2.30 kN/m^2 , respectively. Assume the total head loss in the suction pipe as 1.70 m of water, examine whether the proposed installation is safe from cavitation effects.

(5)

Q. 6(b) A model of a water turbine is tested in a laboratory. The diameter of the model is 8.0 cm , its volume flow rate is $17.0\text{ m}^3/\text{h}$, it spins at 1500 rpm , and it operates with a net head of 15.0 m . At its best efficiency point, it delivers 450 W of shaft power. Calculate the efficiency of the model turbine. What is the most likely kind of turbine being tested?

(5)

Department of Mechanical Engineering
National Institute of Technology Patna
Manufacturing Process-II (ME42103)
End Semester Examination JAN-JUNE, 2024
Date: May 15, 2024

Timing: 09:30 AM - 12:30 PM

B. Tech.: 4th Sem.

Max. Marks:

Instruction:

1. Attempt any 4 Questions only.
2. Assume appropriate data if required.
3. The Marks, CO (Course Outcome) and BL (Bloom's Level) related to questions are mentioned on the right-hand side margin.

		Marks	CO	BL
1.(a)	A steel washer of 40 mm outer diameter and 22 mm inner diameter is to be made from 1.2 mm thick sheet in one operation. If the shear stress is 400 N/mm ² and percentage penetration is 20%, determine: (i) Maximum punch force necessary to blank and punch the washer. (ii) Reduction in punch force if 0.5 mm double shear is ground on the tool.	8	1	4
1.(b)	(i) Define neutral point and neutral plane in rolling process. (ii) What do you understand by draft on forging and why it is provided?	7	1	2
2.(a)	Derive the expression for drawing stress " σ_d " during the tube drawing with stationary mandrel when there is no friction.	8	1	4
2.(b)	Define powder metallurgy. What are the necessary steps involving in the powder metallurgy? Discuss in detail.	7	2	3
3.(a)	(i) Explain the three methods that can be employed to generate a tapered surface on lathe. (ii) Illustrate differences between orthogonal and oblique cutting. Draw neat sketches.	8	2	3
3.(b)	List the various types of milling cutters and discuss the applications of each.	7	2	2
4.(a)	(i) With diagram explain the working principle of quick-return mechanism. (ii) Explain different types of drilling machine with their applications.	8	2	2
4.(b)	Define broaching. When is the use of this process recommended? Discuss the advantages and limitations of broaching operations.	7	3	2
5.(a)	(i) Explain centreless grinding. (ii) Discuss broaching. (iii) Define tool life. (iv) How clearance is given in sheet metal working?	8	1,3	1
5.(b)	Use sketches to illustrate the different types of machining chips and explain when and why we can expect to have each of these types.	7	2	2



NATIONAL INSTITUTE OF TECHNOLOGY PATNA
DEPARTMENT OF MECHANICAL ENGINEERING
END SEMESTER EXAMINATION, Jan-June 2024

B.Tech: IVth Semester

Course Name: Industrial Engineering & Management
TIME: 09:30 AM to 12:30 PM

DATE: 18/05/2024
Course Code: ME42105
MAX. MARKS: 60

INSTRUCTIONS:

1. Answer all the Questions.
2. Assume any suitable data, if necessary.
3. The Marks, CO (Course Outcome) and BL (Bloom's Level) related to questions are mentioned on the right-hand side.

1. Explain the steps in Systematic layout planning (SLP). (5 Marks) [CO-1, BL-2]
2. Explain SIMO Chart with an example. (5 Marks) [CO-1, BL-2]
3. Define forecasting and explain the tracking signal. (5 Marks) [CO-2, BL-2]
4. Discuss the ABC and VED analysis with an example. (5 Marks) [CO-2, BL-2]

5. The elemental times (in minutes) for 4 cycles of an operation using a stop watch are presented below:

Elements	Cycle time in minutes			
	1	2	3	4
1	1.5	1.5	1.3	1.4
2	2.6	2.7	2.4	2.6
3	3.3	3.2	3.4	3.4
4	1.2	1.2	1.1	1.2
5	0.51	0.51	0.52	0.49

Calculate standard time for the operations if

- Element 2 and 4 are machine elements
- For other elements, the operator is rated at 110%
- Total allowance is 15% of the normal time.

(8 Marks) [CO-1, BL-3]

6. A firm believes that its annual profit depends on its expenditures for research. The information for the preceding six years is given below. Estimate the profit when the expenditure is 8 units.

Year	2018	2019	2020	2021	2022	2023	2024
Expenditure for Research	3	4	6	5	12	7	8
Annual Profit	22	27	36	32	45	36	?

(8 Marks) [CO-2, BL-3]

7. The annual demand for an automobile component is 36,000 units. The carrying cost is Rs. 0.50/unit/year, the ordering cost is Rs. 25.00 per order and the shortage cost is Rs. 15/unit/year. Find the optimal values of the following.
- Economic ordering quantity
 - Maximum Inventory
 - Maximum shortage quantity
 - Cycle Time in days
 - Inventory Period in days
 - Shortage Period in days

(8 Marks) [CO-2, BL-3]

8. Consider the data of a Project as shown below:

Activity	Normal Time (Weeks)	Normal Cost (Rs.)	Crash Time (Weeks)	Crash Cost (Rs.)
1-2	13	700	9	900
1-3	5	400	4	460
1-4	7	600	4	810
2-5	12	800	11	865
3-2	6	900	4	1130
3-4	5	1000	3	1180
4-5	9	1500	6	1800

If the indirect cost per week is Rs. 250, find the optimal crashed project completion time
(8 Marks) [CO-3, BL-3]

9. Consider the following 3 machine and 5 jobs flow shop problem. Check whether Johnson's rule can be extended to this problem. If so, what is the optimal schedule and the corresponding makespan?

Job	Machine 1	Machine 2	Machine 3
1	7	4	3
2	9	5	8
3	5	1	7
4	6	2	5
5	10	3	4

(8 Marks) [CO-3, BL-3]

National Institute of Technology Patna

Department of Mechanical Engineering

End Semester Examination, Jan_June 2024

Subject: Kinematics of Machinery
Date: 14/05/2024

Subject Code: ME42104
Time: 3 hr

$$10 \times 6 = 60$$

Answer any six questions

1. A four bar mechanism has the following dimensions: $DA = 300 \text{ mm}$; $CB = AB = 360 \text{ mm}$; $DC = 600 \text{ mm}$. The link DC is fixed and the angle $\angle ADC$ is 60° as shown in Fig. 1. The driving link DA rotates uniformly at a speed of 100 r.p.m. clockwise and the constant driving torque has the magnitude of 50 N-m . Determine the velocity of the point B and angular velocity of the driven link CB . Also find the actual mechanical advantage and the resisting torque if the efficiency of the mechanism is 70% . 10

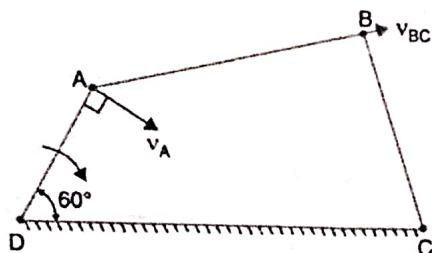


Fig. 1

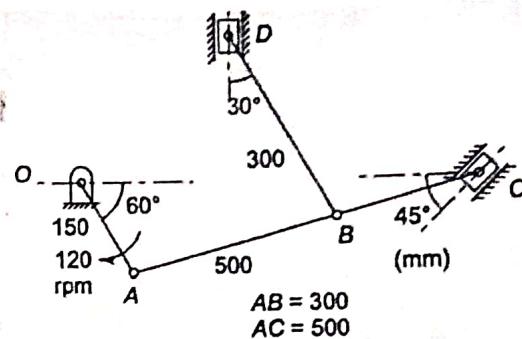


Fig. 2

2. For the four-link mechanism shown in Fig. 2, find the linear velocities of sliders C and D and the angular velocities of links AC and BD . 10

3. a) Write the classification of Cam and Follower.

- b) A cam is to be designed for a knife edge follower with the following data:

Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion. Dwell for the next 30° . During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion and Dwell during the remaining 180° . The radius of the base circle of the cam is 40 mm . Determine the maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 240 r.p.m. 4+6=10

4. What is the function of a governor? State the different types of governors. Explain the term height of the governor. Derive an expression for the height in the case of a Watt governor. What are the limitations of a Watt governor? 1+2+1+4+2=10

5. A Hartnell governor having a central sleeve spring and two right-angled bell crank levers moves between 290 r.p.m. and 310 r.p.m. for a sleeve lift of 15 mm . The sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of each ball is 2.5 kg . The ball arms are parallel to the governor axis at the lowest equilibrium speed. Determine: 1. loads on the spring at the lowest and the highest equilibrium speeds, and 2. stiffness of the spring. 6+4=10

National Institute of Technology Patna

Department of Mechanical Engineering

End Semester Examination, Jan_June 2024

Subject: Kinematics of Machinery
Date: 14/05/2024

Subject Code: ME42104
Time: 3 hr

6. The speed ratio of the reverted gear train, as shown in Fig.3, is to be 12. The module pitch of gears A and B is 3.125 mm and of gears C and D is 2.5 mm. Calculate the suitable numbers of teeth for the gears. No gear is to have less than 24 teeth. 10

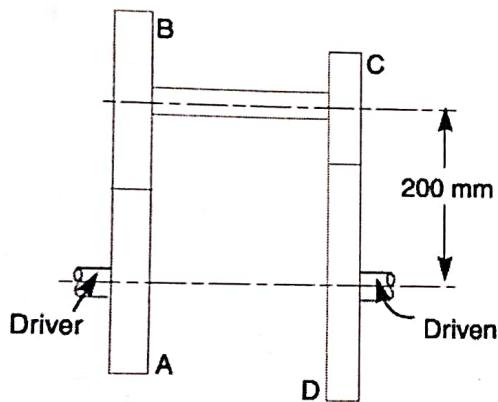


Fig. 3

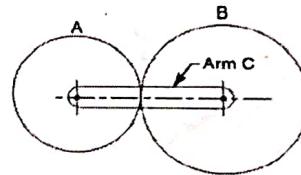


Fig. 4

7. In an epicyclic gear train (Fig. 4), an arm carries two gears A and B having 36 and 45 teeth respectively. If the arm rotates at 150 r.p.m. in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed, makes 300 r.p.m. in the clockwise direction, what will be the speed of gear B? 10



NATIONAL INSTITUTE OF TECHNOLOGY PATNA
Department of Mechanical Engineering
Applied Thermodynamics (ME-42101)
End Semester Examination, Date: 09-05-2024

Time: 09:30 AM – 12:30 PM

Section – A, B & DD

Session: Jan – July 2024

B.Tech. (4th Sem.)

MM: 60

General Instructions:

- i. All questions are compulsory.
- ii. Please note the serial number of the question before attempting it.
- iii. All students bring their own steam table and calculator. **Sharing of steam tables and calculators is not permitted.**
- iv. Students must make sure that nothing is written on their Steam table.
- v. The invigilator is able to examine any of the student steam tables.

1. What do you mean by IBR? What are the advantages of IBR? (CO-2/ BL-1) [4]
2. What do you mean by boiler mounting and accessories? List down four mountings and accessories with their usage. (CO-2/ BL-1) [6]
3. What is the difference between surface and jet condensers? Discuss briefly the effect of air leakage in a condenser. (CO-4/ BL-2) [6]
4. An 80-L vessel contains 4 kg of refrigerant-134a at a pressure of 160 kPa. Determine (a) the temperature, (b) the quality, (c) the enthalpy of the refrigerant, and (d) the volume occupied by the vapor phase. The properties of refrigerant 134a is given below (CO-1/ BL-2)

Pressure	T _{sat}	v_f (m ³ /kg)	v_g (m ³ /kg)	h_f (kJ/kg)	h_{fg} (kJ/kg)
160 kPa	257.55 K	0.0007435	0.12355	31.18	209.96

[8]

5. The following readings were taken during the test at full load on a single cylinder, double-acting condensing type throttle governed steam engine:

Diameter of the cylinder =400 mm, Stroke of the engine =600 mm, Cut-off =50% of stroke Pressure of steam supplied =11 bar, Back pressure =0.8 bar, Brake wheel diameter =4.5 m, Net load on the brake =4900 N, Speed of the engine =150 rpm, Diagram factor =0.82 (i) Find the indicated power, brake power and mechanical efficiency of the engine at full load. (CO-3/ BL-2) [6]

6. In an oil fire boiler the fuel had an analysis by mass: Carbon 84%, Hydrogen 10%, Sulphur 3.2%, oxygen 1.8% remainder incombustible. The analysis of dry flue gas by volume gave: combined CO₂+SO₂ 15.72%, O₂ 1%, there being no CO and SO₃.

Roll No.:.....

Calculate per Kg of fuel (a) mass of air supplied (b) percentage excess air supplied (c) mass of dry flue gas produced (d) mass of water vapor formed. (CO-1/ BL-2) [10]

7. In a steam power plant operating on an ideal regenerative Rankine cycle, steam enters the turbine at 60 bar and 450°C and is condensed in the condenser at 0.2 bar. Steam is extracted from the turbine at 4 bar to heat the feed water in a closed feed water heater and leave the feed water heater as a saturated liquid. Then it is pumped to boiler pressure followed by mixing with the incoming feed water from the condenser (via a pump, thereby raising its pressure to boiler pressure), in a mixing chamber. Show the cycle on a T-s diagram, and determine (a) the net work output per kilogram of steam flowing through the boiler and (b) the thermal efficiency of the cycle. (CO-3/ BL-3)

OR

A steam power plant operates on the reheat Rankine cycle. Steam enters the high-pressure turbine at 12.5 MPa and 550°C at a rate of 7.7 kg/s and leaves at 2 MPa. Steam is then reheated at constant pressure to 450°C before it expands in the low-pressure turbine. The isentropic efficiencies of the turbine and the pump are 85 percent and 90 percent, respectively. Steam leaves the condenser as a saturated liquid. If the moisture content of the steam at the exit of the turbine is not to exceed 5 percent, determine (a) the condenser pressure, (b) the net power output, and (c) the thermal efficiency. (CO-3/ BL-3) [10]

8. In an impulse turbine (with a single row wheel) the mean diameter of the blades is 1.05 m and the speed is 3000 rpm. The nozzle angle is 18° , the ratio of blade speed to steam speed is 0.42 and the ratio of the relative velocity at outlet from the blades to that at inlet is 0.84. The outlet angle of the blade is to be made 3° less than the inlet angle. The steam flow is 10 kg/s. Draw the velocity diagram for the blades and derive the following: (i) Net thrust on the blades (ii) Power developed in the blades (iii) Blading efficiency. (CO-4/ BL-2)

OR

The following data relate to a stage of reaction turbine:

Mean rotor diameter = 1.5 m ; speed ratio = 0.72 ; blade outlet angle = 20° ; rotor speed = 3000 r.p.m. (i) Determine the diagram efficiency. (ii) Determine the percentage increase in diagram efficiency and rotor speed if the rotor is designed to run at the best theoretical speed (or maximum efficiency), the exit angle being 20° . (CO-4/ BL-2) [10]

*****BEST WISHES*****

10 X 10⁵