Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING, MUMBAI

DEPARTMENT OF MECHANICAL ENGINEERING

END SEMESTER EXAMINATION, JUNE 2022

(Direct Second Year Admission Batch)

S. Y. B. Tech (M) Sem IV 6/7/22

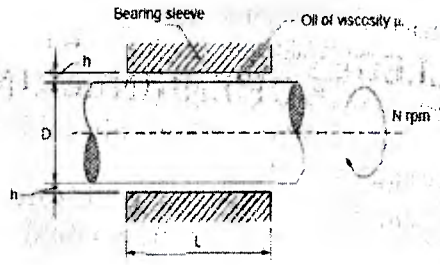
PROGRAM: SY B.Tech. (Mechanical), Semester-IV
COURSE: PE-BTM403 – Fluid Mechanics

Total points: 100
Duration: 3 HOURS

Note:

- Answer any 5 questions. Each question carries 20 points,
- Answer should be question specific and to the point,
- All component of a question must be answered together,
- Data in the last column represents course outcome and Blooms Taxonomy of respective question.

			CO/BT
Q1.	(A) Derive one dimensional area-velocity relation of a compressible flow as a function of Mach number for a variable area adiabatic flow. Interpret the expression to predict pressure and velocity change under subsonic and supersonic flow condition.	**10**	7/4
	(B) The pressure , temperature and Mach number at the entry of a flow passage are 2.45bar, 26.5 °C and 1.4 respectively. If the exit Mach number is 2.5. For the adiabatic flow of a perfect gas with γ=1.3 and R=0.469kJ/kg-K, determine a. Stagnation temperature, b. Temperature and velocity of gas at the exit, and c. The flow rate per square meter of the inlet cross -section.	**10**	7/3,4
Q2.	(A) Derive an expression for the force on a thin plate of given arbitrary shape immersed in a liquid at an angle θ to the free surface. Also find an expression to calculate the centre of pressure.	**10**	2/3,4
	(B) A wooden cylinder having a specific gravity of 0.6 has a concrete cylinder of the same diameter and 0.2 m length attached to it at one end. The specific gravity of the concrete is 2.5. Determine the length of the wooden cylinder for the composite block to float vertically	**10**	2/4
Q3.	(A)Write Reynolds Transport Equation and explain the significance of each term involved in the equation. Use it to derive the integral form of the continuity equation.	**10**	4/1,2
	(B) The distance between the centers of the two arms of a U-tube open to the atmosphere is 25 cm, and the U-tube contains 20-cm-high alcohol in both arms. Now the U-tube is rotated about the left arm at 4.2 rad/s. Determine the elevation difference between the fluid surfaces in the two arms.	**10**	4/3
Q4.	(A) (a) Derive expressions from basics for the pressure inside a droplet and a free jet. (b) Define kinematic viscosity and explain the significance of the same. (c) Distinguish between Newtonian and non-Newtonian Fluids.	**10**	2/2,3 4/3
	(B) A shaft of D = 80 mm, gap(h) = 0.1 mm and length of bearing, L = 0.3 m as shown in the following figure where a lubricating oil of viscosity 0.1 kg/ms and SG. 0.9 is used. (a) if shaft is moved axially at 0.8 m/s, determine the resistive force offered. (b) If shaft is rotated at 1800 rpm, estimate the resistive torque and power required to rotate the shaft.		



Q5. Consider following velocity field **20** 5/4

$$u = 2x^2 + 3y,\ v = -2xy + 3y^2 + 3zy,$$

$$w = -\frac{3}{2}z^2 + 2xz - 9y^2z$$

What can be concluded about the nature of the possible flow field? Write your comment.

Also calculate following at a point (1,1,1) of the flow field.

(a) Find the acceleration and vorticity components at for above flow field.

(b) Shear stress at x-y, y-z and z-x plane.

Q6. (A) What is Couette flow? Mention all assumptions and derive an expression for developed laminar velocity profile for the flow. **10** 4/2

(B) (a) What is boundary layer? Explain the concept of the displacement and momentum thicknesses. **10** 6/4

(b) Write Prandtle's boundary layer assumption and derive the equation for it.

Q7. (A) What is turbulence? What characteristics a turbulent flow has? Write RAN'S equation and explain different terms. **10** 5/1,2

(B) There is a 45° bend in the horizontal plane. The inlet area is 1.2 m^2 and the outlet area is 0.6 m^2. The velocity of water at inlet is 12 m/s. The pressures at inlet and cutlet are 40 and 30 kPa respectively. Calculate the magnitude and direction of the resultant force on the bend. **10** 3/3,4

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SARDAR PATEL COLLEGE OF ENGINEERING, MUMBAI

DEPARTMENT OF MECHANICAL ENGINEERING

END SEMESTER EXAMINATION, MAY 2022

S. Y. B. Tech (Mech) Sem IV 19/5/22

PROGRAM: SY B.Tech. (Mechanical), Semester-IV
COURSE: PE-BTM403 – Fluid Mechanics

Total points: 100
Duration: 3 HOURS

Note:

- Answer any 5 questions. Each question carries 20 points
- Answer should be question specific and to the point.
- All component of a question must be answered togather.
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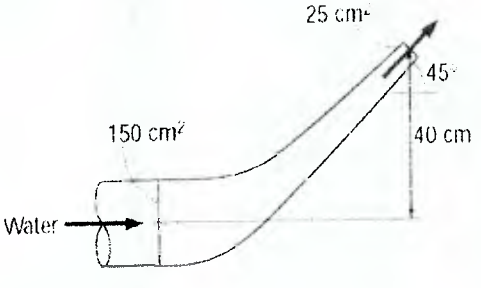
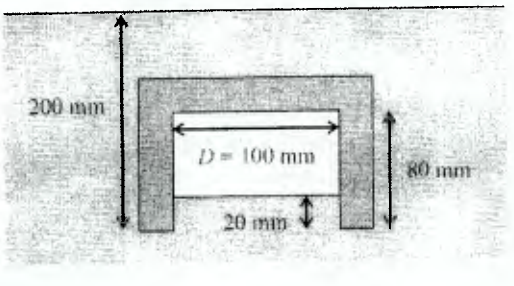
			CO/BT
Q1.	(A) Explain the concept of lift and drag with an illustration. How does the increase in Reynolds number effects the coefficient of drag for flow over a cylinder? Explain it and show its variations graphically.	**10**	6/2
	(B) A reducing elbow is used to deflect water flow at a rate of 30 kg/s in a horizontal pipe upward by an angle θ=45° from the flow direction while accelerating it. The elbow discharges water into the atmosphere. The cross sectional area of the elbow is 150 cm^2 at the inlet and 25 cm^2 at the exit. The elevation difference between the centers of the exit and the inlet is 40 cm. The mass of the elbow and the water in it is 50 kg. Calculate the anchoring force needed to hold the elbow in place, using **Reynold's Transport Equation**.	**10**	4/4



Q2.	(A) Derive a general equation of hydrostatics. Assume a container filled with water fall freely from a certain height. Use this equation to predict the variation pressure inside the liquid.	**10**	2/3
	(B) A cylindrical bowl is inverted symmetrically and held in a dense fluid, SG=15.6, to a depth of 200 mm measured along the centre-line of the bowl from the bowl rim. The bowl height is 80 mm, and the fluid rises 20 mm inside the bowl. The bowl is 100 mm inside diameter, and it is made from an old clay recipe, SG=6.1. The volume of the bowl itself is about 0.9 L. Calculate is the force required to hold it in place?	**10**	2/4



Q3.	(A) Write Navier-Stokes equation for a Newtonian fluid in the differential form. Explain significance of each term in the equation. Simplify it to obtain following • Euler's equation • Stoke's equation	**10**	4/1

(B) The velocity profile of a developed laminar flow in circular cross-section, pipe is given by **10** 4/3

$$u = -\frac{1}{4\mu}\frac{dp}{dx}\left(1 - \frac{r^2}{R^2}\right)$$

Using above profile derive expression for the following quantities-

(i) Maximum velocity
(ii) Discharge rate
(iii) Average velocity
(iv) Ratio of maximum to average velocity
(v) Wall shear stress

Q4. (A) Starting with NS equation, derive Bernoulli's equation along a streamline. List the assumption made if any. Explain the terms - Total energy line and hydraulic gradient line. **10** 4/2,1

(B) Water flows at the rate of 600 l/s through a horizontal venture-meter with diameter 0.5 m and 0.245 m. The pressure gauge fitted at the entry to the venture-meter reads 2 bar. Barometric pressure is 1 bar. Calculate **10** 4/3

(i) Static throat pressure
(ii) Stagnation pressure at inlet and throat
(iii) Total energy at inlet and throat

If same venture-meter is used in vertical arrangement, recalculate all above if converging length is 1.5 m and analyze the results.

Q5. (A) With an illustration explain the theory of boundary layer separation on a body under pressure gradient along the flow. What is its impact on the performance of the body? Suggest and explain any four methods to reduce its impact. **10** 5/4

(B) A second degree velocity distribution in the boundary layer is given by, **10** 6/3

$$\frac{u}{U} = 2\frac{y}{\delta} - \left(\frac{y}{\delta}\right)^2$$

where U is free stream velocity. Using the integral momentum equation determine the expression for the following terms.

(i) the boundary layer thickness
(ii) the boundary layer skin friction coefficient,
(iii) the displacement and momentum thicknesses.

Q6. (A) What is Couette flow? Mention all assumptions and derive an expression for developed laminar velocity profile for the flow. **10** 4/2

(B) A 1.5 km long pipeline (f= 0.04) of diameter 0.6m is used to transport drinking water to a city. In order to augment the discharge, another parallel line of same diameter is introduced in the second half of the length. Neglecting minor losses, find % increase / decrease in the discharge. Assume the head at inlet is 30 m over that at the outlet. **10** 6/4

Q7. (A) List down the characteristic features of a compressible flow compared to an incompressible flow. What is the significance of speed of sound in compressible fluid flow? Derive an expression for it. **10** 7/1

(B) A nozzle is designed to expand air isentropically to atmospheric pressure from a large tank in which properties are held constant at 5°C and 304 kPa(abs). The desired mass flowrate is 1 kg/s. Determine following- **10** 7/3

(i) Stagnation temperature, pressure and density.
(ii) Exit pressure, temperature and Mach number
(iii) Exit area of the nozzle

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING, MUMBAI

DEPARTMENT OF MECHANICAL ENGINEERING

RE-EXAMINATION EXAMINATION, JULY 2022

S.Y. B.Tech (Mech) Sem IV 8/12/22

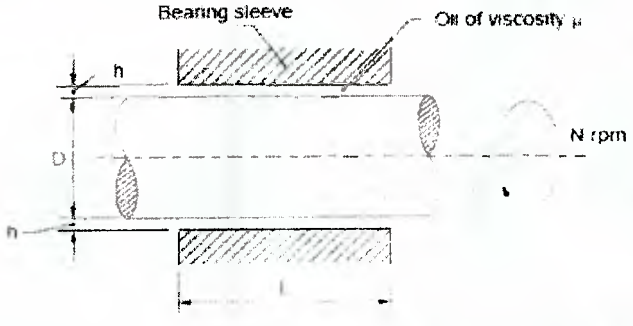
PROGRAM: SY B.Tech. (Mechanical), Semester-IV
COURSE: PE-BTM403 – Fluid Mechanics

Total points: 100
Duration: 3 HOURS

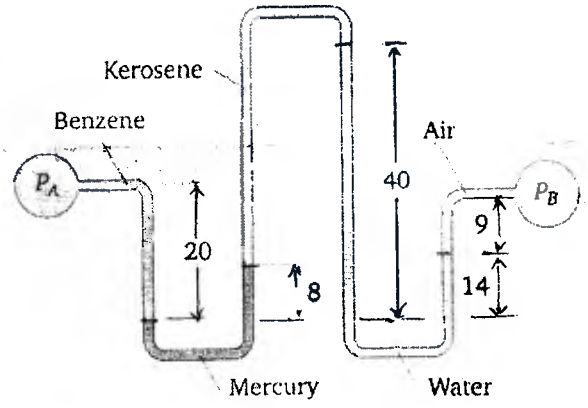
Note:

- Answer any 5 questions. Each question carries 20 points
- Answer should be question specific and to the point.
- All component of a question must be answered togather.
- Data in the last column represents course outcome and Blooms Taxonomy of respective question

			CO/BT
Q1.	(A) Define and explain the following terms. i) Compressible flow, ii) Mach number, iii) Stagnation state, iv) Critical state, and v) Supersonic flow	10	1/2
	(B) If D = 80 mm, h = 0.1 mm and L = 0.3 m as shown below, where a lubricating oil of viscosity 0.1 kg/ms and SG. 0.9 is used. (i) determine the resistive force offered by lubricants if shaft is moved axially at 0.8 m/s. (ii) If shaft is rotated at N=1800 rpm, estimate the resistive torque and power required to rotate the shaft.	10	2,3/3

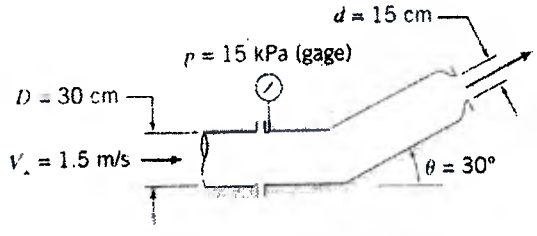


Q2.	(A) 'The surface tension is an interfacial property of a liquid". Explain it with three different examples. How angle of contact and capillary rise/fall associated to this property?	10	1,2/3,4
	(B) Following is an approximate boundary layer velocity profile. $$\frac{u}{U}=2\frac{y}{\delta}-\left(\frac{y}{\delta}\right)^2$$ where U is free stream velocity and remaining terms carries usual meaning. Develop expression for the displacement and momentum thicknesses.	10	2/4
Q3.	(A) Derive differential form of a general continuity equation. Simplify it to obtain continuity equation for (i) a steady flow, (ii) a incompressible flow	10	1,2/5
	(B) A multi fluid manometer is used for a certain application where it appears as shown below. Length shown is in centimetres. Specific gravity of Benzene and Kerosene is 0.88 and 0.80 respectively. Predict P_B-P_A.	10	3/3



Q4. (A) Differentiate between differential and integral approach of solving a flow problem. Write integral and differential form of mass and momentum equation. **10** 4/4

(B) Consider flow of water through a pipe bend depicted below geometrical and operating condition. Calculate the resultant force acting on bend and find the direction of action of that force also. Use Reynolds Transport equation.
If the bend angle, $\theta = 0°$, will there be any resultant force acting on the pipe? **10** 3,4/3,4



Q5. (A) What is turbulence? List down its characteristics and explain it with suitable examples. Write RANS equation of the turbulent flow. **10** 2/1,2

(B) For a given flow field $\vec{V} = 2x\,\vec{i} - yt\,\vec{j}$ m/s where x and y are in meters and t is in seconds. **10** 4/4,5

(i) What is the dimension of flow?
(ii) Is the flow possible?
(iii) Find the equation of the streamline passing through (2,-1).
(iv) Calculate velocity, acceleration, angular velocity and vorticity of flow at a location (1,1,1) and time t = 2s.

Q6. (A) Differentiate between- **10** 1,2/4

i) Lagrangian and Eularian methods of study of fluid flow
ii) Streamlines and streak lines

(B) A wooden cylinder having a specific gravity of 0.6 has a concrete cylinder of the same diameter and 0.2 m length attached to it at one end. The specific gravity of the concrete is 2.5. Determine the length of the wooden cylinder for the composite block to float vertically **10** 2,3/3

Q7. (A) What are minor and major losses in fluid flow. Provide examples with sufficient explanation. **10** 1/1,2

(B) The pressure , temperature and Mach number at the entry of a flow passage are 2.45bar, 26.5 °C and 1.4 respectively. If the exit Mach number is 2.5. For the adiabatic flow of a perfect gas with γ=1.3 and R=0.469kJ/kg-K, determine **10** 2,3/3

(i) Stagnation temperature,
(ii) Temperature and velocity of gas at the exit, and
(iii) The flow rate per square meter of the inlet cross -section.

S.Y. B. Tech (Mech) Sem IV

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)
Munshi Nagar, Andheri (W) Mumbai – 400058

End Semester - May 2022 Examinations

25/5/22

Program: B.Tech Second Year Mechanical | **Duration: 03 Hrs**

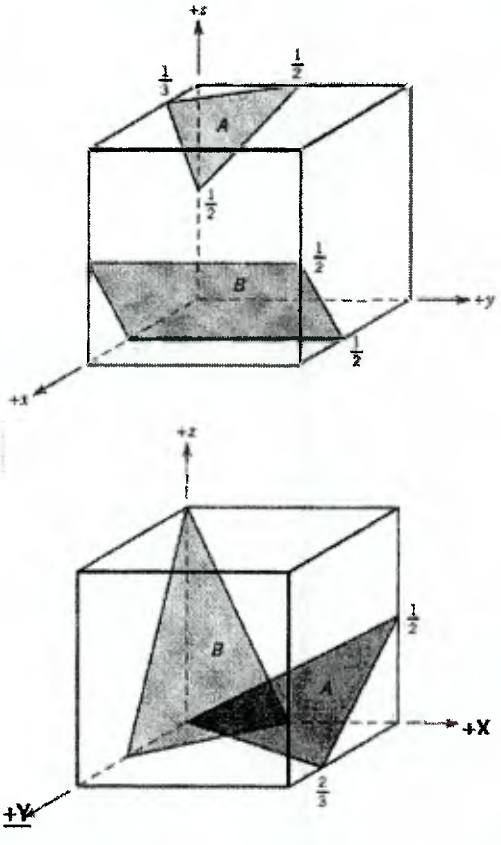
Course Code: PC-BTM406 | **Maximum Points: 100**

Course Name: Material Science | **Semester: IV**

Notes:
1. **Question no 1 is compulsory**
2. Attempt any **four questions** from the remaining six questions.
3. If necessary **assume suitable** data with justification
4. Draw **neatly labeled sketches** wherever required.

Q. No.	Questions	Points	CO	BL	PI
1A	Determine the tensile stress that is applied along the $[1\bar{1}0]$ axis of a silver crystal to cause a slip on the $(1\bar{1}\bar{1})$ $[0\bar{1}1]$ system. The critical resolved shear stress is 6MPa.	06	2	5	3.2.3
1B	Explain the method of plotting a TTT diagram. What information is obtained from this diagram?	06	3	2	2.3.1
1C	From the data given below for the Cu-Ni system, plot the equilibrium diagram to scale and label the diagram. The melting point of Cu:1,085 °C. the melting point of Ni:1,455 °C Answer the following for 65%Ni alloy composition: A. What is the composition of the first solid crystallizing out from liquid? B. What is the composition of the last solid formed at the end of the solidification process? C. What is the amount of solid and liquid at 1340 °C.	08	3	3	2.4.1
2A	Discuss why it is important to consider the entire life cycle rather than just the first stage of materials.	06	1,4	6	3.2.1
2B	You are appointed as a design engineer for Mumbai local train. Your work is to find out the weight of each coach when trains are standing on the platform. Select suitable material and explain it and	06	1,2	6	4.2.1

Weight % Ni	20	40	60	80
Liquidus temp. °C	1200	1275	1345	1440
Solidus Temp °C	1165	1235	1310	1380

	explain why a particular material is only selected.				
2C	Draw Fe-C equilibrium diagram and label the temperature, composition, and phases. "Liquid is going to convert into two solid" explain this statement using Fe-C diagram. Also, find the exact amount of components of the given statement.	08	3	4	3.8.1
3 A	Determine the Miller indices for the planes shown in the following unit cell: 	08	3	5	3.1.1
3B	Name the material which changes state from liquid to solid when applied to an either electrical or magnetic field. Write an application where such material is used. Explain the working of material with anyone application.	07	1	2	1.3.1
3C	Following are the product specification required from the customer. Suggest the process to achieve the given requirement and procedure. 1. Gear, Steel (0.1% Al, 1.5% Cr,0.3%Mo) surface hardness 1100HV, case depth:0.1 to 0.6mm. Crankshaft, medium carbon steel, case depth:0.7 to 6mm.	05	4,3	5	3.1.1

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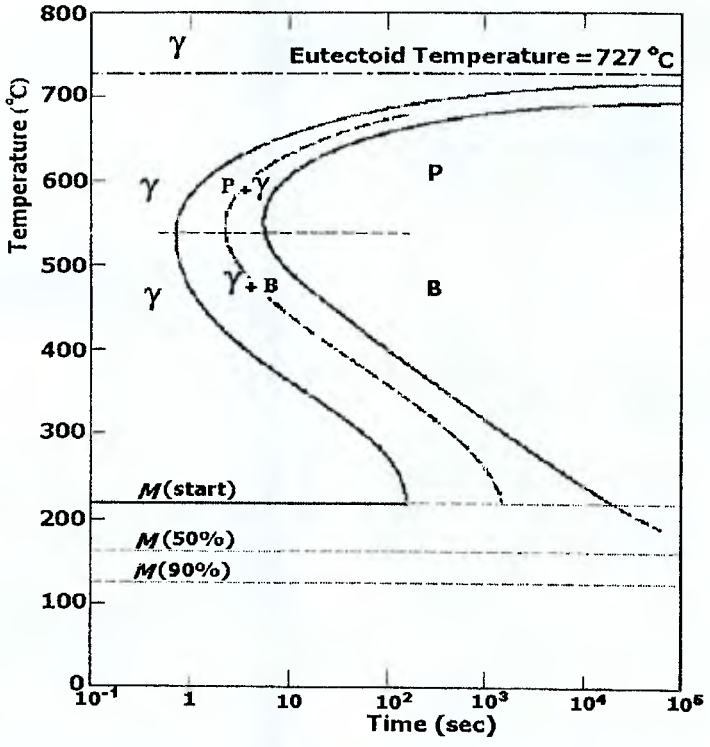
SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

End Semester - May 2022 Examinations

4A	Discuss each case of the heat treatment process of Fe-0.77% C eutectoid steel rapidly cooled from a preheated temperature of 860^{0}C (>727^{0}C) as follows [NOTE: explain, write properties of the final product] 1. Rapidly cool to 350^0 C, hold for 10^4 s and quench to room temperature 2. Rapidly cool to 250°C, hold for 100 s and quench to room temperature; 3. Rapidly cool to 650 °C, hold for 20 s, rapidly cool to 400 °C, hold for 10^3 s and quench to room temperature;  	10	4	6	2.4.1
4B	Explain metallurgical classes of stainless steel. Explain which stainless steel are not heat treatable and the reason behind it.	05	4	2	3.2.2
4C	Explain the crystal system in material science. Also, explain primitive and non-primitive unit cells using a schematic diagram.	05	2	3	2.3.1
5A	Write the effect of alloying elements on the properties of materials when they are added to the material composition. 1. Nickel 2. Molybdenum 3. Vanadium 4. Cobalt	06	4		2.2.1

	5. lead				
5B	Classify ceramics based on application. Explain magnetic ceramics in detail.	06	4	4	4.2.2
5C	What is the tempering heat treatment process? Discuss the various stages in the tempering process.	08	4	2,6	2.2.2
6A	Classify composite based on the form of reinforcement. Explain single layer fibrous composite materials.	08	4	4	4.2.2
6B	Write a composition of the following materials and their application. 1. yellow metal 2. Nickel gun-metal 3. Deoxidized copper 4. Dow metal	06	3,4	3	3.2.1
6C	Explain the reason behind the Properties changes when engineering Materials are in Bulk and Fiber Forms. [Note: explain by taking some properties and materials]	06	4	3	3.2.3
7A	Derive an equation for finding out the critical size of nucleation. Explain the relationship between critical radius and free energy with the help of a suitable figure.	08	2,3	4	3.8.1
7B	Discuss the recycling issue in the materials. Suggest other consumer action for minimal environmental impact than just recycling.	07	1,4	6	3.4.1
7C	Calculate the equilibrium no of vacancies per cubic meter for copper at 1000^0C. the energy for vacancies formation is 0.9ev/atom. The atomic weight and density (at 1000^0C) for copper are 63.5 g/mol and 8.4g/cm^{3}respectively.	05	2	5	3.2.1

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(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

End Semester (DSY)-July 2022 Examinations

S. Y. B.Tech (Mech) Sem IV 13/7/22

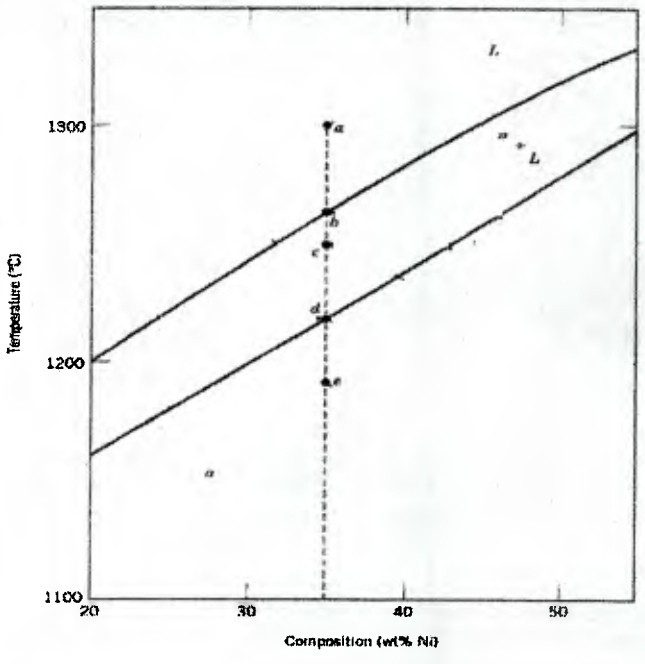
Program: B.Tech Second Year Mechanical (DSY) **Duration: 03 Hrs**

Course Code: PC-BTM406 **Maximum Points: 100**

Course Name: Material Science **Semester: IV**

Notes:

1. **Question no 1 is compulsory**
2. Attempt any **four questions** from the remaining six questions.
3. If necessary **assume suitable** data with justification
4. Draw **neatly labeled sketches** wherever required.

Q. No.	Questions	Points	CO	BL	PI
1A	A FCC crystal yield under a normal stress of 2MPa applied in the $[\bar{1}\ 3\ 2]$ system. The slip system is (111) $[\bar{1}\ 0\ 1]$. Determine critical resolved shear stress. Also draw cubic crystals showing, slip plane and slip direction.	06	2	5	3.2.3
1B	Explain different types of grain structure form at the end of solidification process when eutectoid steel is cool from above 727^0 C, explain using TTT diagram.	06	3	2	2.3.1
1C	Explain the given all points in the phase diagram containing an alloy of composition 35wt% Ni–65 wt% Cu as it is cooled from 1300^0C.consider equilibrium cooling condition.(use graph paper) 	08	3	3	2.4.1

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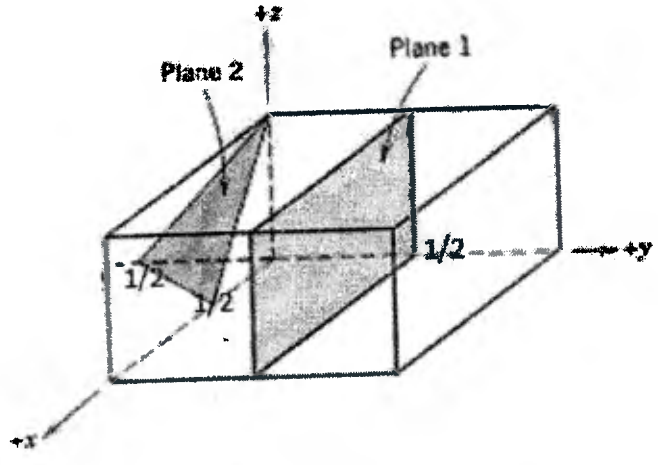
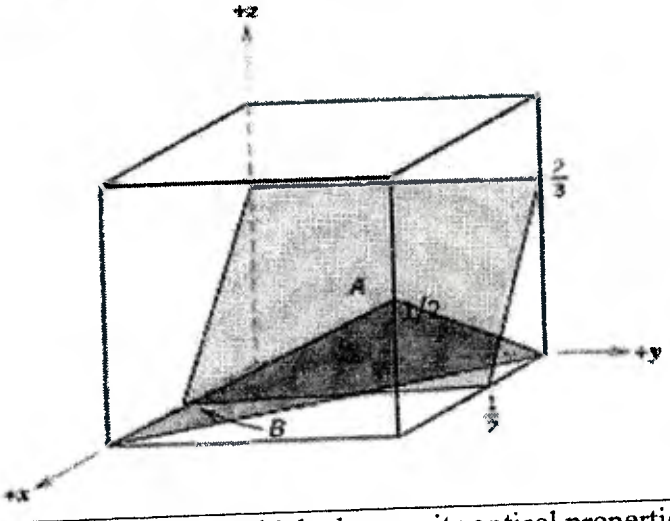
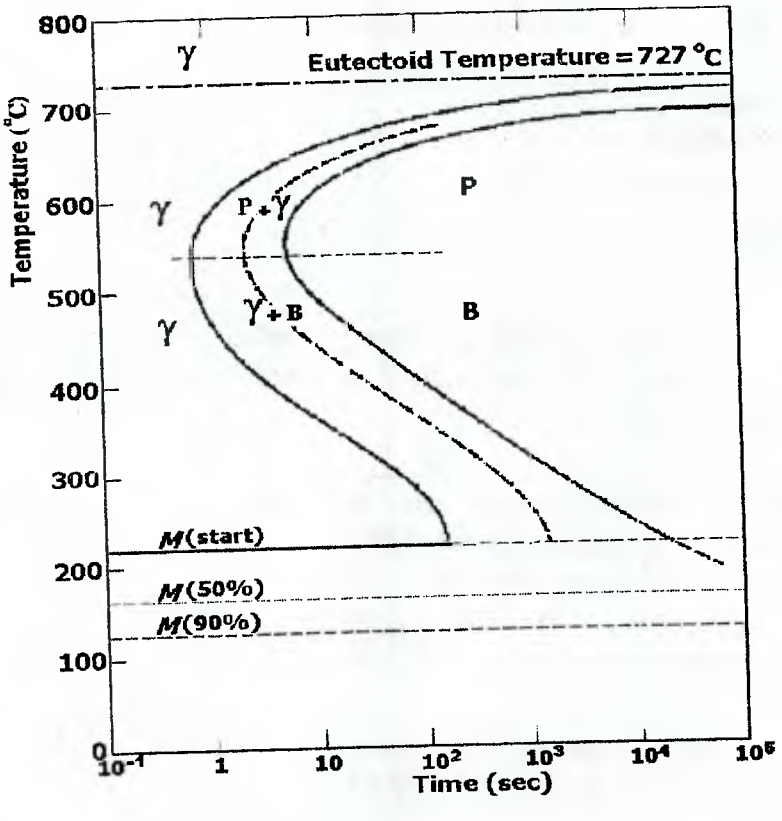
SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

End Semester (DSY)-July 2022 Examinations

2A	Discuss why it is important to consider the entire life cycle rather than just the first stage of materials.	06	1,4	6	3.2.1
2B	You are appointed as a material engineer in the medical implant industry. Suggest material for total hip replacement. Select suitable material and explain it. Also explain why a particular material is only selected.	06	1,2	6	4.2.1
2C	Draw Fe-C equilibrium diagram and label the temperature, composition, and phases. Explain the phases existing in it.	08	3	4	3.8.1
3 A	Determine the Miller indices for the planes shown in the following unit cell:  	08	3	5	3.1.1
3B	Name the material which changes its optical properties. Write an application where such material is used. Explain the working of material with anyone application.	07	1	2	1.3.1
3C	Explain quenching medium. Explain the quenching mechanism when heated components are put in any quenching medium.	05	4,3	5	3.1.1

4A	Discuss each case of the heat treatment process of Fe-0.77% C eutectoid steel rapidly cooled from a preheated temperature of 860^{0}C (>727^{0}C) as follows [NOTE: explain, write properties of the final product, use graph paper] 1. Rapidly cool to 650^0 C, hold for 10^4 s and quench to room temperature 2. Rapidly cool to 310°C, hold for 70 s and quench to room temperature; 3. Rapidly cool to 650 °C, hold for 20 s, rapidly cool to 400 °C, hold for 10^3 s and quench to room temperature;  	10	4	6	2.4.1
4B	Explain metallurgical classes of stainless steel. Explain which stainless steel are not heat treatable and the reason behind it.	05	4	2	3.2.2
4C	Why does diamond stay stable at room temperature and not transform to graphite although it is an unstable phase of carbon at room temperature? Explain with a suitable diagram. .	05	2	3	2.3.1
5A	Write the effect of alloying elements on the properties of materials when they are added to the material composition. 1. Cobalt 2. Tungsten 3. Titanium 4. lead	06	4		2.2.1

End Semester (DSY)-July 2022 Examinations

5B	Classify ceramics based on application. Explain magnetic ceramics in detail.	06	4	4	4.2.2
5C	Which heat treatment process used to improve the machinability of the annealed hypereutectoid steel? This heat treatment process used cyclic heating around the eutectoid point. Explain it with a schematic diagram. Explain properties of materials before and after the heat treatment process.	08	4	2,6	2.2.2
6A	Classify composite based on the type of matrix material. Explain MMC and carbon matrix composite. Differentiate between composite materials and alloy materials.	08	4	4	4.2.2
6B	Write a composition of the following materials and their application. 1. yellow metal 2. Nickel gun-metal 3. Deoxidized copper 4. Dow metal	06	3,4	3	3.2.1
6C	Explain the reason behind the Properties changes when engineering Materials are in Bulk and Fiber Forms. [Note: explain by taking some properties and materials]	06	4	3	3.2.3
7A	Explain in detail about nucleation, growth rate, and overall transformation. give the proper reason of the following with suitable diagram(consider solidification process): 1.low transformation rate at initial period 2. At the end of the transformation rate is slow.	08	2,3	4	3.8.1
7B	Discuss the recycling issue in the materials. Suggest other consumer action for minimal environmental impact than just recycling.	07	1,4	6	3.4.2
7C	Explain twinning phenomenon and slipping with suitable diagrams.	05	2	5	3.2.1

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Munshi Nagar, Andheri (W) Mumbai – 4

Re-Examination – Julv 2022 Examinations

S.Y. B.Tech (Mech) Sem IV 11/7/22

Program: B.Tech Second Year Mechanical **Duration: 03 Hrs**

Course Code: PC-BTM406 **Maximum Points: 100**

Course Name: Material Science **Semester: IV**

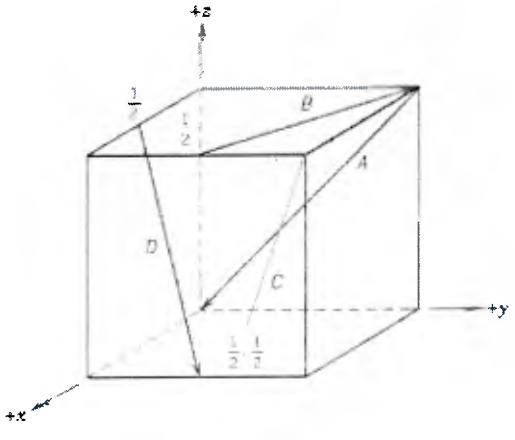
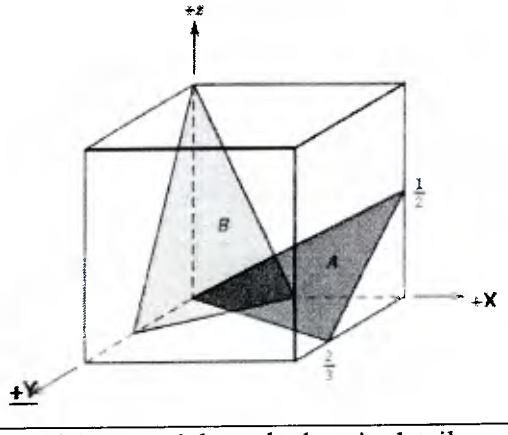
Notes:

1. **Question no 1 is compulsory**
2. Attempt any **four questions** from the remaining six questions.
3. If necessary **assume suitable** data with justification
4. Draw **neatly labeled sketches** wherever required.

Q. No.	Questions	Points	CO	BL	PI
1A	Derive an equation for finding out the critical size of nucleation. Explain the relationship between critical radius and free energy with the help of a suitable figure.	06	2	5	3.2.3
1B	As a material engineer, I have predefined the different grain structures for the one selected material. Explain how to achieve a predefined grain structure. Use the proper schematic diagram to represent this.	06	3	2	2.3.1
1C	From the data given below for the Cu-Ni system, plot the equilibrium diagram to scale and label the diagram. The melting point of Cu: 1,085 °C. the melting point of Ni:1,455 °C Answer the following for 65%Ni alloy composition: A. What is the composition of the first solid crystallizing out from liquid? B. What is the composition of the last solid formed at the end of the solidification process? C. What is the amount of solid and liquid at 1340 °C?	08	3	3	2.4.1
2A	Explain the total material cycle with a schematic drawing. Explain how you can save natural resources.	06	1,4	6	3.2.1

Weight % Ni	20	40	60	80
Liquidus temp. °C	1200	1275	1345	1440
Solidus Temp °C	1165	1235	1310	1380

Re-Examination – July 2022 Examinations

2B	You are appointed as a material engineer in the medical implant industry. Suggest material for total hip replacement. Select suitable material and explain it. Also explain why a particular material is only selected.	06	1,2	6	4.2.1
2C	Draw Fe-C equilibrium diagram and label the temperature, composition, and phases. Explain eutectoid transformation. Also, find the exact amount of components present in the eutectoid transformation.	08	3	4	3.8.1
3 A	Determine the Miller indices for the directions and the planes shown in the following unit cell:   	10(6 +4)	3	5	3.1.1
3B	Explain material tetrahedron in detail.	05	1	2	1.3.1
3C	Explain the following case hardening process:(process, characteristics , application) 1. Induction Hardening 2. Carbonitriding	05	4,3	5	3.1.1

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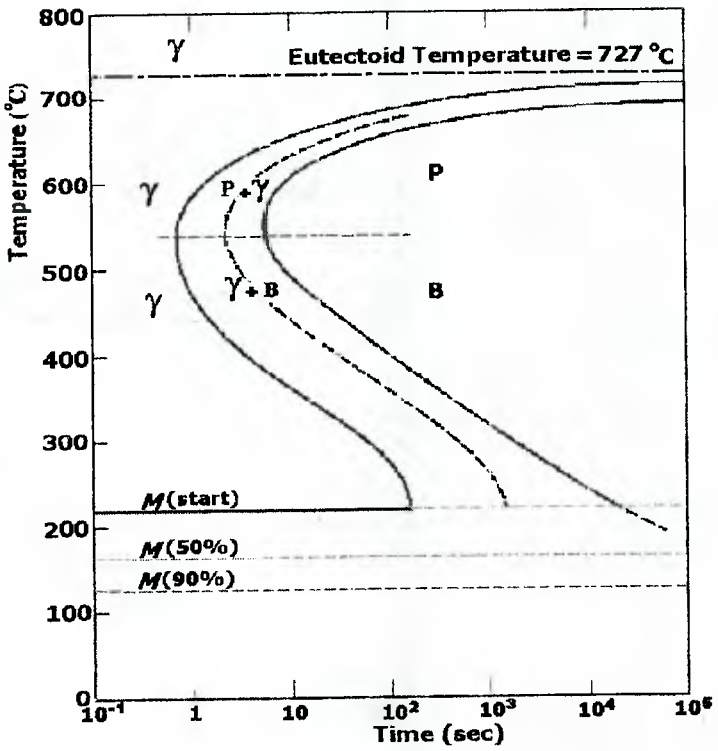
Re-Examination – July 2022 Examinations

4A	Discuss each case of the heat treatment process of Fe-0.77% C eutectoid steel rapidly cooled from a preheated temperature of 860^0C (>727^0C) as follows [NOTE: explain, write properties of the final product] 1. Rapidly cool to 620^0 C, hold for 10^4 s and quench to room temperature 2. Rapidly cool to 300°C, hold for 80 s and quench to room temperature; 3. Rapidly cool to 650 °C, hold for 20 s, rapidly cool to 400 °C, hold for 10^3 s and quench to room temperature; 	10	4	6	2.4.1
4B	Explain metallurgical classes of stainless steel. Explain which stainless steel is not heat treatable and the reason behind it.	05	4	2	3.2.2
4C	What is a burger vector? Explain how it is obtained?	05	2	3	2.3.1
5A	Write the effect of alloying elements on the properties of materials when they are added to the material composition. 1. Nickel 2. Molybdenum 3. Vanadium 4. Cobalt 5. lead	06	4		2.2.1

Re-Examination – July 2022 Examinations

5B	Classify ceramics based on application. Explain magnetic ceramics in detail.	06	4	4	4.2.2
5C	Which heat treatment process used to improve the machinability of the annealed hypereutectoid steel? This heat treatment process used cyclic heating around the eutectoid point. Explain it with a schematic diagram.	08	4	2,6	2.2.2
6A	Classify composite based on the type of matrix material. Explain MMC and carbon matrix composite. Differentiate between composite materials and alloy materials.	08	4	4	4.2.2
6B	Write a composition of the following materials and their application. 1. Cartridge Brass 2. Muntz metal 3. Deoxidized copper 4. Admiralty gun-metal	06	3,4	3	3.2.1
6C	Explain the reason behind the Properties changes when engineering Materials are in Bulk and Fiber Forms. [Note: explain by taking some properties and materials]	06	4	3	3.2.3
7A	A FCC crystal yield under a normal stress of 2MPa applied in the $[\bar{1}\ 3\ 2]$ system. The slip system is (111) $[\ \bar{1}\ 0\ 1]$. Determine critical resolved shear stress. Also draw cubic crystals showing, slip plane and slip direction.	08	2,3	4	3.8.1
7B	Discuss the recycling issue in the materials. Suggest other consumer action for minimal environmental impact than just recycling.	07	1,4	6	3.4.2
7C	Find the theoretical density of copper (FCC) assuming the atom to be a hard sphere. The atomic weight of copper is 63.54gm/mole and radius of atom is 1.278 A^0.	05	2	5	3.2.1

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SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

S. Y. B. Tech (Mech) Sem IV 4/7/22

ENDSEM- EXAMINATION(DSY) JUNE-2022

Program: MECHANICAL **Duration: 03 Hours**

Course Code: BS-BTM401 **Maximum Points: 100**

Course Name: APPLIED MATHEMATICS-IV **Semester: IV**

- **Attempt any five out of seven questions**
- **Use of scientific calculator is allowed.**

QNO.	QUESTION	POINTS	CO	BL	PI
QI a)	Let X & Y be two independent binomial variates with parameters (n_1=6,p=1/2) and (n_2=4,p=1/2) respectively. Evaluate P(X+Y)=3.	06	1	2	2.1.3
QI b)	Find a real root of $2x^3 - 2x - 5 = 0$ by regula-falsi method upto third approximation	06	3	3	1.1.1
QI c)	Verify whether the following functions can be looked upon as probability density function? $f(x) = \frac{1}{2}e^{-\lvert x\rvert}, -\infty \prec x \prec \infty$	08	1	1	1.1.2
QII a)	The diameters of can tops produced by a machine are normally distributed with standard deviation of 0.01 cms.At what mean diameter the machine be set that not more than 5% of the can tops produced by the machine have diameters exceeding 3 cms?	06	1	2	2.1.4
QII b)	Compute spearman's rank coorelation coefficient for the following data X: 10, 12, 18, 18, 15, 40 Y: 12, 18, 25, 25, 50, 25	06	2	2	2.3.1
QII c)	Verify Stoke's theorem for the vector field $\vec{F} = (2x - y)\hat{i} - yz^2\hat{j} - y^2z\hat{k}$ over the upper half surface of $x^2 + y^2 + z^2 = 1$ bounded by its projection on the XY-plane.	08	2	2	2.3.1
QIII a)	Two bad eggs are mixed accidently with 10 good ones. Find the probability distribution of the number of bad eggs in 3, drawn at random, without replacement from this lot.	06	1	2	1.1.2
QIII b)	The sales-data of an article in six shops before and after a special promotional campaign are as under Shops: A, B, C, D, E, F	06	1	2	1.1.1

ENDSEM- EXAMINATION(DSY) JUNE-2022

	Before Campaign	53	28	31	48	50	42			
	After Campaign	58	29	30	55	56	45			
	Can the campaign be judged to be a success at 5% LOS.									
QIII c)	In a partially destroyed laboratory record of an analysis of correlation data, the following results only are legible: Variance of X = 9 Regression equations: $8x-10y+66=0$ $40x-18y=214$ What are i.Mean, value of x and y ii.Standard deviation of y. iii.Coefficient of correlation between x and y							08	1	1	2.1.4
QIV a)	A car – hire firm has two cars, which it hires out day by day. The number of demands for a cal on each day is distributed a Poisson distribution with mean 1.5. Calculate the proportion of days on which neither car is used and the proportion of days on which some demand is refused.							06	1	3	2.3.1
QIV b)	Prove that $\vec{F}=(ye^{xy}\cos z)\hat{i}+(xe^{xy}\cos z)\hat{j}-(e^{xy}\sin z)\hat{k}$ is conservative and find the scalar potential Φ.							06	2	2	1.1.3
QIV c)	Find the positive root of $x-\cos x=0$ by Bisection method.							08	3	1	2.3.4
QV a)	Fit a binomial distribution for the following data and compare the theoretical frequencies with the actual ones: X: 0 1 2 3 4 5 f: 2 14 20 34 22 8							06	1	1	2.3.1
QV b)	In an experiment on immunization of cattle from tuberculosis the following results were obtained. Inoculated: Affected 267, Not affected 27							06	1	2	1.1.1

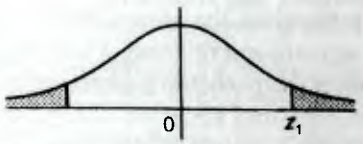
ENDSEM- EXAMINATION(DSY) JUNE-2022

	Not Inoculated | 757 | 155 | 862 Use Chi square test to determine the efficacy of vaccine in preventing tuberculosis.					
QV c)	Compute $\int_{0.2}^{1.4} \sin x - \log_e x + e^x \, dx$ using (i) Trapezoidal rule (ii) Simpson's $1/3^{rd}$ rule taking $h = 0.2$.	08	3	2	2.3.4
QVI a)	Verify Green's theorem in the plane for $\oint_c (3x^2 - 8y^2)dx + (4y - 6xy)dy$ where C is the boundary of region defined by $y = \sqrt{x}$ & $y = x^2$.	06	2	1	1.1.3
QVI b)	A die is thrown 264 times with the following results No appeared on die | 1 | 2 | 3 | 4 | 5 | 6 Frequency | 40 | 32 | 28 | 50 | 54 | 60 Show that the die is biased	06	1	3	2.1.3
QVI c)	Using Runge-Kutta method {IVth order} find the numerical solution at $x = 0.6$ for $\frac{dy}{dx} = \sqrt{x+y}$, given $y(0.4) = 0.41$ using $h = 0.2$.	08	3	1	1.1.1
QVI I a)	Using Newton-Raphson method find the root of $x\log_{10} x = 12.34$ with $x_0 = 10$ upto 3 places of decimal.	06	3	3	2.1.4
QVI I b)	If $z = ax + by$ and 'r' is the correlation between x and y show that $\sigma_z^2 = a^2\sigma_x^2 + b^2\sigma_y^2 + 2abr\sigma_x\sigma_y$ Further show that $r = \frac{\sigma_x^2 + \sigma_y^2 - \sigma_{x-y}^2}{2\sigma_x\sigma_y}$ Where σ_x, σ_y and σ_{x-y} are the standard deviation of x, y and x – y respectively	06	2	2	1.1.3

ENDSEM- EXAMINATION(DSY) JUNE-2022

QVI Ic)	Verify Divergence Theorem for $\vec{F}=(x^2-yz)\hat{i}+(y^2-zx)\hat{j}+(z^2-xy)\hat{k}$ taken over the rectangular parallelepiped $0 \le x \le a$, $0 \le y \le b$, $0 \le z \le c$.	08	2	2	1.1.3

Percentage Points of t - distribution



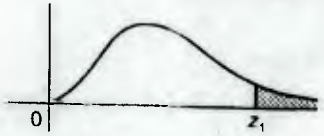
Example

For $\Phi = 10$ d. o. f.

$P(|t| > 1.812) = 0.1$

Φ \ P	0.20	0.10	0.05	0.02	0.01
1	3.078	6.314	12.706	31.812	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.287
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
40	1.303	1.684	2.021	2.423	2.704
60	1.296	1.671	2.000	2.390	2.660
120	1.289	1.658	1.980	2.358	2.617
∞	1.282	1.645	1.960	2.325	2.576

Percentage Points of χ^2 - Distribution



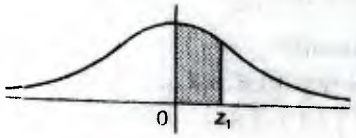
Example

For $\Phi = 10$ d. o. f.

$P(\chi^2 > 15.99) = 0.10$

Φ \ P	0 = .99	0.95	0.50	0.10	0.05	0.02	0.01
1	.000157	.00393	.455	2.706	3.841	5.214	6.635
2	.0201	.103	1.386	4.605	5.991	7.824	9.210
3	.115	.352	2.366	6.251	7.815	9.837	11.341
4	.297	.711	3.357	7.779	9.488	11.668	13.277
5	.554	1.145	4.351	9.236	11.070	13.388	15.086
6	.872	1.635	5.348	10.645	12.592	15.033	16.812
7	1.339	2.167	6.346	12.017	14.067	16.622	18.475
8	1.646	2.733	7.344	13.362	15.507	18.168	20.090
9	2.088	3.325	8.343	14.684	16.919	19.679	21.666
10	2.558	3.940	9.340	15.987	18.307	21.161	23.209
11	3.053	4.575	10.341	17.275	19.675	22.618	24.725
12	3.571	5.226	11.340	18.549	21.026	24.054	26.217
13	4.107	5.892	12.340	19.812	22.362	25.472	27.688
14	4.660	6.571	13.339	21.064	23.685	26.873	29.141
15	4.229	7.261	14.339	22.307	24.996	28.259	30.578
16	5.812	7.962	15.338	23.542	26.296	29.633	32.000
17	6.408	8.672	16.338	24.769	27.587	30.995	33.409
18	7.015	9.390	17.336	25.989	28.869	32.346	34.805
19	7.633	10.117	18.338	27.204	30.144	33.687	36.191
20	8.260	10.851	19.337	28.412	31.410	35.020	37.566
21	8.897	11.591	20.337	29.615	32.671	36.349	38.932
22	9.542	12.338	21.337	30.813	33.924	37.659	40.289
23	10.196	13.091	22.337	32.007	35.172	38.968	41.638
24	10.856	13.848	23.337	32.196	36.415	40.270	42 980
25	11.524	14.611	24.337	34.382	37.652	41.566	44.314
26	12.198	15.379	25.336	35.363	38.885	41.856	45.642
27	12.879	16.151	26.336	36.741	40.113	44.140	46.963
28	13.565	16.928	27.336	37.916	41.337	45.419	48.278
29	14.256	17.708	28.336	39.087	42.557	46.693	49.588
30	14.953	18 493	29.336	40.256	43.773	47.962	50.892

Area Under Standard Normal Curve



The table gives the area under the standard normal curve from $z = 0$ to $z = z_1$ which is the probability that z will lie between $z = 0$ and $z = z_1$.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.8832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4415	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4878	.4688	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4841	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4560	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

27/5/22

ENDSEM- EXAMINATION MAY-2022

S. Y. B. Tech (Mech) Sem IV 27/5/22

Program: MECHANICAL **Duration: 03 Hours**

Course Code: BS-BTM401 **Maximum Points: 100**

Course Name: APPLIED MATHEMATICS-IV **Semester: IV**

- **Attempt any five out of seven questions**
- **Use of scientific calculator is allowed.**

QN O.	QUESTION	POINTS	CO	BL	PI
QI a)	The ratio of the probability of 3 successes in 5 independent trials to the probability of 2 successes in 5 independent trials is ¼. What is the probability of 4 successes in 6 independent trials?	06	1	2	2.1.3
QI b)	Find a real root of $x^2 - x - 1 = 0$ by regula-falsi method upto third approximation	06	3	3	1.1.1
QI c)	Given below is the probability distribution of a drv x with mean=16 then find 'a' & 'b' and variance of x.	08	1	1	1.1.2
QII a)	If the actual amount of coffee which a filling machine puts into 6 ounce jars is a random variable having normal distribution with standard deviation 0.05 ounce and if only 3% of the jars are to contain less than 6 ounce of coffee what must be the mean fill of these jars?	10	1	2	2.1.4
QII b)	Verify Stoke's theorem for the vector field $\vec{F}=(x^2-y^2)\hat{i}+2xy\hat{j}$ over the box bounded by planes x = 0, x = a, y = b, z = C if the face z = 0 is cut.	10	2	2	2.3.1
QIII	Five defective bulbs are accidently mixed with twenty good once. It is not possible to just look at the bulb and tell whether or	06	1	2	1.1.2

x	8	12	16	20	24
P(x)	1/8	a	b	1/4	1/12

ENDSEM- EXAMINATION MAY-2022

<table>
<tr><td>a)</td><td>not it is defective. Find the probability distribution of the number of defective bulbs, if four bulbs are drawn out at random from this lot.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>QIII b)</td><td>The sales-data of an article in six shops before and after a special promotional campaign are as under
<table>
<tr><td>Shops</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr>
<tr><td>Before Campaign</td><td>53</td><td>28</td><td>31</td><td>48</td><td>50</td><td>42</td></tr>
<tr><td>After Campaign</td><td>58</td><td>29</td><td>30</td><td>55</td><td>56</td><td>45</td></tr>
</table>
Can the campaign be judged to be a success at 5% LOS.</td><td>06</td><td>1</td><td>2</td><td>1.1.1</td></tr>
<tr><td>QIII c)</td><td>In an examination marks obtained by students in mathematics, physics and chemistry are normally distributed with means 51,53 and 46 with standard deviations 15,12,16 respectively. Find the probability of securing total marks (i) 180 or more (ii) 90 or below</td><td>08</td><td>1</td><td>1</td><td>2.1.4</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>QIV a)</td><td>Suppose that a local appliances shop has fond from experience that the demand for tube lights roughly distributed as Poisson with a mean of 4 tubes per week. If the shop keeps 6 tubelights during a particular week. What is the probability that the demand will exceed the supply during that week?</td><td>06</td><td>1</td><td>3</td><td>2.3.1</td></tr>
<tr><td>QIV b)</td><td>Prove that $\vec{F}=(ye^{xy}\cos z)\hat{i}+(xe^{xy}\cos z)\hat{j}-(e^{xy}\sin z)\hat{k}$ is conservative and find the scalar potential Φ.</td><td>06</td><td>2</td><td>2</td><td>1.1.3</td></tr>
<tr><td>QIV c)</td><td>Find the positive root of $x-\cos x=0$ by Bisection method.</td><td>08</td><td>3</td><td>1</td><td>2.3.4</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>QV a)</td><td>Fit a binomial distribution for the following data and compare the theoretical frequencies with the actual ones:
<table>
<tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>f</td><td>2</td><td>14</td><td>20</td><td>34</td><td>22</td><td>8</td></tr>
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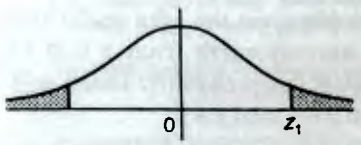
<tr><td>QV b)</td><td>Investigate the association between the darkness of eyecolour in father and son from the following data
Colour of father's eyes</td><td>06</td><td>1</td><td>2</td><td>1.1.1</td></tr>
</table>

ENDSEM- EXAMINATION MAY-2022

			Dark	Not Dark	Total				
		Dark(Son)	48	90	138				
		Not Dark(Son)	80	782	862				
		Total	128	872	1000				
QV c)	Evaluate $\int_0^1 e^{-x^2} dx$ dividing the range into four equal parts using (i) Trapezoidal rule (ii) Simpson's 1/3rd rule					08	3	2	2.3.4
QVI a)	Apply Green's thm to evaluate $\oint_c (y - \sin x)dx + \cos x\, dy$ where C is the plane triangle enclosed by the lines y = 0, x = π/2 & $y = \frac{2x}{\pi}$.					06	2	1	1.1.3
QVI b)	A die is thrown 264 times with the following results					06	1	3	2.1.3
	No appeared on die	1	2	3	4	5	6		
	Frequency	40	32	28	50	54	60		
	Show that the die is biased								
QVI c)	Using Runge - Kutta method of fourth order, solve $\frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2}$ given y(0) = 1 at x = 0.2					08	3	1	1.1.1
QVI I a)	Using Newton-Raphson method find the root of $x \log_{10} x = 12.34$ with $x_0 = 10$ upto 3 places of decimal.					10	3	3	2.1.4
QVI I b)	Verify Divergence Theorem for $\vec{F} = x\hat{i} - y\hat{j} + z\hat{k}$ taken over the region bounded by the cylinder $x^2 + y^2 = a^2$, z = 0, z = b $(a > 0, b > 0)$					10	2	2	1.1.3

Percentage Points of t - distribution



Example

For $\Phi = 10$ d. o. f.

$P(|t| > 1.812) = 0.1$

Φ \ P	0.20	0.10	0.05	0.02	0.01
1	3.078	6.314	12.706	31.812	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.287
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
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29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
40	1.303	1.684	2.021	2.423	2.704
60	1.296	1.671	2.000	2.390	2.660
120	1.289	1.658	1.980	2.358	2.617
∞	1.282	1.645	1.960	2.325	2.576

Percentage Points of χ^2 - Distribution

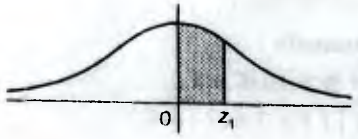
Example

For $\Phi = 10$ d. o. f.

$P(\chi^2 > 15.99) = 0.10$

Φ \ P	0 = .99	0.95	0.50	0.10	0.05	0.02	0.01
1	.000157	.00393	.455	2.706	3.841	5.214	6.635
2	.0201	.103	1.386	4.605	5.991	7.824	9.210
3	.115	.352	2.366	6.251	7.815	9.837	11.341
4	.297	.711	3.357	7.779	9.488	11.668	13.277
5	.554	1.145	4.351	9.236	11.070	13.388	15.086
6	.872	1.635	5.348	10.645	12.592	15.033	16.812
7	1.339	2.167	6.346	12.017	14.067	16.622	18.475
8	1.646	2.733	7.344	13.362	15.507	18.168	20.090
9	2.088	3.325	8.343	14.684	16.919	19.679	21.666
10	2.558	3.940	9.340	15.987	18.307	21.161	23.209
11	3.053	4.575	10.341	17.275	19.675	22.618	24.725
12	3.571	5.226	11.340	18.549	21.026	24.054	26.217
13	4.107	5.892	12.340	19.812	22.362	25.472	27.688
14	4.660	6.571	13.339	21.064	23.685	26.873	29.141
15	4.229	7.261	14.339	22.307	24.996	28.259	30.578
16	5.812	7.962	15.338	23.542	26.296	29.633	32.000
17	6.408	8.672	16.338	24.769	27.587	30.995	33.409
18	7.015	9.390	17.338	25.989	28.869	32.346	34.805
19	7.633	10.117	18.338	27.204	30.144	33.687	36.191
20	8.260	10.851	19.337	28.412	31.410	35.020	37.566
21	8.897	11.591	20.337	29.615	32.671	36.349	38.932
22	9.542	12.338	21.337	30.813	33.924	37.659	40.289
23	10.196	13.091	22.337	32.007	35.172	38.968	41.638
24	10.856	13.848	23.337	32.196	36.415	40.270	42 980
25	11.524	14.611	24.337	34.382	37.652	41.566	44.314
26	12.198	15.379	25.336	35.363	38.885	41.856	45.642
27	12.879	16.151	28.336	36.741	40.113	44.140	46.963
28	13.565	16.928	27.336	37.916	41.337	45.419	48.278
29	14.256	17.708	28.336	39.087	42.557	46.693	49.588
30	14.953	18 493	29.336	40.256	43.773	47.962	50.892

Area Under Standard Normal Curve



The table gives the area under the standard normal curve from $z = 0$ to $z = z_1$ which is the probability that z will lie between $z = 0$ and $z = z_1$.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	0753
0.2	.0793	.8832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4415	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4878	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4841	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4560	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

S. Y. B. Tech (Mech) Sem IV 12/7/22

ENDSEM- REEXAMINATION JULY 2022

Program: MECHANICAL **Duration: 03 Hours**

Course Code: BS-BTM401 **Maximum Points: 100**

Course Name: APPLIED MATHEMATICS-IV **Semester: IV**

- **Attempt any five out of seven questions**
- **Use of scientific calculator is allowed.**

QN O.	QUESTION	POINTS	CO	BL	PI
QI a)	The ratio of the probability of 3 successes in 5 independent trials to the probability of 2 successes in 5 independent trials is ¼. What is the probability of 4 successes in 6 independent trials?	06	1	2	2.1.3
QI b)	Find a real root of $x^2 - x - 1 = 0$ by regula-falsi method upto third approximation	06	3	3	1.1.1
QI c)	Calculate Karl Pearson's coefficient of correlation for the following data: X: 78, 89, 99, 60, 59, 79, 68 Y: 125, 137, 156, 112, 107, 136, 123	08	1	1	1.1.2
QII a)	The length of time a lady speaks on telephone is found to be a random variable with PDF $f(x) = \begin{cases} Ae^{-x/5}, x \geq 0 \\ 0, x < 0 \end{cases}$. Find A and the probability that she will speak for (i) more than 10 minutes (ii)less than 5 minutes(iii) between 5 & 10 minutes.	10	1	2	2.1.4
QII b)	Verify Stoke's theorem for the vector field $\vec{F} = (x^2 - y^2)\hat{i} + 2xy\hat{j}$ over the box bounded by planes x = 0, x = a, y = b, z = C if the face z = 0 is cut.	10	2	2	2.3.1
QIII a)	Two bad eggs are mixed accidently with 10 good ones. Find the probability distribution of the number of bad eggs in 3, drawn at random, without replacement from this lot.	06	1	2	1.1.2
QIII b)	The sales-data of an article in six shops before and after a special promotional campaign are as under	06	1	2	1.1.1

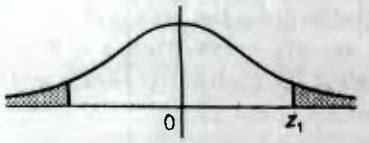
ENDSEM- REEXAMINATION JUNE 2022

	Shops	A	B	C	D	E	F
	Before Campaign	53	28	31	48	50	42
	After Campaign	58	29	30	55	56	45
	Can the campaign be judged to be a success at 5% LOS.						
QIII c)	The mean weight of 500 male students at a certain college is 151 lb and standard deviation is 15 lb. Assuming that the weights are normally distributed, find how money students weigh a) Between 120 & 155 lb b) More than 185 lb	08	1	1	2.1.4
QIV a)	The probability that a smoker aged 25 years will die before reaching the age of 30 years may be taken a 0.018. Out of a group of 400 smokers, now aged 25 years, what is the probability that 2 smokers will die within the next 5 years?	06	1	3	2.3.1
QIV b)	Prove that $\vec{F}=(2xy+z^3)\hat{i}+(x^2+z)\hat{j}+(y+3xz^2)\hat{k}$ is conservative and find the work done by $\vec{F}$ displacing the particle from A (0, 1, 1) to B(1,0,2).	06	2	2	1.1.3
QIV c)	Find the positive root of $x-\cos x=0$ by Bisection method.	08	3	1	2.3.4
QV a)	Fit a binomial distribution for the following data and compare the theoretical frequencies with the actual ones: X: 0 1 2 3 4 5 f: 2 14 20 34 22 8	06	1	1	2.3.1
QV b)	Investigate the association between the darkness of eyecolour in father and son from the following data Colour of father's eyes Dark(Son): 48 / 90 Not Dark(Son): 80 / 782	06	1	2	1.1.1

ENDSEM- REEXAMINATION JUNE 2022

	Total	128	872	1000		
QV c)	Evaluate $\int_0^1 e^{-x^2} dx$ dividing the range into four equal parts using (i) Trapezoidal rule (ii) Simpson's 1/3rd rule	08	3	2	2.3.4
QVI a)	Evaluate by Green's thm $\oint_c e^{-x}(\sin y\,dx + \cos y\,dy)$ where C is the rectangle with vertices (0, 0), (π/0) (π, π/2) & (0, π/2).	06	2	1	1.1.3
QVI b)	A die is thrown 264 times with the following results No appeared on die: 1 | 2 | 3 | 4 | 5 | 6 Frequency: 40 | 32 | 28 | 50 | 54 | 60 Show that the die is biased	06	1	3	2.1.3
QVI c)	Using Runge-Kutta method IVth order. Solve $\frac{dy}{dx} = \frac{1}{x+y}$; $x_0 = 0$, $y_0 = 1$ for the interval (0, 1) choosing h = 0.5.	08	3	1	1.1.1
QVI I a)	Using Newton-Raphson method find the root of $x\log_{10} x = 12.34$ with $x_0 = 10$ upto 3 places of decimal.	10	3	3	2.1.4
QVI I b)	Verify Divergence Theorem for $\vec{F} = (x^2 - yz)\hat{i} + (y^2 - zx)\hat{j} + (z^2 - xy)\hat{k}$ taken over the rectangular parallelepiped $0 \le x \le a$, $0 \le y \le b$, $0 \le z \le c$.	10	2	2	1.1.3

Percentage Points of t - distribution



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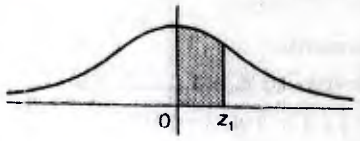
3	.115	.352	2.366	6.251	7.815	9.837	11.341
4	.297	.711	3.357	7.779	9.488	11.668	13.277
5	.554	1.145	4.351	9.236	11.070	13.388	15.086
6	.872	1.635	5.348	10.645	12.592	15.033	16.812
7	1.339	2.167	6.348	12.017	14.067	16.622	18.475
8	1.646	2.733	7.344	13.362	15.507	18.168	20.090
9	2.088	3.325	8.343	14.684	16.919	19.679	21.666
10	2.558	3.940	9.340	15.987	18.307	21.161	23.209
11	3.053	4.575	10.341	17.275	19.675	22.618	24.725
12	3.571	5.226	11.340	18.549	21.026	24.054	26.217
13	4.107	5.892	12.340	19.812	22.362	25.472	27.688
14	4.660	6.571	13.339	21.064	23.685	26.873	29.141
15	4.229	7.261	14.339	22.307	24.996	28.259	30.578
16	5.812	7.962	15.338	23.542	26.298	29.833	32.000
17	6.408	8.672	16.338	24.789	27.587	30.995	33.409
18	7.015	9.390	17.338	25.989	28.869	32.346	34.805
19	7.633	10.117	18.338	27.204	30.144	33.687	36.191
20	8.260	10.851	19.337	28.412	31.410	35.020	37.566
21	8.897	11.591	20.337	29.615	32.671	36.349	38.932
22	9.542	12.338	21.337	30.813	33.924	37.859	40.289
23	10.196	13.091	22.337	32.007	35.172	38.968	41.638
24	10.856	13.848	23.337	32.196	36.415	40.270	42 980
25	11.524	14.611	24.337	34.382	37.852	41.566	44.314
26	12.198	15.379	25.336	35.363	38.885	41.856	45.642
27	12.879	18.151	28.336	36.741	40.113	44.140	46.963
28	13.565	16.928	27.336	37.916	41.337	45.419	48.278
29	14.256	17.708	28.336	39.087	42.557	46.693	49.588
30	14.953	18 493	29.336	40.256	43.773	47.962	50.892

Area Under Standard Normal Curve



The table gives the area under the standard normal curve from $z = 0$ to $z = z_1$ which is the probability that z will lie between $z = 0$ and $z = z_1$.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	0753
0.2	.0793	.8832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	1808	.1844	1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	2852
0.8	.2881	.2910	.2939	.2987	.2995	.3023	.3051	.3078	.3106	3133
0.9	3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	3365	3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4415	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4878	.4686	.4693	.4699	4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4888	.4871	.4875	.4878	.4841	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4560	.4961	.4962	.4963	4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	4990

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

DSY End Semester – JUNE 2022 Examinations

Program: S.Y.B. Tech. (Mechanical Engineering) Sem IV **Duration: 03 Hrs**

Course Code: PC-BTM404 **Maximum Points: 100**

Course Name: Mechanical Engineering Measurement **Semester: IV**

8/7/22

Notes:

1. **Question number 1 is compulsory**
2. **Solve any 4 questions from question number 2 to 7**
2. **If necessary assume suitable data with justification**
3. **Draw neat labeled sketches wherever required.**

Q. No.	Questions	Points	CO	BL	PI
1	Following table list the measuring instruments (left hand side column of the table) for measuring mechanical properties (right hand side column of the table) of the system. Students shall match the measuring instrument with the corresponding mechanical property. **Measuring Instruments** / **Measurand** Linear Variable Differential Transducer / Temperature Stroboscope / Displacement Rotameter / Pressure Venturimeter / Flow rate Laser Doppler Anemometer / Speed Further student shall explain only the working principle of the measurement instrument listed on left hand side column of the table with neat sketch. **(Note: Credits will be given only if match is perfect)**	05 15	3	4	1.2.3
2 (A)	It is proposed to develop measurement and control system for maintaining temperature and pressure of a reactor chamber in pharmaceutical applications. Proposed design aimed to retrieved data from system and controlled it remotely using internet network system. Students are instructed to present architecture of such network integrated measurement and control system (explain with neat schematic diagram).	10	2	3	1.2.2
2 (B)	Explain generalized measurement system with neat schematic diagram. Further map the different constituents of generalized measurement system with the physical elements of Bourdon Pressure Gauge	10	1	2	1.6.1
3 (A)	A single strain gauge having resistance of 130 Ω is mounted on a steel cantilever beam at a distance 0.12 m from the free end. The beam dimensions are 25 cm (length) x 2.0 cm (width) x 0.3 cm (depth). An unknown force F applied at the free end produces a deflection of 11.8 mm	10	4	4	4.6.1

	of the free end. If the changes in gauge resistance is found to be 0.145 Ω, calculate the gauge factor. Deflection of the free end $\delta = FL^3/3EI$, where F= Force, L=Length, E= Youngs modulus, I=Moment of Inertia, Take Young's modulus for steel as 200×10^9 N/m^2				
3 (B)	Following is the calibration data of a pressure transducer: **q_i(Mpa) | q_o (increasing) (Mpa) | q_o (decreasing) (Mpa)** 0 | 2 | -1 10 | 8 | 12 20 | 17 | 23 30 | 26 | 34 40 | 39 | 41 50 | 49 | 49 Find out: (i) The equation for the best-linear fit. (ii) The standard deviation of input qi, output q0, slope and intercept. (iii) qi if the instrument reads q0=30 after calibration. (iv) Plot Hysteresis curve and find Maximum Hysteresis error and dead band	10	3	2	3.1.1
4 (A)	A small cantilever beam is constructed for measurement of force F. It is made of spring Steel having modulus of elasticity E=200X10^9 N/m^2. The beam is 4.75 mm wide and 0.9 mm thick, with a length of 25±0.025 mm. An LVDT is used for displacement sensing. It is estimated that the limiting error in displacement is ±0.025 mm. Calculate the value of force and the limiting error if the displacement of LVDT is 2.5 mm. The limiting error in bar dimensions (in width and thickness) is ±0.0075 mm. Given force $F = \frac{3EI}{L^3}x$ Where I= MOI of beam, m4 L=Length of beam, m; and x= displacement of LVDT, m	10	2	2	2.1.2
4 (B)	Following are the different applications/systems/processes wherein the temperature measurement is essential; (i) Processor of the computing system (ii) Temperature of human beings entering institute campus under COVID-19 pandemic situation. Students shall select the appropriate temperature measuring system for the above applications with justification and also explain their working principle with neat labelled sketches. (Note: Points will be assigned to explanation only if selection of system is appropriate).	10	4	6	3.8.1

5 (A)	A diaphragm pressure gauge is constructed of spring steel to measure differential of 7 MN/m^2. The diameter of diaphragm is 12.5 mm. Calculate the thickness of diaphragm, if the maximum deflection is 0.333 of thickness. Also calculate the natural frequency of diaphragm. Given: Young's modulus=200 GN/m^2, Poisson's ratio-0.28 and density of steel=7800 kg/m^3	10	2	4	4.1.1.
5 (B)	In laboratory mercury in capillary tube temperature measurement system is available. It was proposed to measure humidity present in the laboratory. Explain step-by-step way to measure humidity. Draw appropriate sketches and flow diagram to explain the procedure	10	2	5	3.6.1
6	With neat labeled diagram explain working of (i) optical encoder (ii) stroboscope (iii) eddy current drag-cup tachometer (iv) peizo-electric accelerometer	20	2	3	2.1.2
7(A)	The transfer function of a system is given as $\frac{361}{\left(S^2+16S+361\right)}$ Find the following for a unit step input: Undamped natural frequency, damping ratio, damped natural frequency, settling time (tolerance within 2%), peak time, rise time, percentage overshoot.	10	4	4	4.1.2
7(B)	A temperature probe is transferred from air at 25^0C to air at 35^0C, then to water at 70^0C, and back to air at 35^0C. Assume that in each case the transfer is "instantaneous". The effective time constants and the timing sequence are as follows: In air, probe dry, τ =30 s; In water, τ =5 s; In air, probe wet, τ =20 s; For $t < 0$, T=25^0C (initial temperature) $0 < t < 7$, T=35^0C (dry probe in air) $7 < t < 15$, T=70^0C (probe in water), $15 < t < 30$, T=35^0C (wet probe in air). Calculate the indicated temperature at the end of each time interval and draw approximate graph of temperature versus time at the interval of 2 seconds.	10	3	4	2.1.2

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

End Semester - May 2022 Examinations

21/5/22

Program: S.Y.B. Tech. (Mechanical Engineering) Sem IV **Duration: 03 Hrs**

Course Code: PC-BTM404 **Maximum Points: 100**

Course Name: Mechanical Engineering Measurement **Semester: IV**

Notes:

1. **Question number 1 is compulsory**
2. **Solve any 4 questions from question number 2 to 7**
2. **If necessary assume suitable data with justification**
3. **Draw neat labeled sketches wherever required.**

Q. No.	Questions	Points	CO	BL	PI
1	Following table list the measuring instruments (left hand side column of the table) for measuring mechanical properties (right hand side column of the table) of the system. Students shall match the measuring instrument with the corresponding mechanical property. **Measuring Instruments** – **Measurand** Radiation pyrometer – Temperature Pirani gauge – Liquid Level Rotameter – Pressure Float Gauges – Flow rate Thermistor – Acceleration Further student shall explain only the working principle of the measurement instrument listed on left hand side column of the table with neat sketch. **(Note: Credits will be given only if match is perfect)**	05 15	3	4	1.2.3
2 (A)	It is proposed to develop measurement and control system for maintaining temperature and pressure of a reactor chamber in pharmaceutical applications. Proposed design aimed to retrieved data from system and controlled it remotely using internet network system. Students are instructed to present architecture of such network integrated measurement and control system (explain with neat schematic diagram).	10	2	3	1.2.2
2 (B)	Explain generalized measurement system with neat schematic diagram. Further map the different constituents of generalized measurement system with the physical elements of Laser Doppler Anemometer.	10	1	2	1.6.1
3 (A)	A single strain gauge having resistance of 130 Ω is mounted on a steel cantilever beam at a distance 0.12 m from the free end. The beam dimensions are 25 cm (length) x 2.0 cm (width) x 0.3 cm (depth). An unknown force F applied at the free end produces a deflection of 11.8 mm	10	4	4	4.6.1

	of the free end. If the changes in gauge resistance is found to be 0.145 Ω, calculate the gauge factor. Deflection of the free end $\delta = FL^3/3EI$, where F= Force, L=Length, E= Youngs modulus, I=Moment of Inertia, Take Young's modulus for steel as 200×10^9 N/m^2				
3 (B)	Explain working principle of Mcleod gauge with neat diagram. A Mcleod gauge has volume of bulb and measuring capillary equal to 110×10^{-6} m^3 and measuring capillary diameter of 1.1 mm. (i) Calculate the pressure indicated when the reading of measuring capillary is 28 mm in case approximate formula is used. What is the error if the exact formula is used for pressure measurement?	10	3	2	3.1.1
4 (A)	A bubbler or purge method is used to measure the water level. Air compressor having pressure range of 0-5 bar is used for the measurement of the water level. Air tube with opening at the bottom of the tank is used to purge the air in the water tank. Operator initially purge the 3 bar pressure in the air tube and no air bubbles are observed. The pressure is varied to maximum rating of 5 bar although no air bubble is observed. In fact at the setting of 5 bar pressure the water rises into the air tube up to 5 meters measured from bottom of the tank. Estimate the water level in the tank from the different observations provided.	10	1	2	2.1.2
4 (B)	Following are the different applications/systems/processes wherein the temperature measurement is essential; (i) Processor of the computing system (ii) Temperature of human beings entering institute campus under COVID-19 pandemic situation. Students shall select the appropriate temperature measuring system for the above applications with justification and also explain their working principle with neat labelled sketches. (Note: Points will be assigned to explanation only if selection of system is appropriate).	10	4	6	3.8.1
5 (A)	A diaphragm pressure gauge is constructed of spring steel to measure differential of 7 MN/m^2. The diameter of diaphragm is 12.5 mm. Calculate the thickness of diaphragm, if the maximum deflection is 0.333 of thickness. Also calculate the natural frequency of diaphragm. Given: Young's modulus=200 GN/m^2, Poisson's ratio-0.28 and density of steel=7800 kg/m^3	10	2	4	4.1.1.
5 (B)	In laboratory mercury in capillary tube temperature measurement system is available. It was proposed to measure humidity present in the laboratory. Explain step-by-step way to measure humidity. Draw appropriate sketches and flow diagram to explain the procedure	10	2	5	3.6.1

6	With neat labeled diagram explain working of (i) optical encoder (ii) stroboscope (iii) eddy current drag-cup tachometer (iv) peizo-electric accelerometer	20	2	3	2.1.2
7(A)	The discharge coefficient C_d of an orifice can be found by collecting the water that flows through during a time interval when it is under a constant head h. The formula is $$C_d = \frac{W}{t\rho A\sqrt{2gh}}$$ Find C_d and its possible error if: W=390±0.25 kg, t=600±2 s, d=12±0.03 mm, ρ=1050±0.1% kg/m^3; A= πd^2/4, h=3.6±0.03 m, g=9.81±0.1% m/s^2	10	4	4	4.1.2
7(B)	The speed of a shaft rotating at 2880 rpm is measured using stroboscope. The stroboscope dial is slowly turned within flashing rates of 96 to 24 per second. Indicate the flash rate setting which give single, double steady images.	10	3	4	2.1.2

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

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Munshi Nagar, Andheri (W) Mumbai – 400058

Re EXAM– JULY 2022 Examinations

S. Y. B. Tech (Mech) Sem IV 12/7/22.

Program: S.Y.B. Tech. (Mechanical Engineering) **Duration: 03 Hrs**

Course Code: PC-BTM404 **Maximum Points: 100**

Course Name: Mechanical Engineering Measurement **Semester: IV**

Notes:

1. Question number 1 is compulsory

2. Solve any 4 questions from question number 2 to 7

2. If necessary assume suitable data with justification

3. Draw neat labeled sketches wherever required.

Q. No.	Questions	Points	CO	BL	PI
1	Following table list the measuring instruments (left hand side column of the table) for measuring mechanical properties (right hand side column of the table) of the system. Students shall match the measuring instrument with the corresponding mechanical property. **Measuring Instruments** – **Measurand** Orificemeter – Temperature Vortex meter – Displacement Anemometer – Pressure Thermistor – Flow rate Further student shall explain only the working principle of the measurement instrument listed on left hand side column of the table with neat sketch. **(Note: Credits will be given only if match is perfect)**	04 16	3	4	1.2.3
2 (A)	It is proposed to develop measurement and control system for maintaining temperature and pressure of a reactor chamber in pharmaceutical applications. Proposed design aimed to retrieved data from system and controlled it remotely using internet network system. Students are instructed to present architecture of such network integrated measurement and control system (explain with neat schematic diagram).	10	2	3	1.2.2
2 (B)	Explain generalized measurement system with neat schematic diagram.	10	1	2	1.6.1
3 (A)	A single strain gauge having resistance of 130 Ω is mounted on a steel cantilever beam at a distance 0.12 m from the free end. The beam dimensions are 25 cm (length) x 2.0 cm (width) x 0.3 cm (depth). An unknown force F applied at the free end produces a deflection of 11.8 mm of the free end. If the changes in gauge resistance is found to be 0.145 Ω, calculate the gauge factor. Deflection of the free end $\delta = FL^3/3EI$, where F= Force, L=Length, E= Youngs modulus, I=Moment of Inertia, Take	10	4	4	4.6.1

	Young's modulus for steel as $200x10^9$ N/m^2				
3 (B)	Write short note on strain gauges (explain working principle and applications)	10	3	2	3.1.1
4 (A)	Write short note on Bourdon Pressure Gauge (explain working principle and applications)	10	2	2	2.1.2
4 (B)	Following are the different applications/systems/processes wherein the temperature measurement is essential; (i) temperature of forged parts (ii) Temperature of human beings entering institute campus under COVID-19 pandemic situation. Students shall select the appropriate temperature measuring system for the above applications with justification and also explain their working principle with neat labelled sketches. (Note: Points will be assigned to explanation only if selection of system is appropriate).	10	4	6	3.8.1
5	Explain working principle of (i) LVDT (ii) Potentiometer (iii) Viscosity measurement technique (iv) Humidity measurement techniques with neat sketches	20	2	4	4.1.1.
6	With neat labeled diagram explain working of (i) optical encoder (ii) stroboscope (iii) eddy current drag-cup tachometer (iv) peizo-electric accelerometer	20	2	3	2.1.2
7(A)	The transfer function of a system is given as $\frac{361}{\left(S^2+16S+361\right)}$ Find the following for a unit step input: Undamped natural frequency, damping ratio, damped natural frequency, settling time (tolerance within 2%), peak time, rise time, percentage overshoot.	10	4	4	4.1.2
7(B)	Explain with neat sketches the two different techniques to measure liquid level in tank	10	3	4	2.1.2

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Munshi Nagar, Andheri (W) Mumbai – 400058

END SEM EXAMINATIONS (Even SEM) May 2022

S. Y. B. Tech Sem IV (Mech) 23/5/22

Program: **BTech Mechanical engg** **Duration: 3.00 hr**

Course Code: **PC-BTM412** **Maximum Points: 100**

Course Name: **Kinematics of Machinery** **Semester: IV**

Notes:

1. Question number **ONE is compulsory** solve any **four** out of remaining
2. **Question nos. two and three should be solved on drawing sheet.**
3. Answers to each sub-questions are grouped together
4. Use of scientific calculator is allowed
5. Begin answer to each question on new page.
6. **Candidates should write the answer legibly**

Q.No.	Questions	Pts	Cos	BL	PI
1	a) Define the following terms, illustrating with sketches where possible, element or link, lower pair, higher pair, kinematic chain. b) Describe with neat sketch a quick return motion mechanism (slotted lever-crank) suitable for shaping machine. Show how the ratio of time taken for the two strokes is determined? c) Sketch the Davis steering gear mechanism and show that it satisfies the required condition for correct steering. d) Sketch and describe different types of followers which are used with radial or disc cam. e) Explain the meaning of the following terms: circular pitch, diametral pitch, module, pressure angle. Illustrate with sketches where possible.	4x5	1 2 3 4	2,3	2.4.1
2	a) A crank-rocker linkage has a 100 mm frame, a 25 mm crank, a 90 mm coupler and a 75 mm rocker. For the given mechanism find the minimum and maximum transmission angle. Sketch both the toggle position and find corresponding crank angles and transmission angles. (Solve graphically). b) For the above given mechanism, find the angular velocities of coupler and follower in terms of input angular velocity of crank as ω, for the configuration of minimum and maximum transmission angle.(Use IC method)	8 12	1	3,4	2.3.1

3	a) Use following data in drawing the displacement, velocity, acceleration verses theta (θ) diagram for a cam in which a knife-edged follower is raised with UARM and is lowered with SHM: least radius of cam 60 mm, lift 45 mm, angle of ascent 60^0, angle of descent 75^0, dwell between ascent and descent 40^0, cam rotation 180 rpm. Determine the maximum velocity and acceleration during ascent and descent. b) Deduce the expression for displacement, velocity and acceleration of the follower when it moves with SHM.	14 6	4	3	2.3.1
4	a) State the fundamental law of gearing, deduce the expression for the same. b) A gear set with a module of 5 mm/tooth has involute teeth with 22.5° pressure angle, and has 19 and 31 teeth, respectively. They have 1.0m for the addendum and 1.5m for the dedendum. (In SI. tooth system modules are given in, m, and a = 1.0m means 1 module, not 1 meter). Tabulate the addendum, dedendum, clearance, circular pitch, base pitch, base circle radius, contact ratio, angle of action for the pinion and wheel.	6 14	4	3	2.3.1
5	a) A spur gears with 9 and 36 teeth are to be cut with 20^0 full-depth cutter with module of 8 mm. i. Determine the amount that the addendum of the gear must be decreased in order to avoid the interference. ii. If the addendum of the pinion is increased by the same amount, determine the contact ratio. b) Deduce the expression for minimum number of teeth on gear wheel.	10 10	4	4	2.2.3
6	a) State the advantages of gear drive over the belt drive. b) What is interference in gear? How it is avoided? c) Define kinematic pair, classify the same. d) State and explain Kennedy's theorem. e) State and prove condition for correct steering.	20	4 4 2 2 2	2	2.3.2
7	a) State the conditions for straight line generating mechanism. Sketch the Peaucellier mechanism and prove that the tracing point 'P' describes the straight line. b) A driving shaft of a Hooke's joint rotates at a uniform speed of 400 rpm. If the maximum variation in the driven shaft is ±5% of the mean speed, determine the greatest permissible angle between the axes of the shafts. What are the maximum and minimum speeds of the driven shaft?	10 10	2	3	2.3.1

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SARDAR PATEL COLLEGE OF ENGINEERING

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Munshi Nagar, Andheri (W) Mumbai – 400058

END SEM EXAMINATION - JULY 2022 (DSY)

S.Y. B.Tech (Mech) Sem IV

Program: S Y BTech (Mech-DSY) **Duration:** 3 hr

Course Code: PC-BTM412 **Maximum Points:** 100

Course Name: Kinematics of Machinery **Semester:** IV 11/7/22

Notes:

1. Question number **ONE is compulsory** solve any **four** out of remaining
2. **Question nos. two and three should be solved on drawing sheet.**
3. Answers to each sub-questions are grouped together
4. Use of scientific calculator is allowed
5. Begin answer to each question on new page.
6. **Candidates should write the answer legibly**

Q.No.	Questions	pts	CO	BL	PI
1	a) What is meant by correct steering? State the condition of correct steering in words. Explain with suitable sketch.	4		2,3	2.4.1
	b) State and explain Kennedy's theorem.	4			
	c) What is meant by quick return ratio(QRR). Draw neat sketch of any two mechanisms which executes the QRR & explain.	4	1,2,		
	d) State and prove the fundamental law of gearing.	4	3,4		
	e) State the conditions for generating straight line, explain with suitable diagram.	4			
2	A crank-rocker linkage has a 250 mm frame, a 100 mm crank, a 500 mm coupler and a 400 mm rocker. Crank makes 70 deg with the horizontal measured in ccw direction. Find the angular velocity and angular acceleration of the coupler and the follower, if crank is having uniform angular velocity of 6 rad/s. Determine coupler and follower angle with horizontal. also their angular velocity and acceleration directions.*(relative velocity method)*	20	1	3	2.3.1
3	a) For the given mechanism in Q.no.2, find the min and max transmission angle. Sketch both the toggle position and find corresponding crank angles and transmission angles. (Solve graphically).	8	1,4	3,4	2.3.1
	b) For a cam with knife edge follower, draw the displacement, velocity, acceleration verses theta (θ) diagram, follower is raised with UARM and is lowered with SHM: lift 45 mm, angle of ascent 60^0, angle of descent 75^0, dwell between ascent and descent 40^0, cam rotation 180 rpm. Determine the maximum velocity and acceleration during ascent and descent.	12			

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END SEM EXAMINATION - JULY 2022 (DSY)

4	a) Deduce the expression for displacement, velocity and acceleration of the follower when it moves with SHM. b) Calculate the angular velocity and acceleration for coupler, linear velocity and acceleration for slider using analytical method (complex algebra). Given crank which is vertically upward is 45 mm, connecting rod(coupler) 180mm, and crank rotates uniformly 10 rad/s in ccw direction.	8 12	4	3,4	2.3 .1
5	a) A pair of spur gears in mesh having gear ratio of 3 are mounted on shafts whose centers are 136 mm apart. If module of the gears is 4 mm, how many teeth are there on each gear? b) Two identical involute spur gears are in mesh. The module is 4 mm and each gear has 22 teeth. If the operating pressure angle is 20^0, determine the minimum value of addendum needed to ensure continuous transmission of motion. c) A gear set with a module of 5 mm/tooth has involute teeth with 22.5° pressure angle, and has 19 and 31 teeth, respectively. They have the addendum of one module and dedendum of 1.25 module. calculate the addendum, dedendum, clearance, circular pitch, base pitch, base circle radius for pinion and wheel, and contact ratio.	6 6 8	4	3,4	2.2 .3
6	a) Explain the phenomenon of interference in gear? How it can be avoided? b) Gear drive is better than the belt drive in certain situations. Explain how? c) What are the different criteria of classification for kinematic pair? List the pairs. (draw suitable sketches) d) What do you meant by instantaneous center of rotation(IC's)? What are their characteristics? What are different types of IC's? e) Define mobility, explain Grubbler's criterion.	20	1,2 3,4	2	2.3 .2
7	a) Deduce the expression for minimum number of teeth on wheel to avoid the interference. b) Prove that Hart's mechanism generates exact straight line.	10 10	2,4	2,3	2.3 .1

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RE-END SEM EXAMINATIONS (Even SEM) JULY 2022

S. Y. B. Tech (Mech) Sem IV 14/7/22

Program: BTech Mechanical engg

Duration: 3.00 hr

Course Code: PC-BTM412

Maximum Points: 100

Course Name: Kinematics of Machinery

Semester: IV

Notes:

1. Question number **ONE is compulsory** solve any **four** out of remaining
2. **Question nos. two and three should be solved on drawing sheet.**
3. Answers to each sub-questions are grouped together
4. Use of scientific calculator is allowed
5. Begin answer to each question on new page.
6. **Candidates should write the answer legibly**

Q.No.	Questions	Pts	Cos	BL	PI
1	a) Define kinematic pair, classify the same. b) What do you meant by instantaneous center of rotation(IC's)? What are their characteristics? What are different types of IC's? c) Sketch and describe different types of Cams. d) Compare involute tooth profile gear with cycloidal tooth profile gear.	20	1 2 3 4	2,3	2.4 1
2	a) A crank-rocker linkage has a 250 mm frame, a 100 mm crank, a 500 mm coupler and a 400 mm rocker. For the given mechanism find the minimum and maximum transmission angle. Sketch both the toggle position and find corresponding crank angles and transmission angles. (Solve graphically). b) For the above given mechanism, find the angular velocities of coupler and follower in terms of input angular velocity of crank as ω, for the configuration of minimum and maximum transmission angle.(***Use relative velocity method)***	8 12	1	3,4	2.3. 1
3	a) Use following data in drawing the displacement, velocity, acceleration verses theta (θ) diagram for a cam in which a knife-edged follower is raised with SHM and is lowered with UARM: least radius of cam 60 mm, lift 50 mm, angle of ascent 75^0, angle of descent 90^0, dwell between ascent and descent 40^0, cam rotation 150 rpm. Determine the maximum velocity and acceleration during ascent and descent. b) Deduce the expression for displacement, velocity and acceleration of	14 6	4	3	2.3, 1

	the follower when it is having ***cycloidal motion***.				
4	a) A pair of spur gears in mesh having gear ratio of 3 are mounted on shafts whose centers are 136 mm apart. If module of the gears is 4 mm, how many teeth are there on each gear? b) Two identical involute spur gears are in mesh. The module is 4 mm and each gear has 22 teeth. If the operating pressure angle is 20^0, determine the minimum value of addendum needed to ensure continuous transmission of motion. c) A gear set with a module of 4 mm/tooth has involute teeth with 20° pressure angle, and has 19 and 37 teeth, respectively. They have the addendum of one module and dedendum of 1.25 module. calculate the addendum, dedendum, clearance, circular pitch, base pitch, base circle radius for pinion and wheel, and contact ratio.	6 6 8	4	3	2.3.1
5	a) State the fundamental law of gearing, deduce the expression for the same b) Deduce the expression for minimum number of teeth on pinion.	10 10	4	4	2.2.3
6	a) State the advantages of gear drive over the belt drive. b) What is interference in gear? How it is avoided? c) State and explain Kennedy's theorem. d) State and prove condition for correct steering.	20	4,2	2	2.3.2
7	a) What is a Pantograph? Show that it can produce path exactly similar to the one traced out by a point on a link. b) Draw a neat sketch of cam profile with roller follower and show the important terms, also define them.	10 10	2	3	2.3.1

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S.Y.B.Tech Sem IV Mechanical. 17/5/22

END-SEMESTER – EVEN SEM – MAY 2022

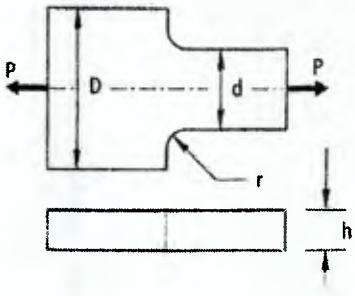
Program: B.Tech. in Mechanical Engineering | **Duration: 3 Hour**

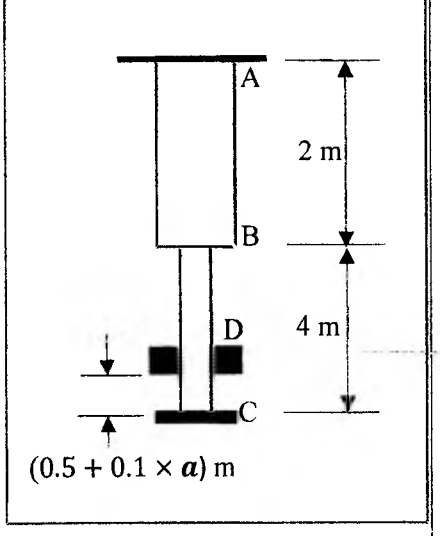
Course Code: PC-BTM415 | **Max. Points: 100**

Course Name: Solid Mechanics | **Semester: IV**

Notes:

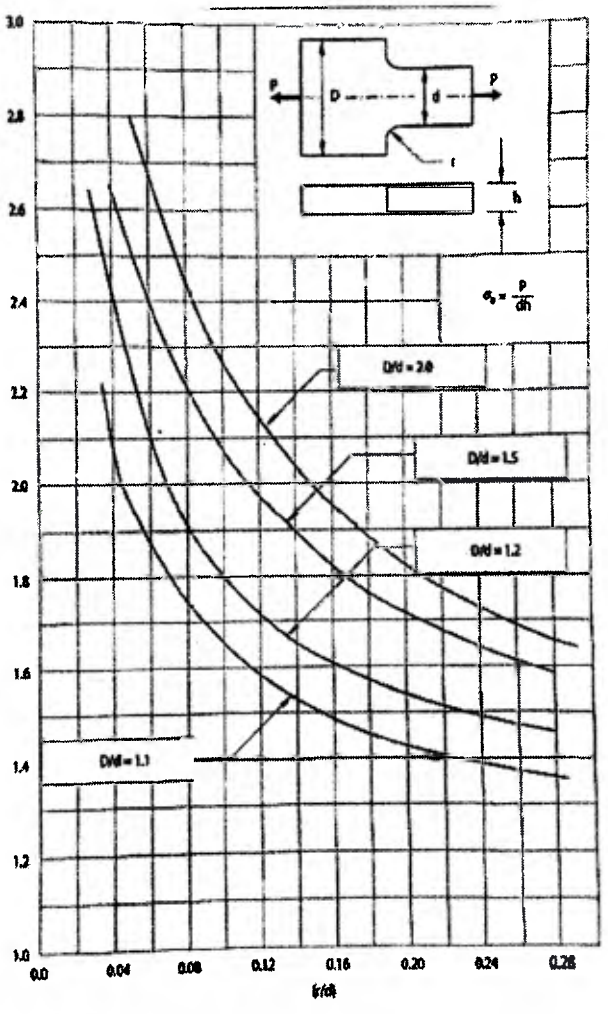
1. **Question no. 1 is compulsory**, solve any 4 of remaining 6 questions.
2. ***'a'*** is the single last digit (0 to 9) of student's registration no. in questions marked with *.
3. Assume suitable data if necessary.

Q. No.	Questions	Points	CO	BL	PI
Q1 COMPULSORY	A) * Given the stress matrix τ_{ij}, determine the magnitude of the normal stress on a plane **parallel to x axis** and **equally inclined** to y and z planes. $\tau_{ij} = \begin{bmatrix} -1 & 1 & -2-a \\ 1 & 1+a & 3 \\ -2-a & 3 & -1 \end{bmatrix}$	(5)	1	3	2.4.1
	B) Derive following expression for an isotropic linear elastic material: $\sigma_3 = \lambda(\varepsilon_1 + \varepsilon_2 + \varepsilon_3) + 2\mu\varepsilon_3$ where $\sigma_1, \sigma_2, \sigma_3$ and $\varepsilon_1, \varepsilon_2, \varepsilon_3$ are the principal stresses and strains and λ, μ are Lame's coefficients. Highlight the step in the derivation which is based on material isotropy.	(5)	3	4	2.3.1
	C) * A flat plate as shown in the figure is made of material with ultimate tensile strength of 500 MPa. Calculate the safe load it can carry with factor of safety as 2.0.  D = 150 mm d = 100 mm r = (6+***a***) mm h = 5 mm	(5)	3	3	2.1.2
	D) * A bar of steel 2 meters long, is 20 mm in diameter for 1000 mm of its length, 10 mm in diameter for the remaining 1000 mm. The bar is in tension, the stress in the largest section being $(100 + 10 \times a)$ MPa. Taking E = 200 GPa, find the energy stored in the bar.	(5)	4	3	2.2.3
Q2	A) * The rectangular components of small strain at a point is given by the following matrix. Determine the principal strains and the direction of maximum principal strain. ($p = 10^{-4}$)	(10)	1	3	2.4.1

	$[\varepsilon_{ij}] = p\begin{bmatrix}1 & 2 & 0\\ 2 & 1+\boldsymbol{a} & -2\\ 0 & -2 & 2\end{bmatrix}$ B) * A 50 mm long steel rod of (25+***a***) mm diameter is pressed on to a steel plate with a force of (10+***a***) N. Consider E = 200 GPa, ν = 0.3. Determine following. i. The width of the contact area ii. The maximum contact pressure iii. The maximum shear stress on the contact surface iv. The maximum shear stress below the surface of contact. C) Give two cases from real life where theory of metal plasticity is essential to analyze the cases. Describe the Bauschinger effect with the help of load vs displacement plot.	**(5)** **(5)**	*2* *3*	*3* *3*	*2.3.1* *2.1.2*
Q3	A) Compare between 'plane stress' and 'plane strain' problems. Give one example of each type of the problem. What is the advantage of this concept? B) One of the differential equations of equilibrium is $\frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \sigma_y}{\partial y} + \frac{\partial \tau_{yz}}{\partial z} + \gamma_y = 0$ Derive above equation. (Hint: use force equilibrium for a cubicle element along a coordinate axis). C) * A thick-walled cylinder has an internal radius of (50+***a***) mm and an external radius of (100+***a***) mm. It is subjected to external pressure of 1 MPa. If E = 200 GPa and = 0.3, determine the permissible internal pressure as per Maximum Principal stress theory of failure. Consider tensile strength as 50 MPa and factor of safety as 2.0. Also determine the changes in internal and external radii.	**(5)** **(5)** **(10)**	*3* *3* *2*	*2* *4* *3*	*2.1.2* *2.3.1* *2.2.3*
Q4	A) * Collar D of 1 kg mass is released from rest in the position shown in the figure and it is stopped by a small plate attached at end C of the vertical rod ABC. Section AB is of 10 mm diameter and section BC is of 5 mm diameter. E = 200 GPa. Determine the instantaneous stresses in the rod.  B) Explain why stress is termed as a tensor entity. Discuss the difference between "stress tensor" and "stress vector" at a point. C) Discuss the following: (i) nature of constitutive equations which relate the stress and strain for a material, (ii) True stress and strain versus Engineering stress and strain.	**(10)** **(5)** **(5)**	*4* *1* *3*	*3* *2* *2*	*2.3.1* *2.3.2* *2.1.3*

Q5	A) * The displacement field for a body is given by: $\bar{u} = [((a+1)x^2z + y^2)\bar{\imath} + ((a+2)yz^2)\bar{\jmath} + (6xy^3z)\bar{k}]10^{-4}$ What are the strain components at (-1, 1, -1)?	(5)	2	3	2.4.1
	B) Explain the principle of superimposition. Prove the uniqueness theorem for elastic bodies using the principle of superimposition.	(5)	3	4	2.3.1
	C) * A steel disk of (500+a) mm diameter is shrunk on a steel shaft of 50 mm diameter. The interference on diameter is 0.025 mm. Find the rotation speed at which contact pressure is zero. Also calculate the maximum tangential stress at above speed. Consider E = 200 GPa, = 0.3 and density = 7850 kg/m^3.	(10)	2	3	2.2.3
Q6	A) * State Cauchy's stress formula. Solve the following problem using the formula. The state of stress at a point is characterized by the matrix shown. Determine σ_{12} such that there is at least a single plane passing throught the point in such a way that the resultant stress on that plane is zero. Determine the direction cosines of the normal to that plane. $[\tau_{ij}] = \begin{bmatrix} -1 & \sigma_{12} & (1+a) \\ 2 & 1 & 3 \\ (1+a) & 3 & -1 \end{bmatrix}$	(10)	3	4	2.3.1
	B) Discuss significance of following terms in solid mechanics: (i) Principal strain, (ii) compatibility equations, (iii) strain gauges	(5)	2	2	2.3.2
	C) * A thin-walled rectangular box section has the mean width and height of (20+a) mm and (40+a) mm respectively. The wall thickness is 1 mm. It is subjected to torque of 10 Nm. Calculate the shear stress in the wall and the angle of twist per unit length. G = 80 GPa.	(5)	2	3	2.3.1
Q7	A) Give two examples from real life about the thermoelastic problems. Write the stress-strain relationship for these problems. Prove that if a body is uniformly heated, the stresses induced are zero.	(5)	2	3	2.3.2
	B) Explain the following: (i) resilience, (ii) proof resilience, (iii) strain energy, (iv) strain energy density, (v) difference between gradually applied and suddenly applied loading.	(5)	4	2	2.3.2
	C) Discuss three modes of fracture and give two examples from real life for each mode.	(5)	3	3	2.3.2
	D) * A rectangular plate of 50 mm width and thickness 25 mm has an edge crack of $(3 + 0.1 \times a)$ mm depth. The plate is subjected to an axial load of 10 kN and a bending moment of 2000 Nm both of which tend to open the crack. The fracture toughness of the plate material is 50 $MPa\sqrt{m}$. Calculate the factor of safety against the fracture failure.	(5)	3	3	2.3.1

ANNEXURE: USEFUL FORMULAE



Stresses for two cylinders in contact with each other

$$b = \sqrt{\frac{2F}{\pi l}\left[\frac{\frac{(1-\nu_1^2)}{E_1}+\frac{(1-\nu_2^2)}{E_2}}{\frac{1}{d_1}+\frac{1}{d_2}}\right]}$$

$$p_{max} = \frac{2}{\pi}\frac{F}{bl}$$

$$\sigma_x = -2\nu p_{max}\left[\sqrt{\left(1+\frac{z^2}{b^2}\right)}-\frac{z}{b}\right]$$

$$\sigma_y = -p_{max}\left[\left(2-\frac{1}{1+z^2/b^2}\right)\sqrt{1+z^2/b^2}-2\frac{z}{b}\right]$$

$$\sigma_z = -p_{max}\left[\frac{1}{\sqrt{1+z^2/b^2}}\right]$$

Stresses in thick pressurized cylinders

$$\sigma_r = \frac{p_a a^2 - p_b b^2}{b^2-a^2} - \frac{a^2 b^2}{r^2}\times\frac{p_a - p_b}{b^2-a^2}$$

$$\sigma_\theta = \frac{p_a a^2 - p_b b^2}{b^2-a^2} + \frac{a^2 b^2}{r^2}\times\frac{p_a - p_b}{b^2-a^2}$$

$\sigma_z = 0$ with both ends open

$\sigma_z = \nu(\sigma_r + \sigma_\theta)$ with both ends closed

Stresses in rotating solid disks

$$\sigma_r = \frac{3+\nu}{8}\rho\omega^2(b^2 - r^2)$$

$$\sigma_\theta = \frac{3+\nu}{8}\rho\omega^2 b^2 - \frac{1+3\nu}{8}\rho\omega^2 r^2$$

Stresses in rotating disks with central hole

$$\sigma_r = \frac{3+\nu}{8}\rho\omega^2\left(b^2 + a^2 - \frac{a^2b^2}{r^2} - r^2\right)$$

$$\sigma_\theta = \frac{3+\nu}{8}\rho\omega^2\left(b^2 + a^2 + \frac{a^2b^2}{r^2} - \frac{1+3\nu}{3+\nu}r^2\right)$$

SIF for edge cracked plate subjected to axial load P / bending moment M

$(K_I)_P = \frac{P}{Bh}\sqrt{\pi a}\,Y_P$,

$$Y_P = 1.12 - 0.23\alpha + 10.55\alpha^2 - 21.72\alpha^3 + 30.39\alpha^4;\ \ \alpha = a/h$$

$(K_I)_M = \frac{6M}{Bh^2}\sqrt{\pi a}\,Y_M$

$$Y_M = 1.122 - 1.4\alpha + 7.33\alpha^2 - 13.08\alpha^3 + 14\alpha^4;\ \ \alpha = a/h$$

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S. Y. B. Tech (Mech) Sem IV

END-SEMESTER – EVEN SEM (DSY) – JULY 2022

Program: B.Tech. in Mechanical Engineering | **Duration: 3 Hour**

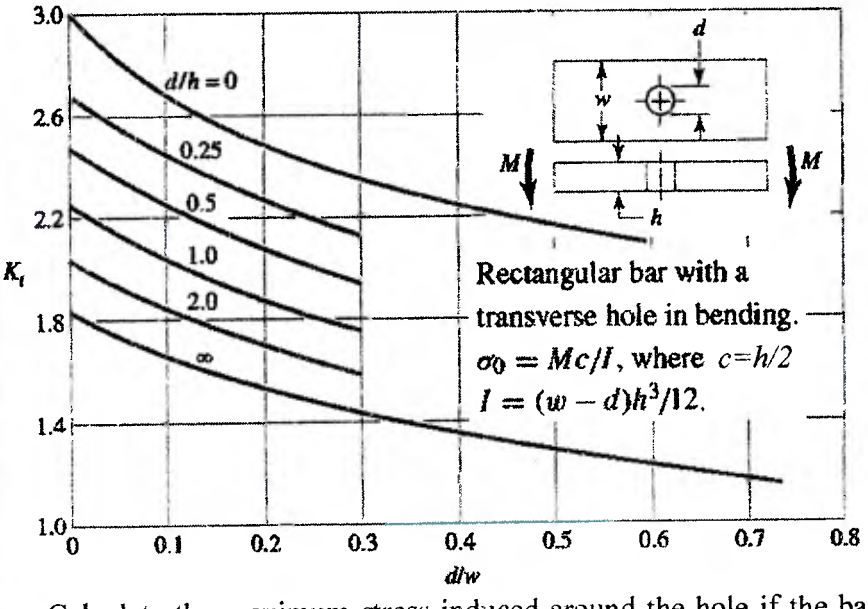
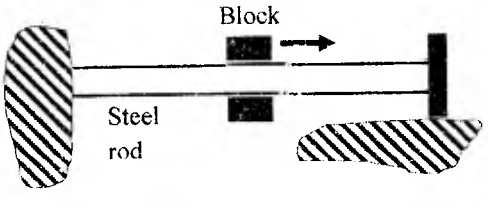
Course Code: PC-BTM415 | **Max. Points: 100**

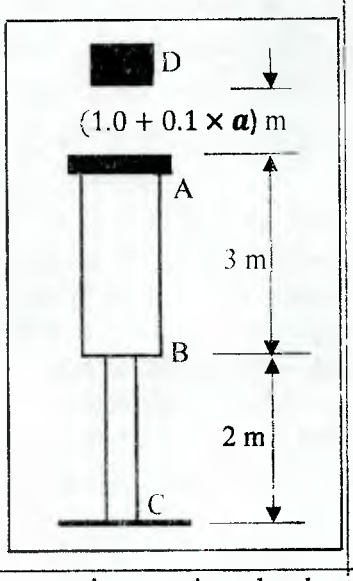
Course Name: Solid Mechanics 15/7/22 | **Semester: IV**

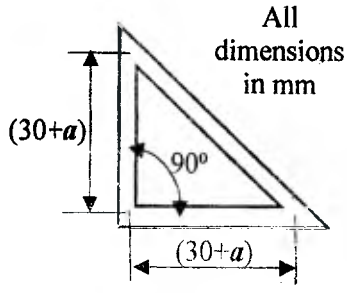
Notes:

1. **Question no. 1 is compulsory**, solve any 4 of remaining 6 questions.
2. ***'a'*** is the single last digit (0 to 9) of student's registration no. in questions marked with *.
3. Assume suitable data if necessary.

Q. No.	Questions	Points	CO	BL	PI
Q1 COMPULSORY	A) Briefly explain the physical meaning of the compatibility equations. Two of the compatibility equations are given below. $$\frac{\partial^2 \varepsilon_x}{\partial y^2}+\frac{\partial^2 \varepsilon_y}{\partial x^2}=\frac{\partial^2 \gamma_{xy}}{\partial x \partial y}$$ $$\frac{\partial}{\partial z}\left(\frac{\partial \gamma_{yz}}{\partial x}+\frac{\partial \gamma_{xz}}{\partial y}-\frac{\partial \gamma_{xy}}{\partial z}\right)=2\frac{\partial^2 \varepsilon_z}{\partial x \partial y}$$ Check if the above equations satisfy the following strain field (p is a constant of small value). $$[\varepsilon_{ij}]=p\begin{bmatrix} x & y & x \\ y & y & (x+y) \\ x & (x+y) & 2(y+z) \end{bmatrix}$$	(5)	2	3	2.3.1
	B) * Given the stress matrix τ_{ij}, determine: Magnitude of the normal and shear stress on a plane which has its normal which is inclined to the x axis by 60 degrees and is inclined to the y axis also by 60 degrees. $$\tau_{ij}=\begin{bmatrix} a-1 & a+3 & 10 \\ a+3 & 1 & 1 \\ 10 & 1 & -1 \end{bmatrix}$$	(5)	1	3	2.4.1
	C) Describe the three modes of fracture with neat sketch. Give two examples of each mode from real life situations.	(5)	2	2	2.3.2
	D) * Two 20 mm long steel rods of (20+a) mm diameter are pressed against each other with a force of (80+a) N. Consider E = 210 GPa, ν = 0.3. Determine following. i. The width of the contact area ii. The maximum contact pressure iii. The maximum shear stress on the contact surface iv. The maximum shear stress below the surface of contact.	(5)	2	3	2.3.1

Q2	A) A thick-walled pipe has internal radius of (100+a) mm. It is subjected to internal pressure of 2.0 MPa and external pressure of 0.25 MPa. If E = 200 GPa and ν = 0.3, determine the thickness as per the maximum principal stress theory of failure. Consider tensile strength as 350 MPa and factor of safety as 3.5. Also determine the changes in internal and external radii for the pipe with the calculated thickness.	**(10)**	*2*	*3*	*2.2.3*
	B) A rectangular bar with transverse hole is subjected to bending moment. The geometry parameters and the stress concentration factor for the bar are as shown in the figure.	**(5)**	*2*	*3*	*2.2.3*
					
	Calculate the maximum stress induced around the hole if the bar subjected to bending moment of 100 Nm. The dimensions of the bar in mm are: d = 10+a, w = 100+a and h=10.				
	C) Describe the importance of metal plasticity with suitable examples. Explain the following terms in the context of plasticity: (i) Deviatoric or π plane, (ii) Yield locus.	**(5)**	*3*	*3*	*2.1.2*
Q3	A) Derive the following compatibility equation. Hint: Begin with the strain-displacement relationship for ε_y and ε_z. $$\frac{\partial^2 \varepsilon_y}{\partial z^2} + \frac{\partial^2 \varepsilon_z}{\partial y^2} = \frac{\partial^2 \gamma_{yz}}{\partial y \partial z}$$	**(5)**	*2*	*3*	*2.3.1*
	B) Explain the principle of superposition with two examples of its application. Discuss why this principle cannot be applied for non-linear systems.	**(5)**	*3*	*4*	*2.3.2*
	C) * A sliding block weighing 100 N slides over a (10+a) mm diameter 1000 mm long horizontal steel rod at a velocity of 4 m/s as shown in the figure. The block is 	**(5)**	*4*	*3*	*2.3.1*

	stopped by its impact with a rigid collar provided at the end of rod. Ignoring friction and bending of bar, find instantaneous stress induced in the rod. Consider E = 200 GPa. Will the stress in the rod increase/decrease if the E value for material is changed to 100 GPa? D) Describe the Bauschinger effect with the help of load-displacement diagram. In which situations this effect is advantageous?	(5)	3	3	2.1.2
Q4	A) One of the differential equations of equilibrium is $$\frac{\partial \tau_{xz}}{\partial x}+\frac{\partial \tau_{yz}}{\partial y}+\frac{\partial \sigma_z}{\partial z}+\gamma_z=0$$ Derive above equation.	(5)	3	4	2.3.1
	B) * Block D of 10 kg mass is released from rest in the position shown in the figure and it is stopped by a cover plate attached at end A of the vertical rod ABC which is fixed at end C. Section AB is of 12 mm diameter and section BC is of 6 mm diameter. E = 200 GPa. Determine the instantaneous stresses in the rod. 	(10)	4	3	2.3.1
	C) Why are the plane stress and plane strain approximations used to solve certain elasticity problems? Give two examples of each type. Compare the difference between these two approaches.	(5)	1	2	2.1.2
Q5	A) * The rectangular components of stress at a point are given by the following matrix. Determine the principal stresses and the direction of the **maximum** principal stress. $$[\tau_{ij}]=\begin{bmatrix} a-10 & 1 & 2 \\ 1 & 3 & -1 \\ 2 & -1 & 5 \end{bmatrix}$$ Briefly discuss the importance of principal stresses in the design of machine components.	(10)	1	3	2.4.1
	B) * A rotor of (400+a) mm diameter is shrunk fitted on a steel shaft of 60 mm diameter. The interference on diameter is 0.02 mm. Find the rotation speed at which contact pressure is zero. Also calculate the maximum tangential stress at the calculated speed. Consider E = 200 GPa, ν = 0.3 and density = 8000 kg/m^3.	(10)	2	3	2.2.3
Q6	A) * The displacement field for a body is given by: $\bar{u}=[(yz^2+(a-10)xy^2z)\bar{\imath}+((a+2)xyz)\bar{\jmath}+(x^3y^3+z^2)\bar{k}]10^{-5}$ What are the strain components at (1, -1, 1)?	(5)	2	3	2.4.1
	B) Discuss the importance of the constitutive equations in solid mechanics. Explain how the nature of these equations change for the isotropic and anisotropic materials.	(5)	3	2	2.1.3

	C) * A thin-walled box section of uniform wall thickness 2 mm has a triangular shape as shown in the figure. The section is subjected to a torque of 25 Nm. Calculate the shear stress induced in the section and the angle of twist per unit length. Consider G = 80 GPa.  	(5)	2	3	2.4.2
	D) * A rectangular plate of 80 mm width and thickness 40 mm has an edge crack of $(10 + 0.1 \times a)$ mm depth. The plate is subjected to an axial load of 25 kN and a bending moment of 2500 Nm both of which tend to open the crack. The fracture toughness of the plate material is 75 $MPa\sqrt{m}$. Calculate the factor of safety against the fracture failure.	(5)	3	3	2.3.1
Q7	A) Describe the relation between the true and engineering stress/strain. Discuss the need of these concepts in engineering analysis.	(5)	3	2	2.1.3
	B) What is the uniqueness theorem? Provide a proof for this theorem.	(5)	3	4	2.3.1
	C) Discuss how temperature loading is accounted for in the stress-strain relationship. Obtain the stresses for a case wherein an unconstrained solid is uniformly heated.	(5)	2	2	2.3.2
	D) Prove that the strain energy stored in a hollow cylinder of length L, polar area moment of intertia J and subjected to torque T is given by $U = \frac{T^2 L}{2JG}$.	(5)	3	3	2.3.2

ANNEXURE: USEFUL FORMULAE

Stresses for two cylinders in contact with each other

$$b = \sqrt{\frac{2F}{\pi l}\left[\frac{\frac{(1-\nu_1^2)}{E_1}+\frac{(1-\nu_2^2)}{E_2}}{\frac{1}{d_1}+\frac{1}{d_2}}\right]} \qquad p_{max} = \frac{2}{\pi}\frac{F}{bl}$$

$$\sigma_x = -2\nu p_{max}\left[\sqrt{\left(1+\frac{z^2}{b^2}\right)}-\frac{z}{b}\right]$$

$$\sigma_y = -p_{max}\left[\left(2-\frac{1}{1+z^2/b^2}\right)\sqrt{1+z^2/b^2}-2\frac{z}{b}\right]$$

$$\sigma_z = -p_{max}\left[\frac{1}{\sqrt{1+z^2/b^2}}\right]$$

Stresses in thick pressurized cylinders

$$\sigma_r = \frac{p_a a^2 - p_b b^2}{b^2-a^2} - \frac{a^2 b^2}{r^2}\times\frac{p_a - p_b}{b^2-a^2}$$

$$\sigma_\theta = \frac{p_a a^2 - p_b b^2}{b^2-a^2} + \frac{a^2 b^2}{r^2}\times\frac{p_a - p_b}{b^2-a^2}$$

$\sigma_z = 0$ with both ends open

$\sigma_z = \nu(\sigma_r + \sigma_\theta)$ with both ends closed

Stresses in rotating solid disks

$$\sigma_r = \frac{3+\nu}{8}\rho\omega^2(b^2-r^2)$$

$$\sigma_\theta = \frac{3+\nu}{8}\rho\omega^2 b^2 - \frac{1+3\nu}{8}\rho\omega^2 r^2$$

Stresses in rotating disks with central hole

$$\sigma_r = \frac{3+\nu}{8}\rho\omega^2\left(b^2+a^2-\frac{a^2b^2}{r^2}-r^2\right)$$

$$\sigma_\theta = \frac{3+\nu}{8}\rho\omega^2\left(b^2+a^2+\frac{a^2b^2}{r^2}-\frac{1+3\nu}{3+\nu}r^2\right)$$

SIF for edge cracked plate subjected to axial load P / bending moment M

$(K_I)_P = \frac{P}{Bh}\sqrt{\pi a}\,Y_P$,

$$Y_P = 1.12 - 0.23\alpha + 10.55\alpha^2 - 21.72\alpha^3 + 30.39\alpha^4;\ \alpha = a/h$$

$(K_I)_M = \frac{6M}{Bh^2}\sqrt{\pi a}\,Y_M$

$$Y_M = 1.122 - 1.4\alpha + 7.33\alpha^2 - 13.08\alpha^3 + 14\alpha^4;\ \alpha = a/h$$

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)
Munshi Nagar, Andheri (W) Mumbai – 400058

S. Y. B.Tech (Mech) Sem IV

END-SEMESTER – RE-EXAMINATION – JULY 2022

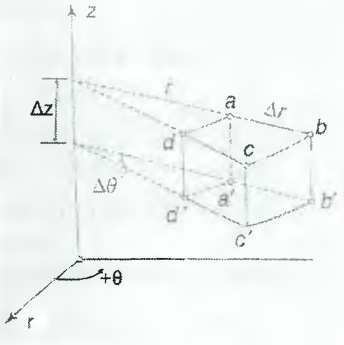
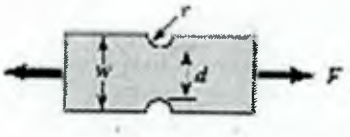
Program: B.Tech. in Mechanical Engineering | **Duration: 3 Hour**

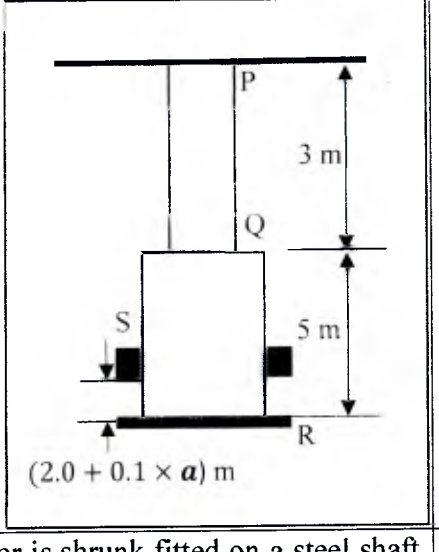
Course Code: PC-BTM415 | **Max. Points: 100**

Course Name: Solid Mechanics | **Semester: IV**

Notes:

1. **Question no. 1 is compulsory**, solve any 4 of remaining 6 questions.
2. ***'a'*** is the single last digit (0 to 9) of student's registration no. in questions marked with *.
3. Assume suitable data if necessary.

Q. No.	Questions	Points	CO	BL	PI
Q1 COMPULSORY	A) Figure shows a solid element located inside a stressed body and defined in a cylindrical coordinate system. To derive one of the equilibrium equations, it is required to compute all forces acting on this element in r-direction due to stresses acting on its six faces and the body force. Obtain the expressions for the forces acting in **r-direction** on the **two faces abcd and a'b'c'd'** and for the body force acting on the element in r-direction. 	(5)	3	4	2.3.1
	B) * A notched rectangular bar as shown in the figure is subjected to tensile force $F = (1000 + 10 \times a)$ N. The dimensions of the bar are $w = 12$ mm, $d = 10$ mm, $r = 1$ mm, thickness = 2 mm. Calculate the maximum stress induced in the bar. 	(5)	3	3	2.1.2
	C) * Given the stress matrix τ_{ij}, determine the magnitude of the normal and shear stress on a plane **parallel to z axis** and **equally inclined** to x and y axes. $\tau_{ij} = \begin{bmatrix} -1-a & 1 & 3 \\ 1 & 4 & 1+a \\ 3 & 1+a & 1 \end{bmatrix}$	(5)	1	3	2.4.1
	D) Discuss the significance of the following terms in the energy-based approach of solid mechanics: (i) strain energy, (ii) strain energy density, (iii) resilience, (iv) proof resilience. Give two examples from real life where the energy-based approach is more suitable for calculating the stresses/strains.	(5)	4	3	2.1.2

Q2	A) * The matrix representation of the stress state at a point is given by the following matrix. Determine the principal stresses and the direction of the **minimum** principal stress. $$[\tau_{ij}] = \begin{bmatrix} a+1 & 5 & -1 \\ 5 & 10-a & 1 \\ -1 & 1 & 2 \end{bmatrix}$$ How are the principal stresses related to the design of machine components?	**(10)**	*1*	*3*	*2.4.1*
	B) * A thick-walled cylindrical vessel has an internal radius of (1000+a) mm and an external radius of (1050+a) mm. It is subjected to the internal pressure of 10 MPa. If E = 200 GPa and = 0.3, determine the permissible external pressure as per the Maximum Principal stress theory of failure. Consider tensile strength as 200 MPa and factor of safety as 2.0. Also determine the changes in internal and external radii.	**(10)**	*2*	*3*	*2.2.3*
Q3	A) * The displacement field for a body is given by: $$\bar{u} = [((a-10)xyz + x^2)\bar{\imath} + (y^2 + xz^2)\bar{\jmath} + ((1+a)xz^3)\bar{k}]10^{-4}$$ What are the strain components at (1, 1, 1)?	**(5)**	*2*	*3*	*2.4.1*
	B) * Two cylindrical rollers of (50+a) mm diameter and (30+a) mm length are pressed against each other with a force of (100+a) N. Consider E = 200 GPa, ν = 0.3. Determine following. i. The width of the contact area ii. The maximum contact pressure iii. The maximum shear stress on the contact surface iv. The maximum shear stress below the surface of contact.	**(5)**	*2*	*3*	*2.3.1*
	C) * Collar S of 2 kg mass is released from rest in the position shown in the figure and it is stopped by a small plate attached at end R of the vertical rod PQR. The rod is fixed at P. Section PQ is of 10 mm diameter and section QR is of 15 mm diameter. E = 200 GPa. Determine the instantaneous stresses in the rod. 	**(10)**	*4*	*3*	*2.3.1*
Q4	A) * A rotor of (600+a) mm diameter is shrunk fitted on a steel shaft of 80 mm diameter. The interference on diameter is 0.03 mm. Find the rotation speed at which contact pressure is zero. Also calculate the maximum tangential stress at the calculated speed. Consider E = 210 GPa, ν = 0.3 and density = 7800 kg/m^3.	**(10)**	*2*	*3*	*2.2.3*
	B) Thermoelastic problems are important in design of machine components. Discuss the nature of thermoelastic problems with	**(5)**	*2*	*3*	*2.3.2*

	two examples from real life and state the stress-strain relationship for these problems. Develop the expression for stresses for stresses in a body which is uniformly heated. C) What are the three modes of fracture in solid bodies? Which mode is the most common? Provide two examples from real life for each mode.	**(5)**	*3*	*3*	*2.3.2*
Q5	A) Discuss significance of following terms in solid mechanics: (i) Compatibility equations, (ii) Strain-displacement equations, (iii) strain gauges.	**(5)**	*2*	*2*	*2.3.2*
	B) State the 'superposition principle' and 'uniqueness theorem'. Provide an outline of proving the uniqueness theorem form the superposition principle.	**(5)**	*3*	*4*	*2.3.1*
	C) * A thin-walled box section is of rectangular shape; it has the mean width and height of (30+***a***) mm and (50+***a***) mm respectively. The wall thickness is 2 mm. It is subjected to torque of 40 Nm. Calculate the shear stress in the wall and the angle of twist per unit length. G = 82 GPa.	**(5)**	*2*	*3*	*2.4.2*
	D) Explain the Bauschinger effect in the context of metal plasticity.	**(5)**	*3*	*3*	*2.1.2*
Q6	A) Explain the following: (i) shear flow, (ii) stress concentration factor, (iii) stress intensity factor, (iv) stress tensor.	**(5)**	*2*	*3*	*2.1.2*
	B) The Lame's coefficients λ, μ for an isotropic linear elastic material are defined as: $\sigma_3 = \lambda(\varepsilon_1 + \varepsilon_2 + \varepsilon_3) + 2\mu\varepsilon_3$ where $\sigma_1, \sigma_2, \sigma_3$ and $\varepsilon_1, \varepsilon_2, \varepsilon_3$ are the principal stresses and strains. Derive these expressions.	**(5)**	*3*	*4*	*2.3.1*
	C) Discuss the plane stress and plane strain approximations. Compare between these approaches with two examples of each type.	**(5)**	*1*	*2*	*2.1.2*
	D) * A bar of steel 1 meters long, is 50 mm in diameter for 250 mm of its length, 20 mm in diameter for the remaining 750 mm. The bar is in compression, the stress in the smallest section being $(200 + 10 \times \boldsymbol{a})$ MPa. Taking E = 200 GPa, find the energy stored in the bar.	**(5)**	*4*	*3*	*2.2.3*
Q7	A) Derive the following equation of equilibrium. $$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} + \gamma_x = 0$$	**(5)**	*3*	*4*	*2.3.1*
	B) Derive the following compatibility equation. Hint: Begin with the strain-displacement relationship for ε_x and ε_y. $$\frac{\partial^2 \varepsilon_x}{\partial y^2} + \frac{\partial^2 \varepsilon_y}{\partial x^2} = \frac{\partial^2 \gamma_{xy}}{\partial x \partial y}$$	**(5)**	*2*	*3*	*2.3.1*
	C) Describe the nature and the need of the constitutive equations. Illustrate the typical form of these equations for the isotropic and anisotropic materials.	**(5)**	*3*	*2*	*2.1.3*
	D) Discuss the metal plasticity and provide suitable examples where it plays an important role in design of certain components. What is the significance of Deviatoric or π plane and Yield locus in the plasticity analysis?	**(5)**	*3*	*3*	*2.1.2*

ANNEXURE: USEFUL FORMULAE

Annexure 1

Stresses for two cylinders in contact with each other

$$p_{max} = \frac{2}{\pi}\frac{F}{bl}$$

$$b = \sqrt{\frac{2F}{\pi l}\left[\frac{\frac{(1-\nu_1^2)}{E_1}+\frac{(1-\nu_2^2)}{E_2}}{\frac{1}{d_1}+\frac{1}{d_2}}\right]}$$

$$\sigma_x = -2\nu p_{max}\left[\sqrt{\left(1+\frac{z^2}{b^2}\right)}-\frac{z}{b}\right]$$

$$\sigma_y = -p_{max}\left[\left(2-\frac{1}{1+z^2/b^2}\right)\sqrt{1+z^2/b^2}-2\frac{z}{b}\right]$$

$$\sigma_z = -p_{max}\left[\frac{1}{\sqrt{1+z^2/b^2}}\right]$$

Stresses in thick pressurized cylinders

$$\sigma_r = \frac{p_a a^2 - p_b b^2}{b^2-a^2} - \frac{a^2 b^2}{r^2}\times\frac{p_a-p_b}{b^2-a^2}$$

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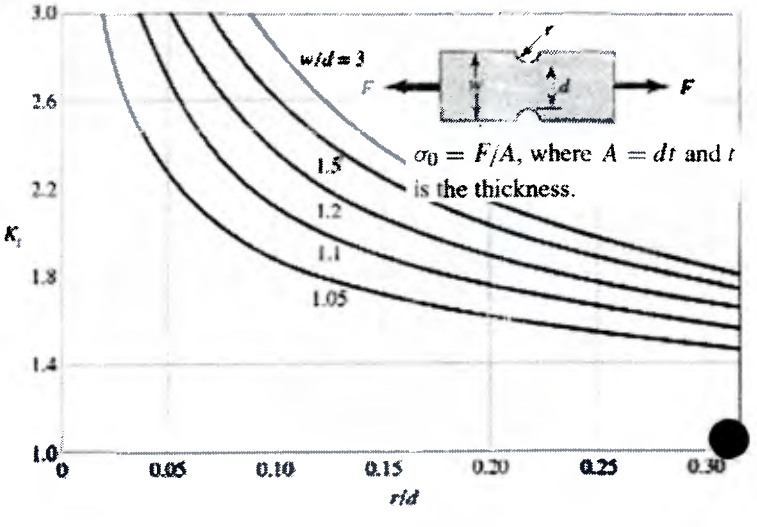

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