Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 4

END SEMESTER EXAMINATION JULY 2023

Program: B.Tech Second Year Mechanical Sem IV

Course Code: PC-BTM406

Course Name: Material Science

Duration: 03 Hrs

Maximum Points: 100

Semester: IV

21/7/23

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	Draw Fe-C equilibrium diagram and label the temperature, composition, and phases. Write properties of austenite region and pearlite region. Explain binary eutectic system in it. Also, find the exact amount of components present in the eutectic transformation.	10	2	5	3.2.3
1B	How do growth rate, nucleation rate, and overall transformation rate contribute to the formation of a Time-Temperature-Transformation (TTT) diagram? Explain theTTT diagram, and illustrate your explanation using the following key points and a schematic diagram.. a. At melting temperature(M.T) b. At higher temperature few temperature below M.T. c. At lower temperature.	10	3	2	2.3.1
2A	Illustrate the complete material life cycle through a schematic diagram and elaborate on the ways in which the conservation of natural resources can be achieved within this context, emphasizing the relationship between materials and the environment.	06	1.4	6	3.2.1
2B	When three thin disk specimens of aluminum oxide are placed over a printed page, they exhibit varying light-transmittance characteristics: the first disk is transparent, the second is translucent, and the third disk is opaque. Despite being made of the same material, explain factors contribute to the different observed properties among these three specimens.	06	1,2	6	4.2.1
2C	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	08	3	4	3.8.1

END SEMESTER EXAMINATION JULY 2023

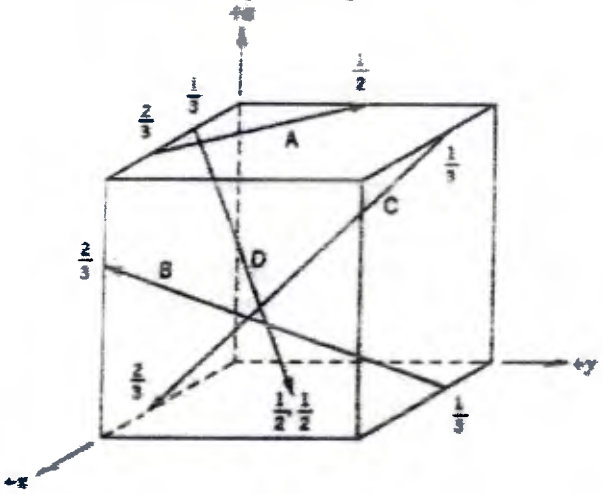
from liquid?

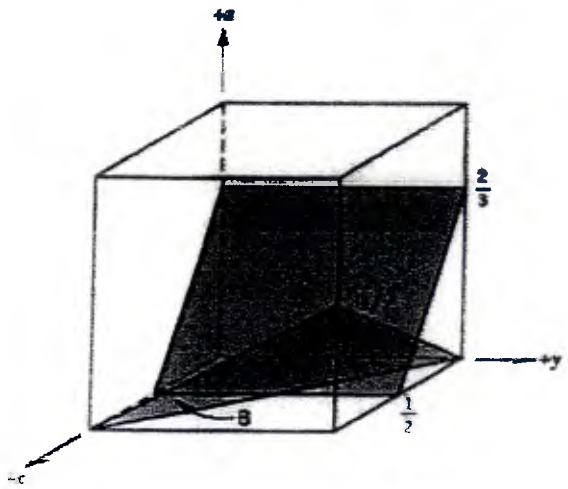
B. What is the composition of the last solid formed at the end of the solidification process?

C. What is the amount of solid and liquid at 1340 °C?

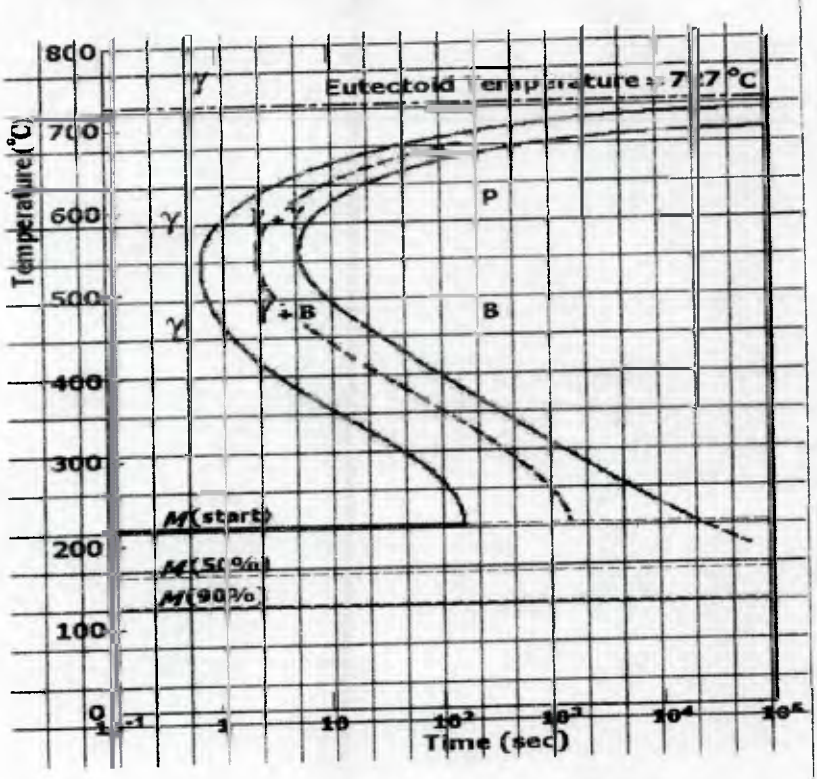
Weight % Ni	20	40	60	80
Liquidus temp. °C	1200	1275	1345	1440
Solidus Temp °C	1165	1235	1310	1380

3 A Determine the Miller indices for the directions and the planes shown in the following unit cell:[Note: provide the stepwise calculations for the given problem] 10(6+4) 3 5 3 1.1





END SEMESTER EXAMINATION JULY 2023

3B	What is a rheological material, and what are the different types of rheological materials? Provide an explanation of one specific type of rheological material and illustrate its application in a suitable real-world scenario.	05	1	2	1.3.1
3C	Explain the purpose and benefits of tempering process in enhancing the mechanical properties of materials.	05	4,3	5	3.1.1
4A	Discuss each case of the heat treatment process of Fe-0.65% 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 640^0 C, hold for 10 s, rapidly cool to 590^0 C hold for 10^3 s and quench to room temperature 2. Rapidly cool to 300°C, hold for 70 s and quench to room temperature; 3. Rapidly cool to 630 °C, hold for 15 s, rapidly cool to 400 °C, hold for 10^4 s and quench to room temperature; 	10	4	6	2.4.1
4B	Classify plain carbon steel and provide a detailed explanation of each type of plain carbon steel, highlighting their respective application(s).	05	4	2	3.2.2
4C	Explain the reason behind the existence of only 14 types of Bravais lattices, emphasizing the role of crystal systems.	05	2	3	2.3.1

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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
5B	Define nanomaterials and elaborate on the top-down and bottom-up approaches used in their synthesis.	06	4	4	4.2.2
5C	Explain the concepts of quenching and martensite in the context of materials science, and how the Time-Temperature-Transformation (TTT) diagram is utilized to understand these processes. Furthermore, elucidate the mechanism by which heat is extracted from a component when liquid quenching media are employed.	08	4	2,6	2.2.2
6A	Classify composites based on the form of reinforcement and provide a detailed explanation of fibrous composite materials. Additionally, discuss why mechanical properties are significantly improved at the micro scale compared to the macro scale.	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. Dow metal	06	3,4	3	3.2.1
6C	Discuss the reasons for the increasing demand of ceramic materials in engineering applications. Classify ceramic materials and list their properties.	06	4	3	3.2.3
7A	Determine the tensile stress that is applied along the [1 $\bar{1}$ 0] axis of a silver crystal to cause slip on the (1 $\bar{1}$ $\bar{1}$) [0$\bar{1}$ 1] system. The critical resolved shear stress is 6MPa.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. Discuss how materials engineering can play a role in "green design."	07	1,4	6	3.4.2
7C	Explain why diamond remains stable at room temperature and does not undergo a transformation to graphite, despite graphite being an unstable phase of carbon at room temperature. Support your explanation with a suitable diagram.	05	2	5	3.2.1

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SARDAR PATEL COLLEGE OF ENGINEERING, MUMBAI

DEPARTMENT OF MECHANICAL ENGINEERING

END SEMESTER EXAMINATION, JULY 2023

19/7/23

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

Total points: 100
Duration: 3 HOURS

Note:

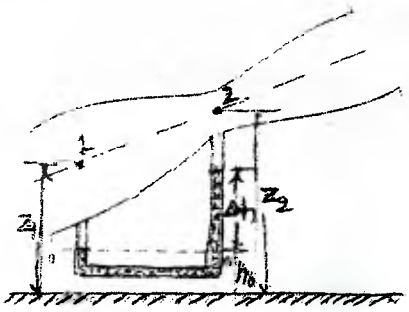
- Answer any 5 questions. Each question carries 20 points
- Answer should be question specific and to the point.
- All component of a question must be answered togather.
- Data in the last column represents course outcome and Blooms Taxonomy of respective question

			CO/Bl
Q1. (A)	What is boundary layer? Explain the concept with the help of flow over a flat plate. How does it effects the motion of a moving of an object in a fluid medium? Is it possible to measure the thickness of a boundary layer? Illustrate your answer with sufficient examples.	**10**	5/2,3
(B)	A vessel of the shape shown in the following figure is filled with liquid of specific gravity 0.92. The pressure gauge at A reads 400 kN/m2. Determine a) the pressure read by gauge located at B. b) the magnitude and location of the force acting on the left wall of the vessel for per unit of its depth.	**10**	2/3
Q2. (A)	What is Newton's Law of Viscosity? Differentiate between the Newtonian and Non-Newtonian Fluids? Classify and characterise the Non-Newtonian Fluids with at least two examples from each class.	**10**	1/2,4
(B)	A test tube is spun in a centrifuge. The tube support is mounted on a pivot so that the tube swings outward as rotation speed increases. At high speeds, the tube is nearly horizontal. Find (a) an expression for the radial component of acceleration of a liquid element located at radius r, (b) the radial pressure gradient dp/dr, and (c) the required angular velocity to generate a pressure of 250 MPa in the bottom of a test tube containing water, (The free surface and bottom radii are 50 and 130 mm, respectively.)	**10**	2/3
Q3. (A)	Derive differential form of a general Continuity Equation. Simplify it to obtain a continuity equation for steady state incompressible flow.	**10**	4/6
(B)	The velocity profile of a developed laminar flow in circular cross-section pipe of radius R is given by $$u = -\frac{1}{4\mu}\frac{dp}{dx}\left(1-\frac{r^2}{R^2}\right)$$ Plot this profile graphically at a pipe cross-section. Using above profile derive expression for the following quantities. a) Discharge rate b) Wall shear stress	**10**	4/3

Q4. (A) Consider a Venturimeter with inlet and throat diameter A_1 and A_2 as shown. Drive the following expression to evaluate the flow rate. **10** 4/6

$$Q = \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \sqrt{2g(\rho_m/\rho - 1)\Delta h}$$

Where, ρ is the density of the flowing fluid, and ρ_m is the density of the manometric fluid.



(B) A 45 degree reducing pipe bend in a horizontal plane, tapers from 600mm diameter to at the inlet to 300mm at the outlet. The pressure at the inlet is 140kPa gauge and the rate of flow of water through the bend is 0.425 m^3/s. Neglecting friction, calculate the net resultant horizontal force exerted by the water on the bend. Assume uniform conditions with straight and parallel streamlines at inlet and outlet and the fluid to be frictionless. **10** 4/5

Consider a little different situation where pipe bend is on a plane normal to the ground. Will the resultant force acting on bend be same? Recommend a cost effective bend arrangement with justification.

Q5. (A) Explain your understanding about following points. **10** 6/2,1

a) Characteristics of a turbulent flow
b) Developed and developing flow
c) Significant of speed of sound in the study of compressible flow

(B) Using the integral momentum equation determine the expression for the following terms for the velocity profile **10** 6/3.5

$$\frac{u}{U} = 2\frac{y}{\delta} - \left(\frac{y}{\delta}\right)^2$$ where U is free stream velocity

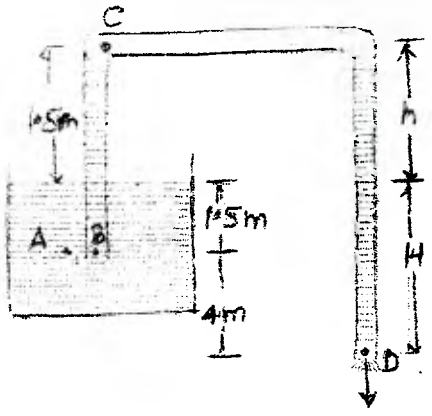
a) the displacement and momentum thicknesses, and interpret the result
b) the boundary layer skin friction coefficient.

Q6 (A) What is Couette flow? Mention all assumptions and derive an expression for developed laminar velocity profile for the flow. **10** 3/2

(B) A tube is used as a siphon to discharge an oil of specific gravity 0.8 from a large open vessel into a drain at atmospheric pressure as shown in the figure. Analyse and calculate, **10** 6/4

a) The velocity of oil through the siphon,
b) The pressure at point A and B,
c) The pressure at the highest point C
d) The maximum height of the C that can be accommodated above the level in the vessel
e) The maximum vertical depth of the right limb of the siphon

(Take the vapour pressure of the liquid at the working temperature to be 29.5kPa and P_{atm} =101kPa)



Q7. (A) Differentiate between **10** 3/2

a) Streamline and Streakline
b) Lagrangian and Eulerian approach
c) Reynold number and Mach Number
d) Integral and Differential approach of flow analysis

(B) 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 **10** 3/2

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SARDAR PATEL COLLEGE OF ENGINEERING

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Munshi Nagar, Andheri (W) Mumbai -- 400058

26/7/23

END-SEMESTER EXAMINATION - JULY 2023

Program: B.Tech. in Mechanical Engineering Sem IV — **Duration: 3 Hours**

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

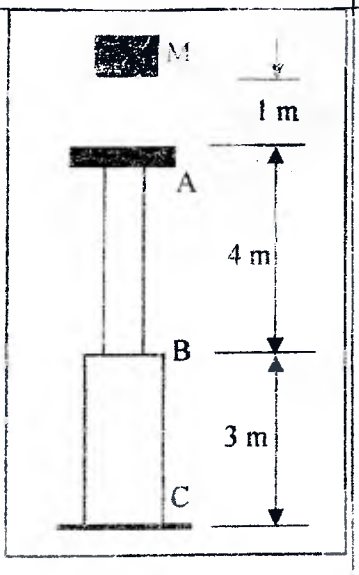
Course Name: Solid Mechanics — **Semester: IV**

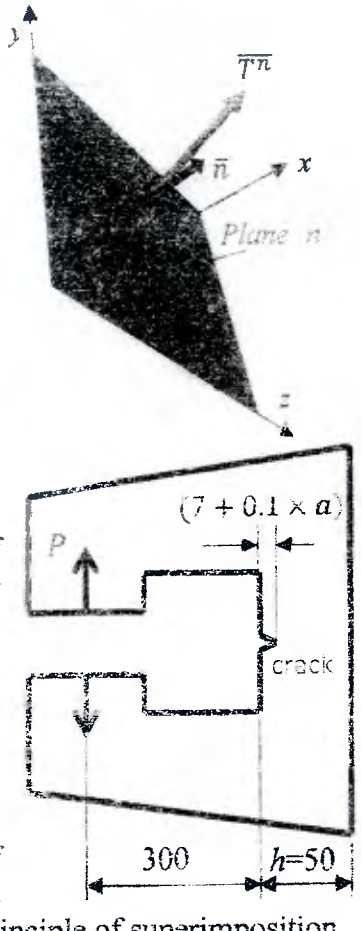
Notes:

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

Q. No.	Questions	Points	CO	BL	Mod. No.
Q1 COMPULSORY	A) * Given the stress matrix τ_{ij}, determine the magnitude of the normal stress on a plane which is equally inclined to all three axes. $\tau_{ij} = \begin{bmatrix} a+1 & -a-1 & 4 \\ -a-1 & -2 & 5 \\ 4 & 5 & 3 \end{bmatrix}$	(5)	1	3	1
	B) * The displacement field for a body is given by: $\bar{u} = [(x^2y^2z^2 + (a+5)xy^2)\bar{\imath} + \left(\frac{xz}{y}\right)\bar{\jmath} + (7y^2z)\bar{k}]10^{-4}$ What are the strain components at (1, 1, 1)?	(5)	2	3	2
	C) * A notched flat plate as shown in the figure is made of material with ultimate tensile strength of 600 MPa. Consider H = (1061+a) mm, d = 100 mm, r = 3 mm, h = 3 mm. Calculate the safe load it can carry with factor of safety as 3.0. 	(5)	3	3	5
	D) * A bar of steel 1 meters long, is (30+a) mm in diameter for 500 mm of its length and (15+a) mm in diameter for the remaining 500 mm. The bar is held fixed at one end, and it is axially hit at the free end by a mass of 10 kg moving at 5 m/s. Taking E = 200 GPa, find the stress induced in the smaller section of the bar due to the impact.	(5)	4	3	6
Q2	A) * The rectangular components of stress at a point are given by the matrix shown. Determine the principal stresses and the direction of the **maximum** principal stress. $[\tau_{ij}] = \begin{bmatrix} 7 & 10 & 5 \\ 10 & 8+a & -10 \\ 5 & -10 & 9 \end{bmatrix}$	(10)	2	3	1
	B) Discuss the advantage of performing the plane stress and plane strain approximations with suitable example of each case. Compare the features of both approximations.	(5)	2	2	3
	C) * A 32 mm long steel rod of (28+a) mm diameter is pressed on to a copper plate with a force of (12+a) N.	(5)	2	3	5

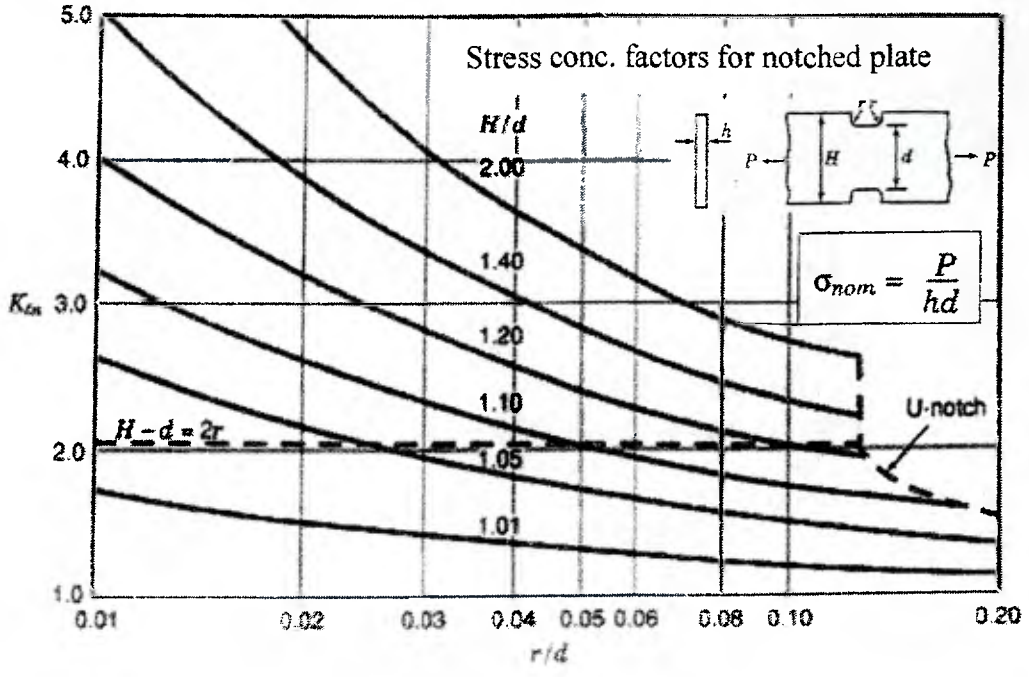
	Consider $E_{steel} = 200\ GPa, \nu_{steel} = 0.3, E_{Cu} = 115\ GPa, \nu_{Cu} = 0.33$. Determine the following: (i) the width of the contact area, (ii) the max. contact pressure, (iii) the principal stresses at the contact.				
Q3	A) * An object M of 20 kg mass is released from rest in the position 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 (5+***a***) mm diameter and section BC is of (10+***a***) mm diameter. E = 200 GPa. Determine the instantaneous stresses in the rod.	**(10)**	4	3	6
	B) * A thick-walled steel tube has an internal radius of (100+***a***) mm and tube wall thickness is (10+***a***) mm. It is subjected to internal pressure of 25 MPa and external pressure of 3 MPa. Consider the tensile strength of steel as 400 MPa. • Determine the factor of safety as per Maximum Principal stress theory of failure. • If E = 200 GPa and ν = 0.3, determine the changes in the internal radius of the tube due to the pressure loading.	**(10)**	3	3	4
Q4	A) Figure shows an infinitesimally small element around plane n'. The plane has its normal vector as $\bar{n}$ and the traction vector on the plane is $\overline{T^n}$. The stress state at the location is represented by the stress matrix $[\tau_{ij}]$. The body force on the element per unit volume is γ_x. Derive the Cauchy's equation for the traction component T_x^n.	**(5)**	1	4	1
	B) (i) Discuss three modes of fracture. (ii) Figure shows a metal plate of thickness B = 20 mm which is used for clamping purpose (all dimensions in mm). Find safe load P in the presence of a crack in the frame at location shown. Material data: $K_{Ic} = 67\ \text{MPa}\sqrt{\text{m}}$.	**(10)**	2	3	7
	C) Discuss the principle of superimposition. Prove the uniqueness theorem for elastic bodies using the principle of superimposition.	**(5)**	3	4	3





Q5	A) Derive the following differential equations of equilibrium. $$\frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \sigma_z}{\partial z} + \gamma_z - 0$$	**(5)**	3	4	2
	B) Explain the following topics in solid mechanics: (i) measurement of strain using strain gauges, (ii) physical interpretation of the compatibility equations.	**(5)**	3	2	2
	C) * A steel disk of (730+***a***) mm diameter is shrink fitted on a steel shaft of (90+***a***) mm diameter. If the shaft is rotating at 5200 rpm, find the minimum required interference between shaft and disk such that disk will not separate from the shaft. Also calculate the maximum tangential stress in the disk at above speed. Consider E = 200 GPa, $\nu = 0.3$ and density = 7850 kg/m^3.	**(10)**	2	3	4
Q6	A) Briefly discuss following terms: (i) Cauchy's strain-displacement equations, (ii) principal strain planes, (iii) strain invariants.	**(5)**	3	2	2
	B) Discuss the significance of generalized Hooke's law in solid mechanics. Describe its form for isotropic and orthotropic materials.	**(5)**	2	2	3
	C) * A thin-walled rectangular box section has the mean width (32+***a***) mm and height (16+***a***) mm. The wall thickness is 2 mm along width and 1 mm along height. It is subjected to torque of 35 Nm. Calculate the shear stress in the wall and the angle of twist. G = 80 GPa.	**(5)**	2	3	5
	D) Discuss the applications of metal plasticity in engineering. Describe the Bauschinger effect with the help of load-displacement diagram.	(5)	3	2	7
Q7	A) Explain the following: (i) True stress and strain versus Engineering stress and strain, (ii) concept of the stress as a tensor quantity.	**(5)**	1	2	1
	B) (i) Give a few examples from real life about axisymmetric bodies subjected to axisymmetric and non-axisymmetric loading. (ii) Derive an expression for circumferential strain ϵ_θ in axisymmetric bodies subjected to axisymmetric loading.	**(5)**	3	3	4
	C) Give a few examples of thermoelastic problems. Explain how temperature loading is accounted for in the stress-strain relationship in thermoelastic problems. Obtain the stresses for a case wherein a fully constrained solid is uniformly heated.	**(5)**	2	3	5
	D) Briefly discuss the following topics: (i) resilience, (ii) proof resilience, (iii) strain energy, (iv) strain energy density, (v) difference between the stresses induced due to static and impact loading.	(5)	4	2	6

ANNEXURE I: USEFUL FORMULAE



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

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

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

Stresses for two cylinders in contact with each other

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

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

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

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

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

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

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

$\alpha = a/h$

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

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

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Munshi Nagar, Andheri (W) Mumbai – 400058

End Semester - July 2023 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**

Notes:

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

24/7/23

Q. No.	Questions	Points	CO	BL	M.N.
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	1,2,3	4	2 to7
2 (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= $\pi d^2/4$, h=3.6±0.03 m, g=9.81±0.1% m/s^2	10	3,4	4	6
2 (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	1,3	4	3,4
3 (A)	It is proposed to develop measurement and control system for maintaining flow rate and pressure of water in reaction type hydraulic turbine for operating to its best efficiency point. Proposed design aimed to retrieved	10	3,4	5	4,5,6

	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**).				
3 (B)	A system is given by differential equation $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 8y = 8x$ where y=output and x=Input. Determine all time domain specifications for unit step input.	10	1	4	2
4(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 Young's modulus for steel as 200×10^9 N/m^2	10	3,4	4	
4 (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	2,3	3	4,5
5 (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	1,2,3	3	
5 (B)	Following are the different applications/systems/processes wherein the temperature measurement is essential; (i) Microwave oven (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	6

6 (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	2,3	4	5,6
6 (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 =35 s; In water, τ =2 s; In air, probe wet, τ =15 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 sketch the rough appropriate indicated temperature (time relationship between t=0 and t=30 s).	10	2,3	5	5
7 (A)	The flow of cooling water in a manufacturing process is measured by a horizontal venturimeter with 200 mm inlet and 100 mm throat. The U-tube mercury manometer connected between inlet and throat of venturi shows a differential pressure of 220 mm mercury. Calculate the water flow rate if coefficient of discharge is 0.98, specific gravity of mercury 13.6 and density of water 1000kg/m^3	10	3,4	3	5,6
7(B)	Following is the calibration data of a pressure transducer: **q_i(Mpa) | q_o (increasing) (Mpa) | q_o (decreasing) (Mpa)** 0 | 2 | 2 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. (ii) qi if the instrument reads q0=30 after calibration.	10	3,4	3	1,2

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

END SEM EXAMINATIONS (Even SEM) July 2023

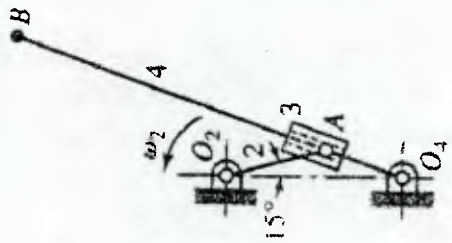
Program: BTech Mechanical engg Sem IV **Duration: 3.00 hr**

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

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

Notes: 17/7/23

1. Question number **ONE is compulsory** solve any **four** out of remaining **six**
2. **Question nos. one, 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) A crank-rocker linkage has a 100 mm frame, a 25 mm crank, a 75 mm coupler and a 90 mm rocker. For the given mechanism find the angular velocity and angular acceleration of coupler and follower, for the configuration of minimum and maximum transmission angle.(Use IC method for velocity analysis and relative method for acceleration analysis.) Take uniform angular velocity of crank as ω= 10 rad/sec (ccw).	20	1,3	3,4	2.3.1
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) Crank 2 of the system shown in fig. has speed of 60 rev/min ccw. derive the expression and calculate the angular velocity and angular acceleration of link 4. (***Use analytical complex algebra method***). O_2O_4 = 300 mm , AO_2 = 175 mm , BO_4 = 700 mm. 	10 10	1,3	3,4	2.3.1

3	A cam, with a minimum radius of 50 mm, rotating clockwise at a uniform speed, is required to give a knife edge follower the motion as described below: a) To move outwards through 50 mm during 120° rotation of the cam b) To dwell for next 60° c) To return to its starting position during next 90° d) To dwell for the rest period of a revolution i.e. 90°. **Draw the profile of the cam**, when the line of stroke of the follower passes through the center of the cam shaft, the displacement of the follower is to take place with *UARM* during outward movement and *SHM* during inward movement Determine the maximum velocity and acceleration of the follower when the cam shaft rotates at 900 r.p.m. Also draw the displacement, velocity and acceleration diagrams for one complete revolution of the cam.	20	3,1	3	2.3.1
4	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) 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
5	a) Deduce the expression for minimum number of teeth on gear wheel. b) A 6 mm/tooth module, 24-tooth pinion is to drive a 36-tooth gear. The gears are cut on the 20° full-depth involute system. Find and tabulate the addendum, dedendum, circular pitch, base pitch, base circle radii, length of path of approach and recess, and contact ratio. Also angle of action for pinion and wheel.	10 10	4	3	2.3.1
6	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) What is interference in gear? How it is avoided? c) State the advantages of gear drive over the belt drive.	10 5 5	4	4	2.2.3
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	3	2.3.1

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

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

END SEMESTER EXAMINATION - JULY 2023

Program: S.Y.B.Tech (Mechanical) Sem IV

Duration: 3 Hours

Course Code: BS-BTM401

Maximum Points: 100

Course Name: Statistics Probability Hypothesis Testing & Vector Calculus

Semester: IV

14/7/23

Note:

1. **Attempt Any Five Questions.**
2. **Answers to the sub questions should be grouped together.**

		Questions	Points	CO	BL	Module
1	a	The probability of a man hitting the target at a shooting range is $\frac{1}{4}$. If he shoots 10 times, what is the probability that he hits the target exactly three times? What is the probability that he hits the target at least once?	6	CO1	BL5	2
	b	The equations of the lines of regression are $20x-9y-107=0$ and $4x-5y+33=0$ Find $\bar{x}, \bar{y}$ and r.	6	CO1	BL5	1
	c	Verify Green's Theorem in the plan for $\oint_C (xy+y^2)dx+x^2dy$, where C is the closed curve of the region bounded by the curves $y=x^2$ and $x=y^2$	8	CO2	BL3	6
2	a	A manufacturer of electric bulbs, according to certain process, finds the S.D. of the life of lamps to be 100 hours. He wants to change the process, if the new process results in a smaller variation in the life of lamps. In adopting a new process, a sample of 150 bulbs gave S.D of 95 hours. Is the manufacturer justified in changing the process?	6	CO1	BL5	5
	b	Evaluate $\iint_S \left(\nabla \times \bar{F}\right) \cdot nds$, where $\bar{F}=2y(1-x)\hat{i}+(x-x^2+y^2)j+(x^2+y^2+z^2)k$ and S is the	6	CO2	BL2	6

END SEMESTER EXAMINATION - JULY 2023

		surface of the hemispherical cap $x^2+y^2+z^2=4,\ z\geq 0$ above XY plane.				
	c	Two independent samples of sizes 8 and 7 contained the following values Sample I: 19, 17, 15, 21, 16, 18, 16, 14 Sample II: 15, 14, 15, 19, 15, 18, 16 Is the difference between the sample means significant?	8	CO1	BL3	4
3	a	Find real root of the equation $x^3-3x+1=0$ lying between 1 and 2 correct to three decimal places using Newton-Raphson method.	6	CO3	BL4	7
	b	Evaluate $\int_C \overline{F}\cdot d\overline{r}$ where $\overline{F}=2x\hat{i}+(xz-y)j+2zk$ and C is the straight line joining the points $O(0,0,0)$ and $P(3,1,2)$	6	CO2	BL5	6
	c	In the usual notation, prove the Spearman's formula for Rank correlation $R=1-\frac{6}{n(n^2-1)}\sum_{i=1}^{n}d_i^2$, where $d_i=x_i-y_i$	8	CO1	BL5	1
4	a	From the following data, compute the rank correlation. X: 82, 68, 75, 61, 68, 73, 85, 68 Y: 81, 71, 71, 68, 62, 69, 80, 70	6	CO1	BL5	1
	b	The marks obtained by students in a certain examination follow a normal distribution with mean 55 and standard deviation 10. If 500 students appeared at an examination, calculate the number of students scoring (i) less than 50 marks (ii) more than 65 marks.	6	CO1	BL3	3
	c	Given $\frac{dy}{dx}=1+xy;\ y(0)=2$. Find $y(0.1)$ and $y(0.2)$ using fourth order Runge-Kutta method.	8	CO3	BL3	7

END SEMESTER EXAMINATION - JULY 2023

5	a	Find constant k such that the function $f(x)=\begin{cases} k(1-x^2), & \text{if } 0\le x\le 1 \\ 0 & \text{elsewhere} \end{cases}$ is the probability density function. Also find $P(0.1\le X\le 0.2)$ and $P(X\ge 0.5)$	6	CO1	BL4,5	5
	b	The S.D of a random sample 0f 1000 is found to be with 2.6 and the S.D of another random sample of 500 is 2.7. Assuming the samples to be independent, find whether the two samples could have come from population with the same S.D?	6	CO1	BL4	4
	c	Verify Gauss Divergence Theorem for $\overline{F}=(x^2-yz)\hat{i}+(y^2-xz)j+(z^2-xy)k$ over the surface of the cuboid $0\le x\le a,\ 0\le y\le b,\ 0\le z\le c$	8	CO2	BL2, BL4	6
6	a	Certain pesticide is packed into bags by a machine. A random sample of 10 bags is drawn and their contents are found to weigh (in kg) as follows 50, 49, 52, 44, 45, 48, 46, 45, 49, 45 Test if average packing can be taken to be 50 kg at 5% LOS.	6	CO1	BL5	4
	b	The coefficient of rank correlation between marks in two subjects obtained by a group of students is 0.8. If the sum of squares of the differences in ranks is 33. Find the number of students in the group.	6	CO1	BL3	6
	c	For normal distribution 30% items are below 45 and 8% items are above 64. Find the mean and variance of the normal distribution	8	CO1	BL3, BL5	2
7	a	Two random sample gave the following data Is the difference between standard deviation significant?	6	CO1	BL2, BL3	1

Sample No	Size	Mean	Variance
1	1000	67.42	2.58
2	1200	67.25	2.5

END SEMESTER EXAMINATION - JULY 2023

b	Use Euler's method to find approximate value of y at $x=2$ (Correct to four decimal places). Given that $\frac{dy}{dx}=2+\sqrt{xy}$; $y(1)=1$. Take $h=0.2$	6	CO3	BL5	7
c	300 digits were chosen at random from a table of random numbers. The frequency of digits are as follows	8	CO1	BL1, BL3	2

Digit	0	1	2	3	4	5	6	7	8	9	Total
Frequency	28	29	33	31	26	35	32	30	31	25	300

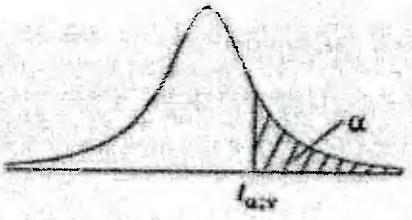
Using χ^2-test examine the hypothesis that the digits were distributed in equal numbers in the table

Chi-Square (χ^2) Distribution

Degrees of Freedom	Area to the Right of Critical Value									
	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.(
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14
5	0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	16
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41
22	8.643	9.542	10.982	12.338	14.042	30.813	33.924	36.781	40.289	42
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.194	46.963	49
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50
29	13.121	14.257	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52
30	13.787	14.954	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140

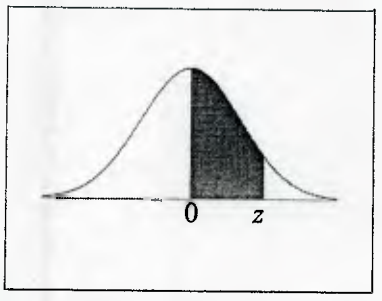
Table of the Student's t-distribution

The table gives the values of $t_{\alpha;\nu}$ where
$Pr(T_\nu > t_{\alpha;\nu}) = \alpha$, with ν degrees of freedom



ν \ α	0.1	0.05	0.025	0.01	0.005	0.001	0.0005
1	3.078	6.314	12.076	31.821	63.657	318.310	636.620
2	1.886	2.920	4.303	6.965	9.925	22.326	31.598
3	1.638	2.353	3.182	4.541	5.841	10.213	12.924
4	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	1.319	1.714	2.069	2.500	2.807	3.485	3.767
24	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	1.296	1.671	2.000	2.390	2.660	3.232	3.460
120	1.289	1.658	1.980	2.358	2.617	3.160	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.090	3.291

Standard Normal Distribution Table



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	.0832	.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	.2704	.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	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.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	.4881	.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	.4960	.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
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998

Gilles Cazelais. Typeset with LaTeX on April 20, 2006.