ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester : A.Y. 2020-2021
Course Code: **ME 4203** — Time : **3 Hours**
Course Title: **Dynamics** — Full Marks : **150**

There are 06 (six) Questions. Answer all of them.
Figures in the Margin indicate the Full Marks.
Assume reasonable data if necessary.

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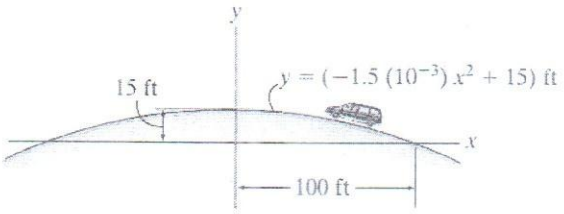
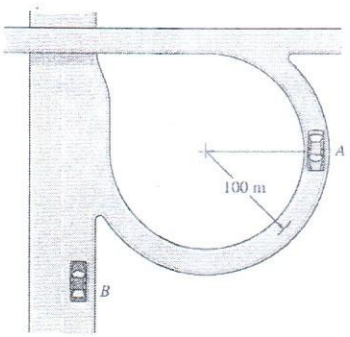
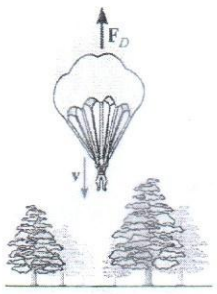
1 a) The van travels over the hill described by $y = (-1.5(10^{-3})\,x^2 + 15)$ft. If it has a constant speed of 75 ft/s, determine the x and y components of the van's velocity and acceleration when x = 50 ft. 15



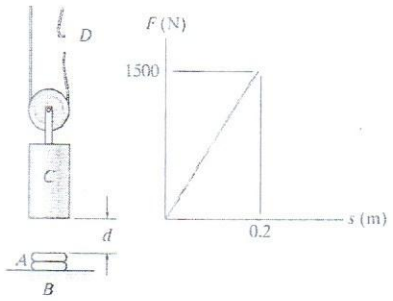
b) At the instant shown, car A has a speed of 20 km/h, which is being increased at the rate of 300 km/h^2 as the car enters the expressway. At the same instant, car B is decelerating at 250 km/h^2 while traveling forward at 100km/h. Determine the velocity and acceleration of A with respect to B. 10



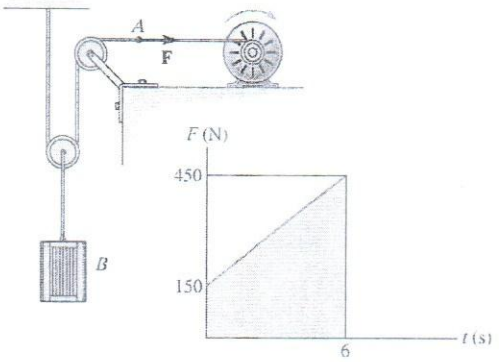
2 a) A parachutist having a mass m opens his parachute from an at-rest position at a very high altitude. If the atmospheric drag resistance is $FD = kv^2$, where k is a constant, determine his velocity when he has fallen for a time t. What is his velocity when he lands on the ground? This velocity is referred to as the terminal velocity, which is found by letting the time of fall $t \rightarrow \infty$ 12.5



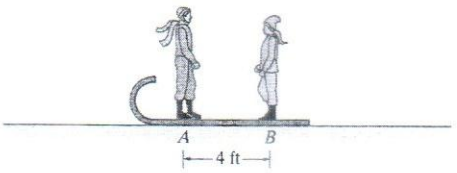
b) The "air spring" A is used to protect the support B and prevent damage to the conveyor-belt tensioning weight C in the event of a belt failure D. The force developed by the air spring as a function of its deflection is shown by the graph. If the block has a mass of 20 kg and is suspended a height d = 0.4 m above the top of the spring, determine the maximum deformation of the spring in the event the conveyor belt fails. Neglect the mass of the pulley and belt 12.5



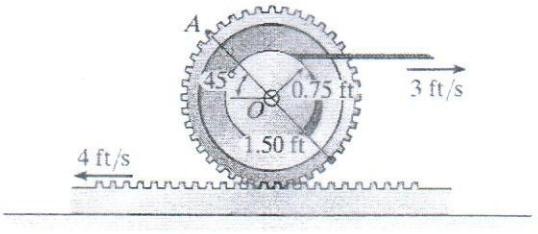
3 a) The motor exerts a force F on the 40-kg crate as shown in the graph. Determine the speed of the crate when t = 3 s and when t = 6 s. When t = 0, the crate is moving downward at 10 m/s. 10



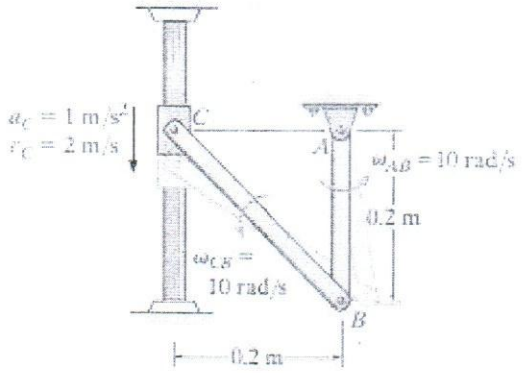
b) A boy A having a weight of 80 lb and a girl B having a weight of 65 lb stand motionless at the ends of the toboggan, which has a weight of 20 lb. If A walks to B and stops, and both walk back together to the original position of A, determine the final position of the toboggan just after the motion stops. Neglect friction between the toboggan and the snow. 15



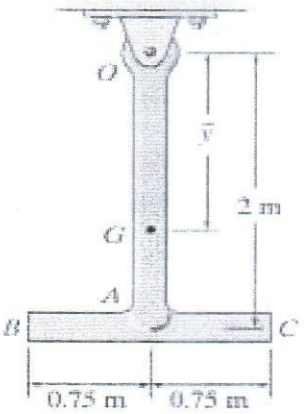
4 a) Determine the velocity of the point A on the rim of the gear at the instant shown. 15



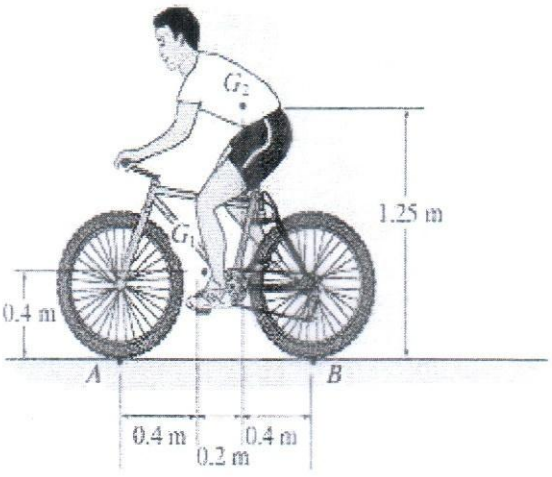
b) The collar C in the figure moves downward with an acceleration of 1 m/s^2 . At the instant shown, it has a speed of 2 m/s which gives links CB and AB an angular velocity $\omega_{AB} = \omega_{CB}$ = 10 rad/s. Determine the angular accelerations of CB and AB at this instant. 10



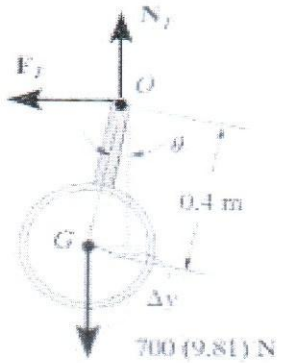
5 a) The pendulum in figure below is suspended from the pin at O and consists of two thin rods. Rod OA has a mass of 12 kg, and BC has a mass of 9 kg. Determine the moment of inertia of the pendulum about an axis passing through (a) point O, and (b) the mass center G of the pendulum. 15



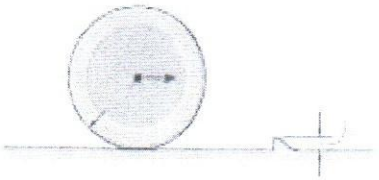
b) The mountain bike has a mass of 40 kg with center of mass at point G1, while the rider has a mass of 60 kg with center of mass at point G2. When the brake is applied to the front wheel, it causes the bike to decelerate at a constant rate of 3 m/s^2. Determine the normal reaction the road exerts on the front and rear wheels. Assume that the rear wheel is free to roll. Neglect the mass of all the wheels. 10



6 a) The 700-kg pipe is equally suspended from the two tines of the fork lift shown in the photo. It is undergoing a swinging motion such that when u = 30° it is momentarily at rest. Determine the normal and frictional forces acting on each tine which are needed to support the pipe at the instant u = 0°. Measurements of the pipe and the suspender are shown in the figure below. Neglect the mass of the suspender and the thickness of the pipe. 15



b) The 10-kg wheel shown in the figure below has a moment of inertia $I_G = 0.156$ kg.m^2 . Assuming that the wheel does not slip or rebound, determine the minimum velocity V_G it must have to just roll over the obstruction at A. 10



B. Sc. in ME & IPE (2nd Semester) 07 April, 2022 (Thursday) [B]

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination **Summer Semester: 2020 - 2021**
Course Number: Phy 4213 **Full Marks: 150**
Course Title: Physics **Time : 3.0 hrs**

There are 7 **(Seven)** questions. Answer **6 (SIX)** questions including one option from question 6 or 7. The symbols have their usual meanings. Marks of each question are written in the brackets.

1.a Distinguish a simple pendulum and a physical pendulum. Draw clearly a simple and a physical pendulum and show the forces acting on them. Define restoring force and restoring torque with the relevant expressions. **(7)**

1.b A reference particle P is moving with uniform circular motion in a reference circle of radius x_m. Derive the expressions for Position, Velocity, and Acceleration of the particle. **(8)**

1.c A block of mass fixed on a vertically clamped spring executes a damped harmonic motion. The mass of the block is m = 250 gm, spring constant k=85 N/m and damping constant of the medium b= 70 g/s. Calculate the **(10)**

(i) period of motion,

(ii) How long does it take for the mechanical energy to drop to one half of its initial value?

2.a Distinguish mechanical waves, electromagnetic waves and matter waves in wave mechanics with example. Define a transverse wave and a longitudinal wave with proper examples. **(7)**

2.b Describe how energy is transferred by wave traveling along a string. Derive an expression for the average rate at which the kinetic energy is transported along the string **(8)**

2.c A string has a linear density μ = 525 g/m and is under tension τ = 45 N. If a sinusoidal wave with frequency f = 120 Hz and amplitude y_m = 8.5 mm is sent along the string, calculate the average rate does the wave transport energy. **(10)**

3.a Discuss superposition of waves and explain how Lissajous figures can be created using an Oscilloscope and Two signal generators. Show the required circuit diagram for this experiment **(7)**

3.b Combine the two vibrations $x=A_1\cos\omega t$ and $y=A_2\cos(\omega t+\delta)$. Construct Lissajous figure for $\omega_2 = 2\omega_1$ and $\delta = 0, \pi/4, \pi/2, 3\pi/4$, and $\delta = \pi$ **(8)**

3.c Discuss Architectural acoustics. How would you improve the quality of sound in an Auditorium? Discuss (i) Loudness (ii) Echelon effect (iv) Extraneous noise (iv) Resonance. **(10)**

4.a Discuss different types of microscopes and their uses. Briefly describe how would you construct a polarizing microscope **(7)**

4.b Describe the construction and working of a compound microscope. Draw a schematic optical diagram of the apparatus. **(8)**

4.c Discuss polarization of light. What are ordinary and extra-ordinary rays? How are these rays identified by a polarimeter? Draw the internal structure of a Nicols prism and show the o-rays and e-rays in the diagram. **(10)**

5.a Write down the postulates of Einstein's Special Theory of Relativity. What are inertial and non-inertial frames of references. Give an example of each. **(7)**

5.b Derive Lorentz Transformation equations. Write down the inverse transformed form of these equations. Can you apply Lorentz Transformation to a particle which is moving at a classical speed? Justify. **(8)**

5.c What are Length contraction and time dilation? Discuss the application of time dilation in modern day GPS system. **(10)**

6.a Define a wave function Ψ. Write down the wave function for an electron moving in a one-dimensional potential well. **(7)**

6.b An electron is orbiting a proton (H-atom) at frequency f= 10^9 Hz. Calculate the current in this orbit. What happens to the orbiting electron if an external electric field **E** is applied on a hydrogen atom? **(8)**

6.c Derive time-independent Schrödinger equation. Normalize the following wave function $\Psi = A\, e^{-i(kx-wt)}$ [$\Psi = 1$, $0<x<a$, and 0 outside]. Find the eigen values for moment p and energy E. **(10)**

OR

7.a What are Fermions and Bosons? How would you identify these two classes of particles in terms of their spins? What is Bose-condensation? **(7)**

7.b Discuss Fermi-Dirac and Bose-Einstein statistics. Derive the Fermi-Dirac distribution function **(8)**

7.c Name some of the practical applications of Fermi-Dirac and Bose-Einstein statistics. **(10)**

(7)

BSc.Eng/2nd Sem.(IPE) 29 March 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2020-2021
Course No. ME 4225 — Time : 3 hours
Course Title: Material Engineering — Full Marks : 150

There are **6** (Six) questions, answer all of them.
Marks in the margin indicate the full marks.

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1 All materials in the universe are belong to one of the several crystal systems. Properties of these materials are highly dependent on these crystal structures. Categorize these crystal systems briefly. Sketch one of these crystal systems with its Bravais lattice that shows maximum ductility at room temperature. 25

2 Phase diagrams are essential to investigate the properties of materials. All phase diagrams are constructed for the equilibrium cooling system. Equilibrium phase diagram of water for three phase system exhibits unique feature compared to many other similar phase diagrams. Write in details about this feature and contrast it with the other ones. 25

3 A composite is made of two components with volume fraction 0.20 and 0.80. Elastic modulus values of the two phases are 200 MPa and 120 MPa. Resulting elastic modulus of the composite will be vastly reliant on the orientation of the reinforcing component. With the perception of the rule of mixture, explain how the value elastic modulus of the composite can be varied based on the orientation of the reinforcing component. Also, estimate maximum and minimum likely values of elastic modulus of the composite for different orientation of the reinforcing component. 25

4 Molecular structure of polymers can be varied a lot. More precisely to say, it is mostly about the structure of the chains. Again, types of monomers can also be different. Based on these two factors, classify polymers with necessary sketches. Also, design a composite which is expected to have a high melting point. 25

5 Iron is one of the most common elements on earth. Although iron is a common element, pure iron is almost never found in nature. Most iron is found in minerals formed by the combination of iron with other elements. Explain why iron making process is exclusively defined as a reductive process. It is not possible to produce steel with well control on the amount of the alloying elements – criticize this stamen. 25

6 In Bangladesh, maximum steel mills use induction furnaces to melt scrap metal. Since appreciable refining is not possible in induction furnace, the scrap must be graded properly. Point out why scrap selection is so much important here. Defend your opinion by describing the case of an electric arc furnace. 25

BSc Engg. (M) 3rd Sem

Date: 01 April 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Final-Semester Examination — Summer Semester, A. Y. 2020-2021

Course No. : ME 4405 — Time : 3 Hours

Course Title : Applied Thermodynamics — Marks : 150

There are **6 (Six)** questions. Answer all questions. All questions carry equal marks. Marks in the margin indicate full marks. Assume the reasonable values, if required.

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1. a) Define second law efficiency with physical significance. (05)

   b) How do the expressions for exergy transfer by heat, work and mass be clarified? Differentiate them with physical significance. (10)

   c) A gearbox which receives 75 kW work through a high-speed shaft and delivers work through a low-speed shaft. The gearbox is cooled on its outer surface by convection with the surrounding air. The outer surface of the gearbox is 1 m^2 and the heat transfer coefficient between the gearbox and its surrounding air is 1.5 kW/m^2K, the temperature of the outer surface of the gearbox is 45°C, the ambient pressure is 1 bar and the ambient temperature is 23°C. Evaluate the work delivered by this gearbox, explore the exergy transfer of the gearbox and the exergy destruction. (10)

   OR

   a) What are the major requirements of a good fuel? (05)

   b) Define the complete and incomplete combustions with appropriate examples. How can a complete combustion be identified and be differentiated? (10)

   c) What are the gross and net calorific values of a fuel? Calculate the gross and net calorific values of a coal sample having the following composition: C = 80%; H = 7%; O = 3%; S = 3.5%; N = 2.5% and ash 4.4%. (10)

2. a) Define the co-generation with physical significance. (05)

b) How can the efficiency of a gas turbine power plant be improved by using the intercooler, reheater and regenerator? Differentiate them with physical significance. (10)

c) You are asked to design a gas turbine power plant wherein the cycle has an overall pressure ratio of 8 and a maximum temperature of 700°C. The turbine drives the compressor and an electric generator, the mechanical efficiency of the drive being 96%. The ambient temperature is 27°C and the air enters the compressor at the rate of 1.5 kg/s. The isentropic efficiencies of the compressor and the turbine are 86 and 88%, respectively. Neglect the changes in Kinetic energy, the mass flow rate of fuel and all pressure losses. Evaluate the (a) power output, (b) cycle efficiency and (c) work ratio. (10)

3. a) What are the desirable properties of an ideal refrigerant? (05)

b) Differentiate among the simple, bootstrap and regenerative aircraft refrigeration systems. (10)

c) A vapor-compression refrigeration cycle with refrigerant-134a is asked to design where the evaporator and condenser pressures are 0.25 MPa and 1.5 MPa, respectively. The cycle has the superheating and sub-cooling temperatures of 15°C and 5°C, respectively. The flow rate of the refrigerant is 0.25 kg/s and The compressor efficiency is 88%. Evaluate the (a) rate of cooling, (b) power input, (c) COP and (d) COP, if the cycle operated on the ideal vapor-compression refrigeration cycle between the same pressure limits. (10)

4. a) Describe briefly the ways to describe the composition of an ideal gas mixture. (05)

b) Describe the Dalton's law of additive pressures and Amagat's law of additive volumes with physical significance. Differentiate them with physical significance. (10)

c) A mixture of ideal gases has following molar composition: Argon ($y_{Ar} = 0.20$), helium ($y_{He} = 0.54$), and the balance is carbon monoxide. Evaluate the (a) mole fraction of carbon monoxide (b) molecular mass of the mixture (c) gravimetric (mass) composition of the mixture. (10)

5. a) What is the difference between the window and split air conditioning system? (05)

b) Define the terms with physical significance: dew point temperature, relative humidity, chemical dehumidification and evaporative cooling. (10)

(10)

c) The dry bulb and wet bulb temperatures of a room are measured as 47°C and 27°C, respectively. After modifying the conditions of the indoor room air, the new dry bulb and wet bulb temperatures of the room are now measured as 33°C and 23°C, respectively. Evaluate the following terms: (a) Locate this two conditions on the psychometric chart, (b) Illustrate the psychometric processes, (c) Write the values of all six psychometric parameters for these two conditions, (d) What changes in the psychometric parameters during this process? (e) Write the overall comment on the Psychometric process. (10)

6. a) Define Joule-Thomson Coefficient with physical significance. (05)

b) What are Maxwell relations? How can the reciprocity and cyclic relations be derived and be differentiated? (10)

c) Propane gas flows steadily through a pipe. The inlet state is 407K, 5.21 MPa, and the exit state is 370K, 4.26 MPa. Evaluate the heat loss from the propane gas to the surroundings per unit mass of propane. (10)

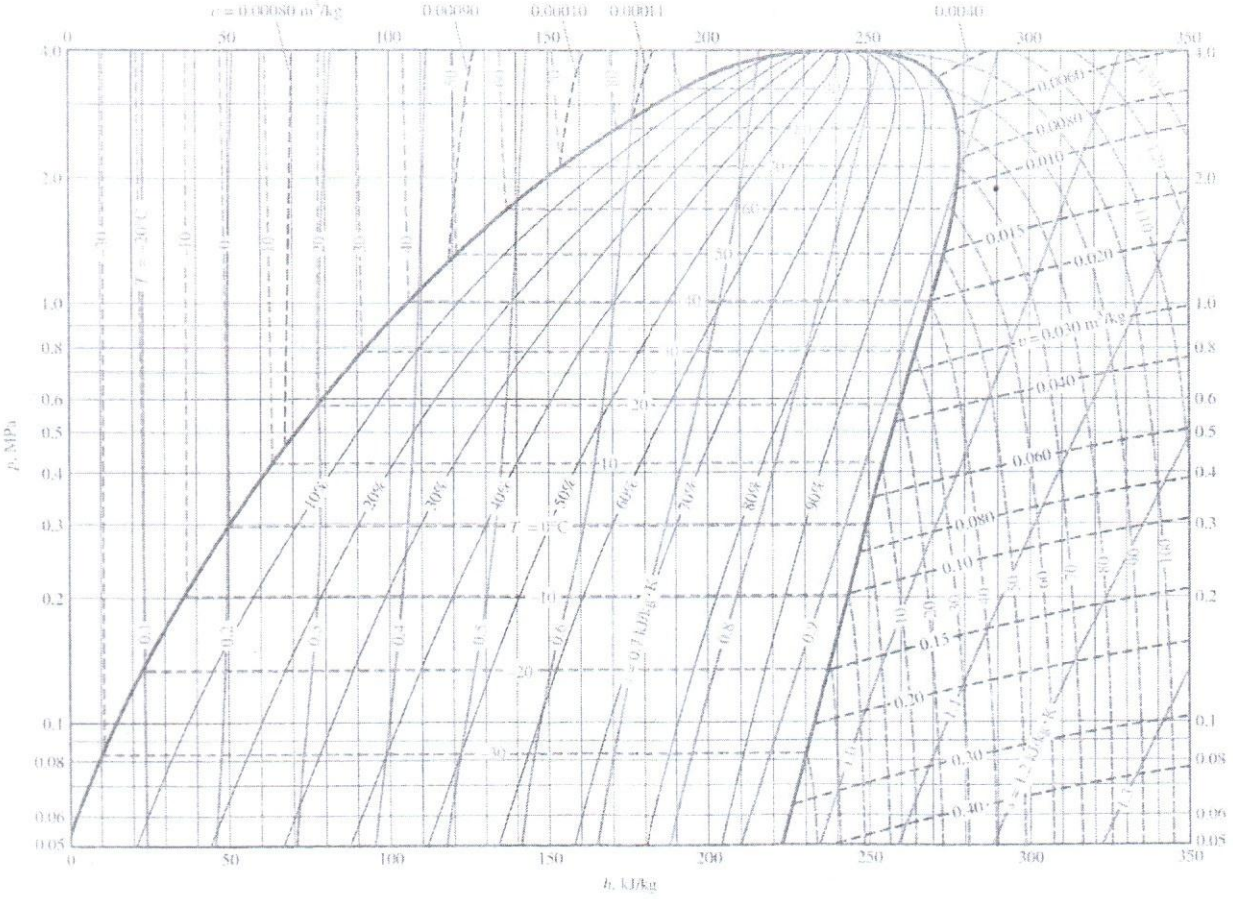
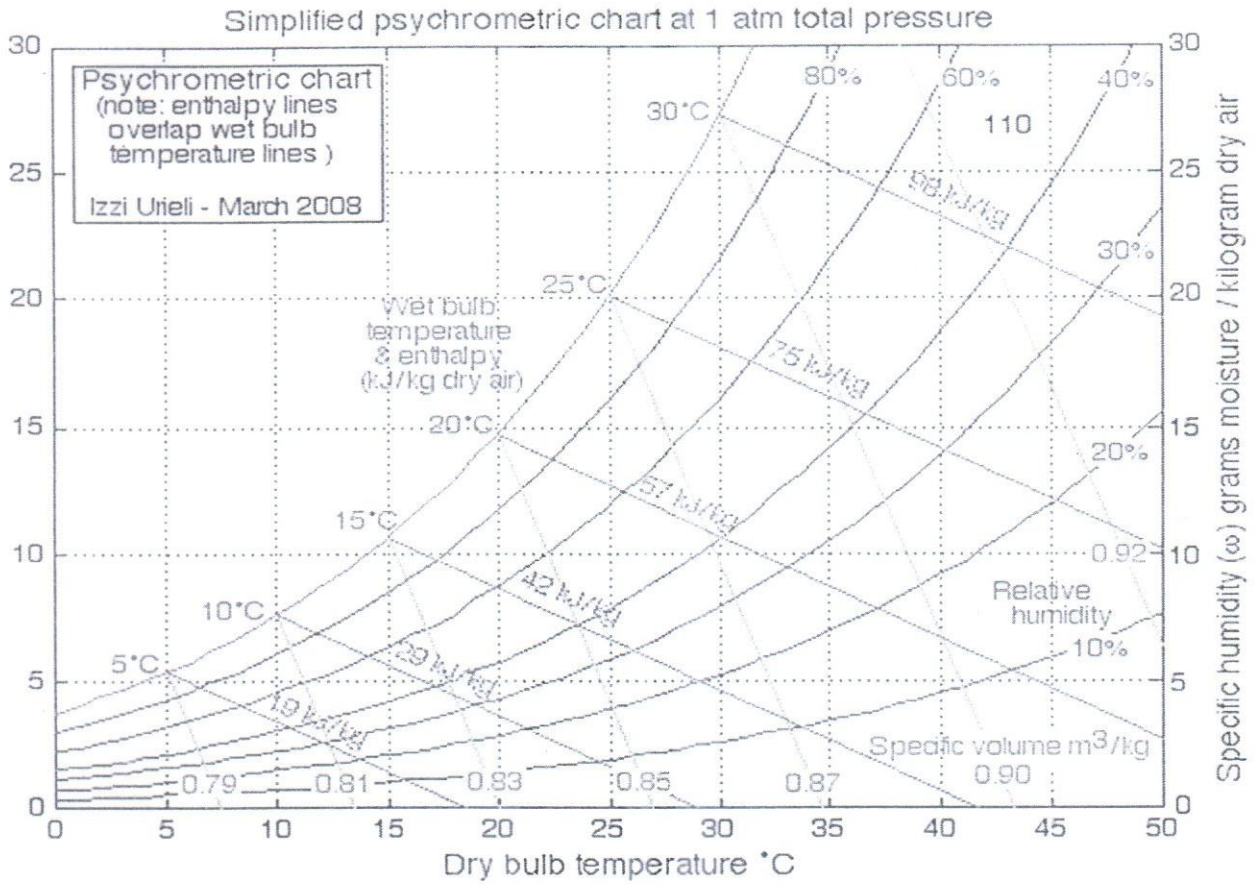


Chart A-11 R134a *ph* diagram. (*Source:* Based on *Thermodynamic Properties of HFC-134a (1,1,1, 2-tetrafluoroethane)*, DuPont Company, Wilmington, Delaware, 1993, with permission.)


Simplified psychrometric chart at 1 atm total pressure
Psychrometric chart
(note: enthalpy lines
overlap wet bulb
temperature lines)
Izzi Urieli - March 2008
Wet bulb
temperature
& enthalpy
(kJ/kg dry air)
30°C
25°C
20°C
15°C
10°C
5°C
110
98 kJ/kg
75 kJ/kg
51 kJ/kg
42 kJ/kg
29 kJ/kg
19 kJ/kg
80%
60%
40%
30%
20%
10%
Relative
humidity
0.92
Specific volume m3/kg
0.79
0.81
0.83
0.85
0.87
0.90
Dry bulb temperature °C
Specific humidity (ω) grams moisture / kilogram dry air
0
5
10
15
20
25
30
35
40
45
50

(12)

B.Sc.Engg. (ME, IPE)/ 4th Sem.
BScTE/2 yr prog (2nd Sem)

11 April, 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

FINAL SEMESTER EXAMINATION — SUMMER SEMESTER: 2020-2021

ME-4403/4695 — TIME : 3 HRS

Mechanics of Materials — FULL MARKS : 150

There are **SIX** Questions. Answer **All** Questions.
Figures in the Right Margin indicate full marks. (Assume reasonable value of any data missing)
Programmable calculators are not allowed. Do not write on this question paper

1. a) What do you mean by buckling and crushing load in a column, and effective length of a column. (5)

   b) Derive the expression of the critical (buckling) load for a both ends fixed column. (10)

   c) A timber column with fixed ends has cross-section $b \times h$ such that $h=2b$. If the column carries an critical load of 200 kN and length of 4.0 m, determine the dimension b. Consider crushing stress of timber is 30 MPa and modulus of elasticity E=10 GPa. Determine the slenderness ratio and show that the column will be failed due to buckling. (10)

2. A solid circular cantilever shaft of diameter 50 mm is subjected to a torque T =500 Nm, a concentrated load at the free end P_1= 20 kN and an axial tensile load P_2 = 50 kN as shown in Fig.1. Determine the principal stresses and the maximum shearing stress at the element A on the top surface of the shaft using Mohr's circle. (25)

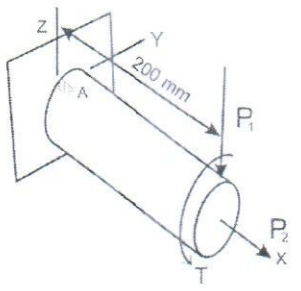


Fig. 1

3. a) Write down the assumptions which should be considered for simple torsion theory. Derive the expression $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$ if a solid or hollow shaft of uniform circular cross-section undergoes a pure torsion. The symbols represent their usual meaning. (10)

   b) A stepped solid circular steel shaft is subjected to a torque of 6 kNm at its free end C and a torque of 10 kNm at the junction B as shown in Fig.2. Determine the angle of twist at its free end. Modulus of rigidity of the shaft material is 80 GPa. (15)

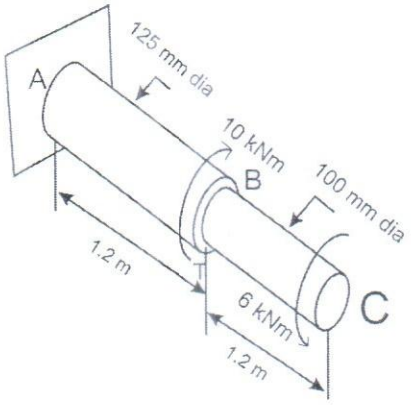


Fig.2

4. A thin walled cylindrical pressure vessel with closed ends is subjected to an internal pressure of 2.5 MPa and a twisting moment of 2 kNm. If the internal diameter is of the pressure vessel is 200 mm, the yield strength of the pressure vessel material is 300 Mpa and the safety factor is 3, determine the wall-thickness using i) the maximum normal stress theory, ii) the maximum shear stress theory and iii) the maximum distortion energy theory. (25)

5. A simply supported beam *AB* having length 7 m carries concentrated loads 20 kN, 15 kN and 20 kN at *C*, *D* and *E* respectively and uniformly distributed load of 10 kN/m from *D* to *E*, and 5 kN/m from *E* to *B* as shown in Fig.3. Determine the slope and deflection at *D* and *E*. Take E=220 GPa, I=90×10^{-6} m^4, length AC=1.5 m, CD=2 m, DE=2 m and EB=1.5 m. (25)

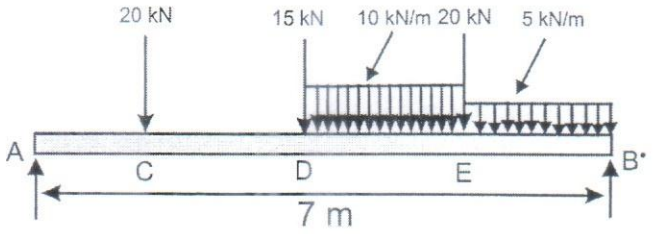


Fig.3

6. a) When a bar of 20 mm diameter is subjected to an axial pull of 60 kN, the extension on a 50 mm gauge length is 0.1 mm and there is a decrease in diameter of 0.015 mm. Determine the values of E, v, G and K. (10)

   b) A material is subjected to two mutually perpendicular strains, $\varepsilon_x = 350 \times 10^{-6}$ and $\varepsilon_y = -50 \times 10^{-6}$, together with an unknown shear strain γ_{xy}. If the principal strain in the material is 450×10^{-6}, determine: (15)

   i) The magnitude of the shear strain;
   ii) The other principal strain;
   iii) the direction of the principal strain axes;
   iv) The magnitude of the principal stresses if E=220 GPa and v=0.3 using Mohr's strain circle.

Related Equations:

Distortion energy theory:

$$(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2 = 2\sigma_y^2$$

Maximum total strain theory:

$$\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - 2\nu(\sigma_1\sigma_2 + \sigma_2\sigma_3 + \sigma_3\sigma_1) = \sigma_y^2$$

Maximum Principal strain theory:

$$\sigma_1 - \nu\sigma_2 - \nu\sigma_3 = \sigma_y$$

Relationship between elastic constants:

$$E = 3K(1 - 2\nu)$$

$$E = 2G(1 + \nu)$$

Principal stresses: σ_1 or σ_2 =

$$= \tfrac{1}{2}(\sigma_x + \sigma_y) \pm \tfrac{1}{2}\sqrt{[(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2]}$$

Relationship between Mohr's stress circle and strain circle:

$$\text{stress scale} = \frac{E}{(1-\nu)} \times \text{strain scale}$$

$$\text{radius of stress circle} = \frac{(1-\nu)}{(1+\nu)} \times \text{radius of strain circle}$$

Strain at an inclined angle θ:

$$\varepsilon_\theta = \tfrac{1}{2}(\varepsilon_x + \varepsilon_y) + \tfrac{1}{2}(\varepsilon_x - \varepsilon_y)\cos 2\theta + \tfrac{1}{2}\gamma_{xy}\sin 2\theta$$

Shear strain at an angle θ:

$$\tfrac{1}{2}\gamma_\theta = \tfrac{1}{2}(\varepsilon_x - \varepsilon_y)\sin 2\theta - \tfrac{1}{2}\gamma_{xy}\cos 2\theta$$

(15)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester: A.Y. 2020-2021
Course No.: IPE 4405 — Time: 3 hours
Course Title: Industrial Law and Management — Full Marks: 150

There are 6 (Six) Questions. Answer all of them.
Marks in the Margin indicate full marks. Do not write on this question paper.

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1 a. Why do you firstly need to comply with the legal compliance then comply to certain standards, codes and ethics? Discuss with examples in favour your arguments. 10

b. Do you agree with the branding "Made in Bangladesh" as a key consideration of compliance? Debate your arguments in favor of this or otherwise. 8

c. Briefly describe the work-area of social compliances and corporate social responsibilities (CSR). How can these be differentiated with respect to technical compliance and security compliance? 7

2 a. Explain the pros-and-cons of one-time pension like gratuity. Can it bring social security for employees? Give reasons in favor of your answer. 5

b. Hazards and risks are almost similar. Do you agree with this statement? Demonstrate your arguments. Explain work place hazards with examples from the view-point of safety hazards, health hazards, work related diseases, work environment risks, chemical hazards, biological hazards and physical hazards. 10

c. How can you differentiate occupational health with physical, mental, social, and spiritual health? Discuss the importance of occupational health for both workers and employers, in views of Changing concept of health, i.e., Bio-Medical concept, Ecological concept, psychological concept including Social, Cultural, Psychological, Economic, political factors and Holistic concept. 10

3 a. Suppose, the basic wage of a worker is BDT 25,000/- and he has been allowed 66 hours overtime in the last month. Calculate his overtime payment according to the Bangladesh Labour Act-2006. Show all steps. 5

b. Al-Hikmah Garments Manufacturing Company is operated in 3 shifts, working 40 hours a week and 50 weeks year. It had 7,000 workers per shift in 2021. In that year 190 accidents occurred out of which 3 was fatal. 13% man-hours were lost due to leave, absence, illness and other reasons. So, 250 days were lost in that year due to accident only. Calculate the Accident Frequency Rate (ACF) and Accident Severity Rate (ASR). Make your comments based on the findings. 10

c. Calculate the amount of payable compensation according to the section 151 and the 5th Schedule of Bangladesh Labour Act-2006 for a worker under the following circumstances: 10

i. In case of death,
ii. In case of permanent total disablement, and
iii. The total compensation for temporary disablement for a worker when his/her monthly wage is BDT 19,000/- and the period of disablement was 15 months.

(16)

4	a.	Do you agree with the definition of worker according Section 2 (65) and Section 175 of BLA-2006? Who is a worker in Bangladesh?	5
	b.	Is collective bargaining in Bangladesh a statutory issue? What is the role of the trade union in collective bargaining? What is the collective bargaining agreement? What is its purpose? Why is collective bargaining agreement important for an organization?	10
	c	Define unfair labor practices. What are the five employer unfair labor practices? What are the five employee unfair labor practices?	10
5	a.	How can you comply upon welfare activities of workers? Briefly discuss it in view of First aid, Drinking Water, Washing Facilities, Canteen, Child Care Room, Compulsory Group Insurance and Maternity Benefits.	10
	b.	"Fire can cause large losses and casualties." Do you agree with the statement? Briefly discuss in favor of your arguments.	10
	c.	Differentiate between Act and Law. State the ethical-moral aspects of them from Islamic perspective.	5
6	a.	How can you develop industrial relations by Employee, Employer, Government, ILO, Participation Committee, Safety committee, Trade union and CBA? Discuss in brief.	10
	b.	How can you maintain and develop health & safety by Cleanliness (S-51), Dust & Fume (S-53), Dustbin & Spittoon (S-60), Temperature & Ventilation (S-52), Sufficient Light (S-57), Noise & vibration and Overcrowding (S-56), according to Bangladesh Labour Act-2006?	10
	c.	Discuss the meaning and scope of Ergonomics (Human Engineering).	5

Or, Q7 is alternative to Q6. Answer either of them.

7	a.	According BLA-2006, section-4 (Amendment -2013), on the basis of the nature and feature of the work, the workers employed in any establishment shall be classified in any of the following classes, such as - Apprentice, Substitute (Badli), Casual, Temporary, Probationer, Permanent and Seasonal Worker. Who can do trade union? Discuss briefly.	5
	b.	Service rule, Service book, Working Hours, leave, Conditions of Appointment, Appointment Letter and Identity Card are the requirements of employment. Explain the statement.	10
	c.	How can you frame management by law, policy, standard and software or technology? Briefly discuss with examples.	10

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(17)

B.Sc. Engg. (ME / IPE) 4th Sem. 28 March 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester, A. Y. 2020-2021
Course No.: ME 4407 — Time: 3 Hours
Course Title: Measurement, Instrumentation and Control — Full Marks: 150

There are 6 (Six) questions. Answer all 6 (Six) questions.

Figures in the right margin indicate full marks. Programmable calculators are not allowed.
Do not write on this question paper.

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1. a) What kinds of errors can be seen in an instrument due to environmental inputs? How can you reduce those kinds of errors by calibration? 13

   b) A load cell is calibrated in an environment at a temperature of 20°C and has the following deflection/load characteristic: 12

Load (kg)	0	50	100	150	200	250
Deflection (mm)	0.0	0.9	1.9	3.2	4.2	4.9

   When used in an environment at 35°C, its characteristic changes to the following:

Load (kg)	0	50	100	150	200	250
Deflection (mm)	0.3	1.3	2.4	3.7	4.8	5.7

   i) Determine the zero drift and sensitivity drift coefficients in units of µm/°C and µm/ kg.°C, respectively.
   ii) Calculate the total zero drift and sensitivity drift at 30°C in units of µm and µm/kg, respectively.

2. a) Explain the working principle of the bimetallic strip thermometer with the necessary diagram. Write down the characteristics of the bimetallic strip thermometer. 13

   b) Write down the working principle of a Hall effect sensor. How do you conduct the following tasks using a Hall effect sensor: 12
      i) Sensing a head-on movement
      ii) Sensing a side-by movement
      iii) Sensing a notch
      iv) Sensing a metal body

3. a) How can you measure pressure with the help of a Time-of-Flight sensor? Illustrate your arrangement with the necessary diagrams. 13

   b) Explain the challenges of using standard binary coding in optical encoders. How can you overcome those challenges? 12

4. a) Calculate the digital output of 4.3V using the Successive-Approximation ADC method (10-bit A/D with range 0–10V)? Also, calculate the error (if any). 13

   b) What are the main two primary challenges of A/D conversion? Explain the following terms: 12
      i) Resolution
      ii) Device range
      iii) Signal input range
      iv) Sampling rate

18

5. a) State the sequence of operations that will occur for cylinders ***A*** and ***B*** in figure 1 when the start button is pressed. Where ***a-***, ***a+***, ***b-***, and ***b+*** (shown in the figure) are limit switches to detect when the cylinders are fully retracted and fully extended. 15

   b) Illustrate how you can control a pneumatic lift system with two push-button 2/2 valves. 10

6. a) A proportional controller is used to control the height of water in a tank where the water level can vary from 0 to 4.0 m. The required height of the water is 3.5 m, and the controller is to close a valve fully when the water rises to 3.9 m and open it fully when the water falls to 3.1 m. 18
   i) Explain the controlling action with a schematic and flow diagram.
   ii) Do you think that Time Proportional Control is needed for the above case? Justify your comment with a proper diagram.
   iii) What will be the effect of Proportional Band on this process performance?

   b) What are the limitations of two-step (on/off) control, and in what situation such a control system is commonly used? 7

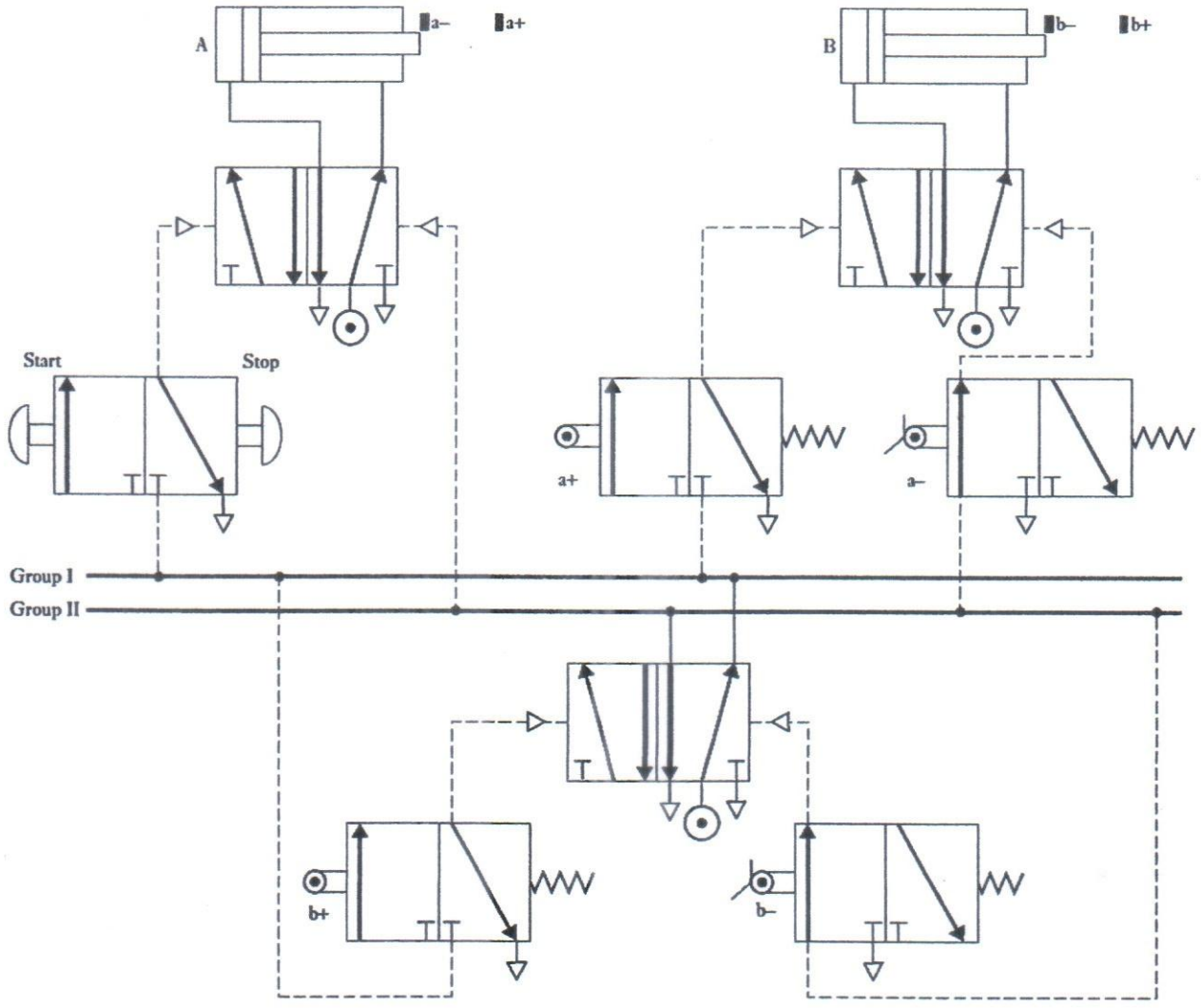

Figure 1 (Question 5 a)

(19)

Name of the Program: B. Sc. (ME/IPE/BScTE)
Semester: 4th Sem./2Y-2nd Sem.

Date: 06 April 2022
Time: 10:00 AM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING (MPE)

Semester Final Examination
Course Code: Math 4411/4699
Course Title: Linear Algebra and Solid Geometry

Summer Semester: 2020 - 2021
Full Marks: 150
Time: 3 Hours

Answer all the questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. The symbols have their usual meaning.

---

1. (a) Define Hermitian and skew-Hermitian matrices. If A is a nonsingular matrix, then show that A^T is nonsingular and $(A^{-1})^T = (A^T)^{-1}$. **[10] CO1 PO1/PO2**

   (b) Use Gauss-Jordan method to find the inverse of the matrix A, where **[15] CO1 PO1/PO2**

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 3 & 1 \\ 4 & 3 & 3 \end{bmatrix}.$$

2. (a) Solve the following system of linear equations after reducing the augmented matrix to its reduced row-echelon form: **[15] CO1 PO1/PO2**

$$\begin{aligned} u - v + \quad w - x + y &= 1 \\ 2u - v + 3w + \quad 4y &= 2 \\ 3u - 2v + 3w + x + y &= 1 \\ u + \qquad w + 2x + y &= 0 \end{aligned}$$

   (b) Consider the set P_2 of all polynomials of degree 2 and the set $S = \{p_1, p_2, p_3\}$, where $p_1 = 1 + x, p_2 = 1 + x^2, p_3 = x + x^2$. Examine whether S is a basis for P_2. **[10] CO2 PO1**

3. (a) Find eigenvalues and the corresponding eigenvectors of **[15] CO1 PO1/PO2**

$$A = \begin{pmatrix} 3 & 2 & 4 \\ 2 & 0 & 2 \\ 4 & 2 & 3 \end{pmatrix}.$$

(20)

(b) Find an LU-decomposition of $A=\begin{bmatrix}6 & -2 & 0\\ 9 & -1 & 1\\ 3 & 7 & 5\end{bmatrix}$. [10] CO1 PO1/PO2

4. (a) Given $A=\begin{bmatrix}1 & -2 & 0 & 0 & 3\\ 2 & -5 & -3 & -2 & 6\\ 0 & 5 & 15 & 10 & 0\\ 2 & 6 & 18 & 8 & 6\end{bmatrix}$. Find bases for the row space and null space of A. Also, verify the dimension theorem for A. [13] CO2 PO1

(b) Find the standard matrix for the transformation T on $\mathbb{R}^3$, where T is the composition of a rotation of 45^0 about the y-axis, followed by a reflection about the yz-plane, followed by a dilation with factor $k=\sqrt{2}$. Then find $T(2,-1,4)$ using the standard matrix. [12] CO1 PO1/PO2

5. (a) If a line makes angles $\alpha,\beta,\gamma,\delta$ with the four diagonals of a cube, then find the value of $\cos^2\alpha+\cos^2\beta+\cos^2\gamma+\cos^2\delta$. [12] CO3 PO2

(b) Find conditions upon which the two lines whose direction cosines are connected by the relations $al+bm+cn=0$ and $ul^2+vm^2+wn^2=0$ are perpendicular and parallel. [13] CO3 PO2

6. (a) Find the equation to the plane passing through the intersection of the planes $x+2y+3z+4=0$ and $4x+3y+2z+1=0$ and perpendicular to the plane $x+y+z+9=0$. [10] CO3 PO2

(b) Find the equation of the line of shortest distance between the lines $\frac{x-3}{3}=\frac{y-8}{-1}=\frac{z-3}{1}$ and $\frac{x+3}{-3}=\frac{y+7}{2}=\frac{z-6}{4}$. [10] CO3 PO2

(c) Write a short note on real world applications of three-dimensional coordinate geometry. [05] CO3 PO2

(21)

BTM /4th Sem. 07 April 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination
Course Code: MCE 4461
Course Title: Mechanical Technology II

Summer Semester: A.Y. 2020-2021
Time : 3 Hours
Full Marks : 150

Answer all 6 (six) questions.
Assume any missing data. Do not write on the question paper.

1. a) Explain briefly what measures can be taken to reduce or eliminate the effect of modifying inputs. [5]

   b) How high gain feedback and signal filtering can be used to reduce system error? Explain briefly. [10]

   c) Write down the sources of systematic error? [10]

2. a) Write down the general differential equation describing the dynamic response of a second order measuring instrument and state the expressions relating the static sensitivity, undamped natural frequency, and damping ratio to the parameters in this differential equation. Sketch the instrument response for cases of heavy damping, critical damping, and light damping and state which of these is the usual target when a second-order instrument is being designed? [10]

   b) Write down the difference between accuracy and precision. [5]

   c) What are the different types of instruments in measurement system? Explain with proper diagram. [10]

3. a) Show a functional block diagram of a simple temperature control system. [5]

   b) A load cell is calibrated in an environment at a temperature of 21°C and has the following deflection/load characteristic: [10]

Load (kg)	0	50	100	150	200
Deflection (mm)	0.0	1.0	2.0	3.0	4.0

When used in an environment at 35°C, its characteristic changes to the following:

Load (kg)	0	50	100	150	200
Deflection (mm)	0.2	1.3	2.4	3.5	4.6

(i) Determine the sensitivity at 21 and 35°C.
(ii) Calculate the total zero drift and sensitivity drift at 35°C.
(iii) Hence determine the zero drift and sensitivity drift coefficients (in units of mm/°C and (mm per kg)/(°C).

   c) How to calculate rise time for a first order system. Explain with proper diagram. [10]

4. a) What are the three basic phenomena that can occur in a thermocouple circuit? [5]

   b) Write down the basic method of measuring temperature using thermocouple. With proper diagram [10]

   c) The output e.m.f. from a chromel-alumel thermocouple (K type) whose hot junction is immersed in a fluid is measured as 6.07 mV. The reference junction of the thermocouple is maintained at 0°C. What is the temperature of the fluid? [10]

ITS-90 Table for Type K Thermocouple (Ref Junction 0°C)

Thermoelectric Voltage in mV

°C	0	1	2	3	4	5	6	7	8	9	10
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.163	1.203
30	1.203	1.244	1.285	1.326	1.366	1.407	1.448	1.489	1.530	1.571	1.612
40	1.612	1.653	1.694	1.735	1.776	1.817	1.858	1.899	1.941	1.982	2.023
50	2.023	2.064	2.106	2.147	2.188	2.230	2.271	2.312	2.354	2.395	2.436
60	2.436	2.478	2.519	2.561	2.602	2.644	2.685	2.727	2.768	2.810	2.851
70	2.851	2.893	2.934	2.976	3.017	3.059	3.100	3.142	3.184	3.225	3.267
80	3.267	3.308	3.350	3.391	3.433	3.474	3.516	3.557	3.599	3.640	3.682
90	3.682	3.723	3.765	3.806	3.848	3.889	3.931	3.972	4.013	4.055	4.096
100	4.096	4.138	4.179	4.220	4.262	4.303	4.344	4.385	4.427	4.468	4.509
110	4.509	4.550	4.591	4.633	4.674	4.715	4.756	4.797	4.838	4.879	4.920
120	4.920	4.961	5.002	5.043	5.084	5.124	5.165	5.206	5.247	5.288	5.328
130	5.328	5.369	5.410	5.450	5.491	5.532	5.572	5.613	5.653	5.694	5.735
140	5.735	5.775	5.815	5.856	5.896	5.937	5.977	6.017	6.058	6.098	6.138

5. a) For the meter-in flow control valve system figure 1, the following data are given: desired cylinder speed = 10 in/s, cylinder piston diameter = 2in, cylinder load = 3000 lb. specific gravity of oil = 0.90 pressure relief valve setting = 1000 psi. Determine the required capacity coefficient of the flow control valve. [10]

b) If you want to control a valve remotely, which type of valve is suitable? Write down its working principle with proper diagram. [10]

c) To control the flow what type of valve can be used? Explain with appropriate figures. [5]

6. a) Write down the working principle of double acting cylinder. [10]

b) "The effective area of double acting cylinders for extension stroke is greater that its retraction stroke" justify this statement with proper explanation. [5]

c) A double-acting cylinder is hooked up in the regenerative circuit of figure 2. The relief valve setting is 105 bars. The piston area is 130 cm^2 and the rod area is 65 cm^2. If the pump flow is 0.0016 m^3/s find the cylinder speed and load-carrying capacity and power delivered to the load (assuming the load equals to the cylinder load-carrying capacity) during the a. Extending stroke, b. Retracting stroke. [10]

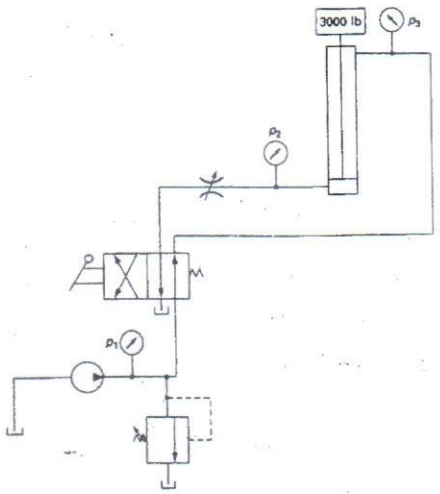

Figure 1

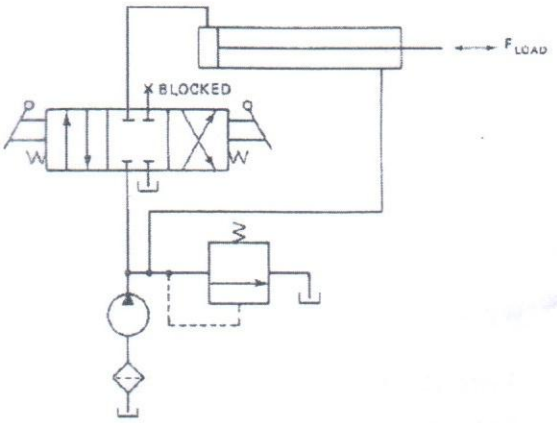

Figure 2

BSc. Engg. ME (6th Sem)/B.Sc.TE (1st Sem) Date: 01 April 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING (MPE)

Semester Final Examination	Summer Semester	: A.Y. 2020-2021
Course Code: **MCE 4609/4693**	Time	: 3 Hours
Course Title: **Machine Design I**	Full Marks	: 100

Assume reasonable data if necessary. State all assumptions very clearly.
Marks in the margin indicates full marks. Do not write on this question paper.
The exam is OPEN BOOK. Any NOTES are not allowed.

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1) The **Figure 1** illustrates a stepped bar OA with an actuating cantilever AB. Both parts are of cast iron. The free-end of the bend is subjected to a vertical load, **F = 500 N**

   a) Draw the free body diagram showing all the internal forces and internal moments.
   b) Calculate all internal forces and moments and discuss their effects.
   c) Determine the critical stresses and sketch the critical stress element. **[15]**

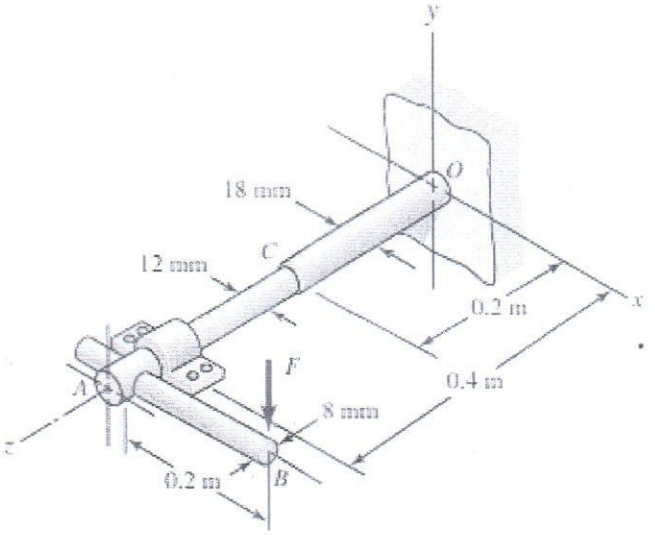


Figure 1

2) Horizontal link 2 is subjected to load **F = 150 kN** at C as shown in **Figure 2**. Link 3, which is a constant circular cross section made of Aluminium, works as a support of link 2. End D of link 3 is fixed in the ground, and the opposite end, B, is pinned to link 2. The effective length of the link 3 is $L_{eff} = 0.5\ L_2$). The lengths of the links are **L_2= R_{CA}= 5 m**, **R_{BA}= 3 m** and **L3= R_{BD} =3 m**. Design the **diameter d** of link 3 considering the static factor of safety guarding against buckling, **n = 3.0** **[15]**

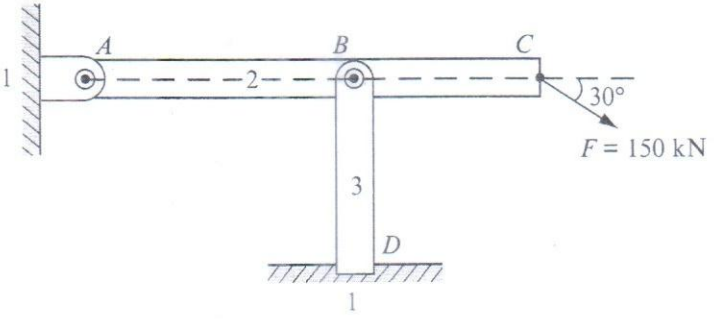


Figure 2

3) **Figure 3** is showing a curved steel beam where **F = 35 kN**. All dimensions are shown in the figure. The Section A-A illustrate the details of the cross section.
   a) Estimate the inner and outer surface stresses at the throat.
   b) Calculate the minimum factor of safety guarding against yielding by using both the maximum shear stress theory and the distortion energy theory. **[15]**

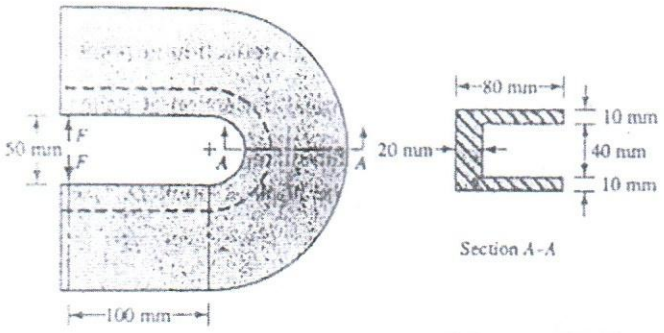


Figure 3

4) **Figure 4** shows the free-body diagram of a connecting-link portion having stress concentration at three sections. The dimensions are **r = 5 mm**, **d = 24 mm**, **h = 16 mm**, w_1= **80 mm**, and w_2 = **50 mm**. The forces **F** fluctuate between a tension of **15 kN** and a compression of **65 kN**. Neglecting any column action, calculate the least factor of safety if the material is Cold-Drawn **AISI 1020 steel**. **[20]**

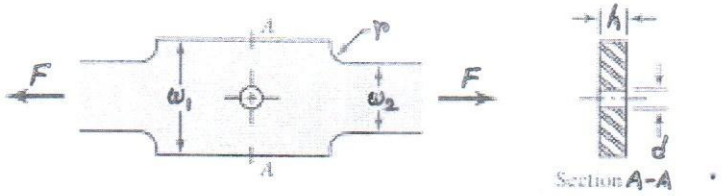


Figure 4

5) Design the countershaft of a gear reduction unit as illustrated in **Figure 5. Gear A** receives power from another gear with the transmitted force F_A applied with pressure angle as shown. The power is transmitted through the shaft and delivered through **Gear B** with transmitted force F_B at the pressure angle shown. Design **the diameter** of the countershaft using a design factor, n_d = **1.6** based on infinite life using a conservative fatigue failure criteria. The shaft rotation is considered constant, the shaft has a constant diameter and made of **AISI 1035** Hot-Rolled steel. Also, find the factor of safety guarding against yielding for the design diameter. **[35]**

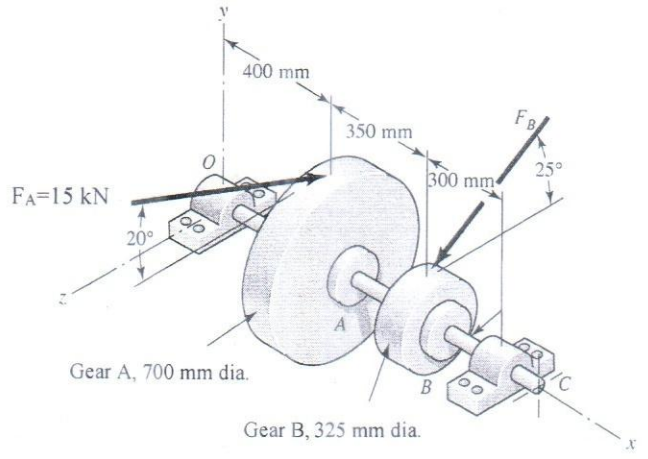


Figure 5

(25)

B.Sc Engg.(M)/6th Sem 4th April, 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination
Course No.: Math 4611
Course Title: Numerical Analysis

Summer Semester: A.Y. 2020-2021
Time: 3 hrs
Full Marks: 150

There are 6 (Six) Questions. Answer all of them

Marks in the Margin indicate full marks. Assume reasonable values for any missing data. Programmable calculators are not allowed.

1. For the following system of equations [25]

$$\begin{aligned} 3x_1 + 6x_2 + 9x_3 &= 39 \\ 2x_2 + 5x_2 - 2x_3 &= 3 \\ x_1 + 3x_2 - x_3 &= 2 \end{aligned}$$

Using *Forward elimination,* form *Upper Triangular matrix* and then perform *backward substitution* to get the solutions.

2. a. How this number x=869.432 will be stored in computer according to *IEEE double precision floating format*? [07]

b. One common instance where *subtractive cancellation* occurs involves finding the roots of a parabola, $ax^2+ bx + c$, with the quadratic formula: [18]

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For $b^2>>4ac$, the difference in the numerator can be very small and *roundoff errors* can occur. In such cases, an alternative formulation can be used to minimize *subtractive cancellation*:

$$x = \frac{-2c}{b \pm \sqrt{b^2 - 4ac}}$$

Use *5-digit arithmetic* with *rounding* to determine the roots of the following equation with both versions of the quadratic formula.

$$x^2 - 5000.002x + 10$$

3. For fluid flow in pipes, friction is described by a dimensionless number, the *Fanning friction factor f*. The Fanning friction factor is dependent on a number of parameters related to the size of the pipe and the fluid, which can all be represented by another dimensionless quantity, the *Reynolds number* Re. A formula that predicts *f* given Re is the *von Karman equation*: 25

$$\frac{1}{\sqrt{f}} = 4 \log_{10}(\mathrm{Re}\sqrt{f}) - 0.4$$

Typical values for the Reynolds number for turbulent flow are 10,000 to 500,000 and for the Fanning friction factor are 0.001 to 0.01.
Use *bisection* to solve for f given a user-supplied value of Re between 2500 and 1,000,000. Ensure that the absolute error in the result is $E_a < 0.000005$

(26)

4. The set of the following five data points is given: 25

x	1	2	4	5	7
y	52	5	-5	-40	10

a) Determine the fourth-order polynomial in the Lagrange form that passes through the points
b) Use the polynomial obtained in part a) to determine the interpolated value for x=3.

5. A plane is being tracked by radar, and data are taken every second in polar coordinates θ and r. 25

t, s	200	202	204	206	208	210
θ, (rad)	0.75	0.72	0.70	0.68	0.67	0.66
r, m	5120	5370	5560	5800	6030	6240

At 206 seconds, use the centered finite-difference (second order correct) to find the vector expressions for velocity and acceleration The velocity and acceleration given in polar coordinates are

$$\vec{v} = \dot{r}\vec{e}_r + r\dot{\theta}\vec{e}_\theta$$
$$\vec{a} = (\ddot{r} - r\dot{\theta}^2)\vec{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\vec{e}_\theta$$

6. The force on a sailboat mast can be represented by the following function: 25

$$f(z) = 200\left(\frac{z}{5+z}\right)e^{-2z/H}$$

where z = the elevation above the deck and H = the height of the mast. The total force F exerted on the mast can be determined by integrating this function over the height of the mast:

$$F = \int_0^H f(z)\,dz$$

The line of action can also be determined by integration:

$$d = \frac{\int_0^H z f(z)\,dz}{\int_0^H f(z)\,dz}$$

Use Numerical Integration to compute F and d for the case where $H = 30$ ($n = 6$).

or

A pond drains through a pipe as shown in Fig. 2 Under a number of simplifying assumptions, 25
the following differential equation describes how depth changes with time:

$$\frac{dh}{dt} = -\frac{\pi d^2}{4A(h)}\sqrt{2g(h+e)}$$

where h = depth (m), t = time (s), d = pipe diameter (m), A(h) = pond surface area as a function of depth (m^2), g =gravitational constant (= 9.81 m/s^2), and e = depth of pipe outlet below the pond bottom (m). Based on the following area-depth table, solve this differential equation to determine how long it takes for the pond to empty, given that h(0) = 8 m, d = 0.35 m, e = 1.5 m

h, m	6	5	4	3	2	1	0
$A(h)$, 10^4 m^2	1.17	0.97	0.67	0.45	0.32	0.18	0

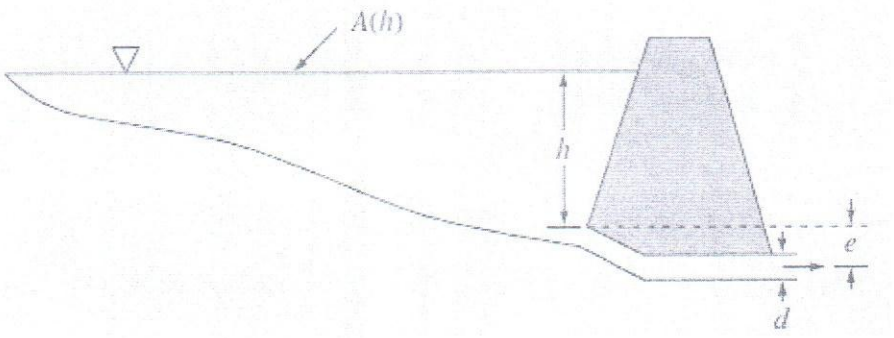


Fig. 2 (Question 6 (or))

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Final Semester Examination
Course No.: MCE 4613
Course Title: Convective Heat Transfer: Phase Change and Mass Transfer

Summer Semester: A.Y. 2020-2021
Time: 3 Hours
Full Marks: 150

There are 06 (Six) Questions. Answer all of them.

Marks in the margin indicate full marks. Don't write on this question paper. Symbols carry their usual meanings. Assume reasonable values for any missing data. Programmable calculators are not allowed.

1. **a)** Heat transfer through a solid is always by conduction, since the molecules of a solid remain at relatively fixed positions. Heat transfer through a liquid or gas, however, can be by conduction or convection, depending on the presence of any bulk fluid motion. Heat transfer through a fluid is by convection in the presence of bulk fluid motion and by conduction in the absence of it. Therefore, conduction in a fluid can be viewed as the limiting case of convection, corresponding to the case of quiescent fluid. We use forced convection in daily life more often than you might think. We resort to forced convection whenever we want to increase the rate of heat transfer from a hot object. For example, we turn on the fan on hot summer days to help our body cool more effectively. The higher the fan speed, the better we feel. We stir our soup and blow on a hot slice of pizza to make them cool faster. The air on windy winter days feels much colder than it actually is. The simplest solution to heating problems in electronics packaging is to use a large enough fan. Identify the dimensionless parameter that is involved to all the stated cases and discuss the physical significance of it. **[05]**

b) Roughening the surface can be used to great advantage in reducing drag, but it can also backfire on us if we are not careful-specifically, if we do not operate in the right range of Reynolds number. With this consideration, golf balls are intentionally roughened to induce turbulence at a lower Reynolds number to take advantage of the sharp drop in the drag coefficient at the onset of turbulence in the boundary layer (typical velocity range of golf balls is 15 to 150 m/s). The critical Reynolds number of dimpled golf balls is about 4×10^4. The occurrence of turbulent flow at this Reynolds number reduces the drag coefficient of a golf ball by half. For a given hit, this means a longer distance for the ball. Experienced golfers also give the ball a spin during the hit, which helps the rough ball develop a lift and thus travel higher and further. Based on the statement given above, discuss the effect of surface roughness on the drag coefficient of a sphere. **[05]**

c) Consider steady laminar flow of a fluid in a circular tube of radius R. The fluid properties ρ, k, and Cp are constant, and the work done by viscous stresses is negligible. The fluid flows along the x-axis with velocity V, The flow is fully developed so that V is independent of x and thus V=V(r). Noting that energy is transferred by mass in the x-direction, and by conduction in the r-direction (heat conduction in the x-direction is assumed to be negligible). Show that the rate of net energy transfer to the control volume by mass flow is equal to the net rate of heat conduction in the radial direction. **[05]**

(20)

2. Boiling is probably the most familiar form of heat transfer, yet it remains to be the least understood form. After hundreds of papers written on the subject, we still do not fully understand the process of bubble formation and we must still rely on empirical or semi-empirical relations to predict the rate of boiling heat transfer. The pioneering work on boiling was done in 1934 by S. Nukiyama, who used electrically heated Nichrome and platinum wires immersed in liquids in his experiments. Nukiyama noticed that boiling takes different forms, depending on the value of the excess temperature and different boiling regimes are observed. These regimes can be illustrated on the curve which is a plot of boiling heat flux versus the excess temperature. The specific shape of the curve depends on the fluid–heating surface material combination and the fluid pressure, but it is practically independent of the geometry of the heating surface. Draw the typical boiling curve for water at 1 atm pressure and identify the different boiling regimes. Also, explain the characteristics of each regime. **[20]**

3. a) As an upcoming mechanical engineer, you have to select a parallel-flow double-pipe heat exchanger that will achieve a specified temperature change in a fluid stream of known mass flow rate or to predict the outlet temperatures of the hot and cold fluid streams in a specified heat exchanger. Definitely you will think to use different methods of heat exchanger analysis. Explain the principles of the heat exchanger analysis method for the given cases. **[15]**

b) Consider two large reservoirs connected by a channel of length L. The entire system contains a binary mixture of gases A and B at a uniform temperature T and pressure P throughout. The concentrations of species are maintained constant in each of the reservoirs. For this system, briefly explain the phenomenon called 'Equimolar Counter Diffusion'. **[10]**

4. You have probably noticed that most fluids, especially liquids, are transported in circular pipes. This is because pipes with a circular cross section can withstand large pressure differences between the inside and the outside without undergoing any distortion. Noncircular pipes are usually used in applications such as the heating and cooling systems of buildings where the pressure difference is relatively small and the manufacturing and installation costs are lower. For a fixed surface area, the circular tube gives the most heat transfer for the least pressure drop, which explains the overwhelming popularity of circular tubes in heat transfer equipment. **[20]**

Develop the temperature profile in fully developed flow in a tube subjected to constant surface heat flux. Show that the temperature gradient is independent of x and thus the shape of the temperature profile does not change along the tube, but the mean fluid temperature along the tube for the case of constant temperature varies exponentially.

5. Consider a vertical plate of height L and width b maintained at a constant temperature T_s that is exposed to vapor at the saturation temperature T_{sat}. The downward direction is taken as the positive x-direction with the origin placed at the top of the plate where condensations initiate. The surface temperature is below the saturation temperature ($T_s < T_{sat}$) and thus the vapor condenses on the surface. The liquid film flows downward under the influence of gravity. The film thickness and thus the mass flow rate of the condensate increases with x as a result of continued condensation on the existing film. Then heat transfer from the vapor to the plate must occur through the film, which offers resistance to heat transfer. **[25]**

Develop and compare the average heat transfer coefficient h for the case of laminar film condensation for vertical and inclined Plates.

30

6. **a)** A computer cooled by a fan contains eight PCBs, each dissipating 10 W of power as shown in **Figure A.** The height of the PCBs is 12 cm and the length is 18 cm. The clearance between the tips of the components on the PCB and the back surface of the adjacent PCB is 0.3 cm. The cooling air is supplied by a 10-W fan mounted at the inlet. If the temperature rise of air as it flows through the case of the computer is not to exceed 10°C, [20]

Calculate (*a*) the flow rate of the air that the fan needs to deliver, (*b*) the fraction of the temperature rise of air that is due to the heat generated by the fan and its motor, and (*c*) the highest allowable inlet air temperature if the surface temperature of the components is not to exceed 70°C anywhere in the system. Use air properties at 25°C.

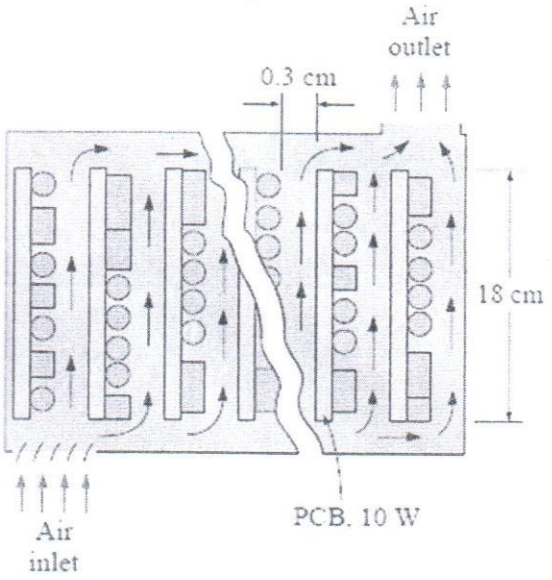


Figure: A

b) Water is boiling in a 12-cm-deep pan with an outer diameter of 25 cm that is placed on top of a stove as shown in **Figure B**. The ambient air and the surrounding surfaces are at a temperature of 25°C, and the emissivity of the outer surface of the pan is 0.95. Assuming the entire pan to be at an average temperature of 98°C, determine the rate of heat loss from the cylindrical side surface of the pan to the surroundings by (*a*) natural convection and (*b*) radiation. (*c*) If water is boiling at a rate of 2 kg/h at 100°C, [15]

Compute the ratio of the heat lost from the side surfaces of the pan to that by the evaporation of water. The heat of vaporization of water at 100°C is 2257 kJ/kg.

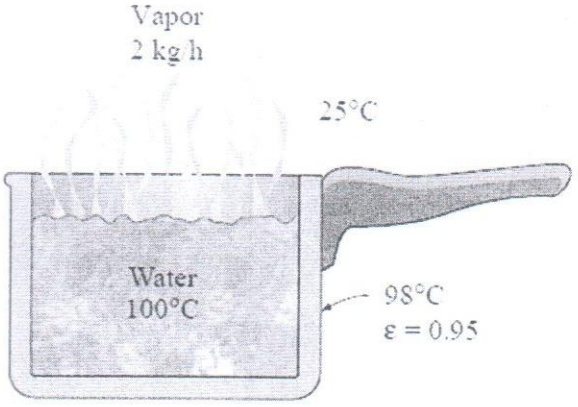


Figure: B

c) In a textile manufacturing plant, the waste dyeing water (Cp = 4295 J/g.°C) at 75°C is to be used to preheat fresh water (Cp = 4180 J/kg.°C) at 15°C at the same flow rate in a double-pipe counter-flow heat exchanger as shown in **Figure C**. The heat transfer surface area of the heat exchanger is 1.65 m2 and the overall heat transfer coefficient is 625 W/m^2.°C. If the rate of heat transfer in the heat exchanger is 35 kW, [10]

Compute the outlet temperature and the mass flow rate of each fluid stream.

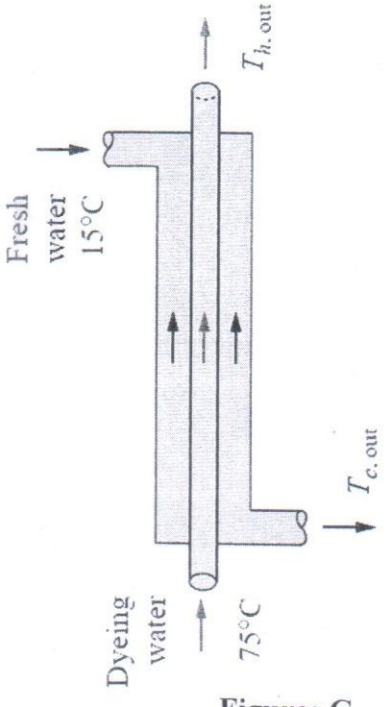


Figure: C

TABLE 9–1

Empirical correlations for the average Nusselt number for natural convection over surfaces

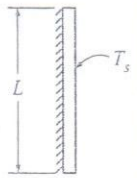
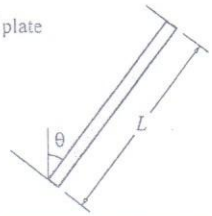
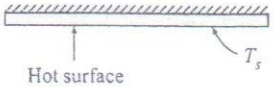
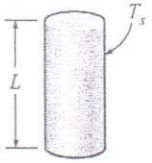
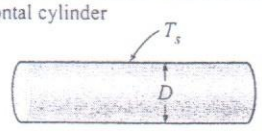
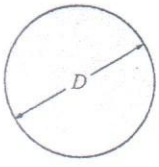
Geometry	Characteristic length L_c	Range of Ra	Nu
Vertical plate 	L	10^4–10^9 10^9–10^{13} Entire range	$\mathrm{Nu} = 0.59\mathrm{Ra}_L^{1/4}$ (9-19) $\mathrm{Nu} = 0.1\mathrm{Ra}_L^{1/3}$ (9-20) $\mathrm{Nu} = \left\{0.825 + \frac{0.387\mathrm{Ra}_L^{1/6}}{[1 + (0.492/\mathrm{Pr})^{9/16}]^{8/27}}\right\}^2$ (9-21) (complex but more accurate)
Inclined plate 	L		Use vertical plate equations for the upper surface of a cold plate and the lower surface of a hot plate Replace g by $g\cos\theta$ for $\mathrm{Ra} < 10^9$
Horiontal plate (Surface area A and perimeter p) (a) Upper surface of a hot plate (or lower surface of a cold plate)  (b) Lower surface of a hot plate (or upper surface of a cold plate) 	A_s/p	10^4–10^7 10^7–10^{11} 10^5–10^{11}	$\mathrm{Nu} = 0.54\mathrm{Ra}_L^{1/4}$ (9-22) $\mathrm{Nu} = 0.15\mathrm{Ra}_L^{1/3}$ (9-23) $\mathrm{Nu} = 0.27\mathrm{Ra}_L^{1/4}$ (9-24)
Vertical cylinder 	L		A vertical cylinder can be treated as a vertical plate when $D \geq \frac{35L}{\mathrm{Gr}_L^{1/4}}$
Horizontal cylinder 	D	$\mathrm{Ra}_D \leq 10^{12}$	$\mathrm{Nu} = \left\{0.6 + \frac{0.387\mathrm{Ra}_D^{1/6}}{[1 + (0.559/\mathrm{Pr})^{9/16}]^{8/27}}\right\}^2$ (9-25)
Sphere 	D	$\mathrm{Ra}_D \leq 10^{11}$ ($\mathrm{Pr} \geq 0.7$)	$\mathrm{Nu} = 2 + \frac{0.589\mathrm{Ra}_D^{1/4}}{[1 + (0.469/\mathrm{Pr})^{9/16}]^{4/9}}$ (9-26)

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TABLE A–15

Properties of air at 1 atm pressure

Temp. T, °C	Density ρ, kg/m³	Specific Heat c_p, J/kg·K	Thermal Conductivity k, W/m·K	Thermal Diffusivity α, m²/s	Dynamic Viscosity μ, kg/m·s	Kinematic Viscosity ν, m²/s	Prandtl Number Pr
−150	2.866	983	0.01171	4.158×10^{-6}	8.636×10^{-6}	3.013×10^{-6}	0.7246
−100	2.038	966	0.01582	8.036×10^{-6}	1.189×10^{-5}	5.837×10^{-6}	0.7263
−50	1.582	999	0.01979	1.252×10^{-5}	1.474×10^{-5}	9.319×10^{-6}	0.7440
−40	1.514	1002	0.02057	1.356×10^{-5}	1.527×10^{-5}	1.008×10^{-5}	0.7436
−30	1.451	1004	0.02134	1.465×10^{-5}	1.579×10^{-5}	1.087×10^{-5}	0.7425
−20	1.394	1005	0.02211	1.578×10^{-5}	1.630×10^{-5}	1.169×10^{-5}	0.7408
−10	1.341	1006	0.02288	1.696×10^{-5}	1.680×10^{-5}	1.252×10^{-5}	0.7387
0	1.292	1006	0.02364	1.818×10^{-5}	1.729×10^{-5}	1.338×10^{-5}	0.7362
5	1.269	1006	0.02401	1.880×10^{-5}	1.754×10^{-5}	1.382×10^{-5}	0.7350
10	1.246	1006	0.02439	1.944×10^{-5}	1.778×10^{-5}	1.426×10^{-5}	0.7336
15	1.225	1007	0.02476	2.009×10^{-5}	1.802×10^{-5}	1.470×10^{-5}	0.7323
20	1.204	1007	0.02514	2.074×10^{-5}	1.825×10^{-5}	1.516×10^{-5}	0.7309
25	1.184	1007	0.02551	2.141×10^{-5}	1.849×10^{-5}	1.562×10^{-5}	0.7296
30	1.164	1007	0.02588	2.208×10^{-5}	1.872×10^{-5}	1.608×10^{-5}	0.7282
35	1.145	1007	0.02625	2.277×10^{-5}	1.895×10^{-5}	1.655×10^{-5}	0.7268
40	1.127	1007	0.02662	2.346×10^{-5}	1.918×10^{-5}	1.702×10^{-5}	0.7255
45	1.109	1007	0.02699	2.416×10^{-5}	1.941×10^{-5}	1.750×10^{-5}	0.7241
50	1.092	1007	0.02735	2.487×10^{-5}	1.963×10^{-5}	1.798×10^{-5}	0.7228
60	1.059	1007	0.02808	2.632×10^{-5}	2.008×10^{-5}	1.896×10^{-5}	0.7202
70	1.028	1007	0.02881	2.780×10^{-5}	2.052×10^{-5}	1.995×10^{-5}	0.7177
80	0.9994	1008	0.02953	2.931×10^{-5}	2.096×10^{-5}	2.097×10^{-5}	0.7154
90	0.9718	1008	0.03024	3.086×10^{-5}	2.139×10^{-5}	2.201×10^{-5}	0.7132
100	0.9458	1009	0.03095	3.243×10^{-5}	2.181×10^{-5}	2.306×10^{-5}	0.7111
120	0.8977	1011	0.03235	3.565×10^{-5}	2.264×10^{-5}	2.522×10^{-5}	0.7073
140	0.8542	1013	0.03374	3.898×10^{-5}	2.345×10^{-5}	2.745×10^{-5}	0.7041
160	0.8148	1016	0.03511	4.241×10^{-5}	2.420×10^{-5}	2.975×10^{-5}	0.7014
180	0.7788	1019	0.03646	4.593×10^{-5}	2.504×10^{-5}	3.212×10^{-5}	0.6992
200	0.7459	1023	0.03779	4.954×10^{-5}	2.577×10^{-5}	3.455×10^{-5}	0.6974
250	0.6746	1033	0.04104	5.890×10^{-5}	2.760×10^{-5}	4.091×10^{-5}	0.6946
300	0.6158	1044	0.04418	6.871×10^{-5}	2.934×10^{-5}	4.765×10^{-5}	0.6935
350	0.5664	1056	0.04721	7.892×10^{-5}	3.101×10^{-5}	5.475×10^{-5}	0.6937
400	0.5243	1069	0.05015	8.951×10^{-5}	3.261×10^{-5}	6.219×10^{-5}	0.6948
450	0.4880	1081	0.05298	1.004×10^{-4}	3.415×10^{-5}	6.997×10^{-5}	0.6965
500	0.4565	1093	0.05572	1.117×10^{-4}	3.563×10^{-5}	7.806×10^{-5}	0.6986
600	0.4042	1115	0.06093	1.352×10^{-4}	3.846×10^{-5}	9.515×10^{-5}	0.7037
700	0.3627	1135	0.06581	1.598×10^{-4}	4.111×10^{-5}	1.133×10^{-4}	0.7092
800	0.3289	1153	0.07037	1.855×10^{-4}	4.362×10^{-5}	1.326×10^{-4}	0.7149
900	0.3008	1169	0.07465	2.122×10^{-4}	4.600×10^{-5}	1.529×10^{-4}	0.7206
1000	0.2772	1184	0.07868	2.398×10^{-4}	4.826×10^{-5}	1.741×10^{-4}	0.7260
1500	0.1990	1234	0.09599	3.908×10^{-4}	5.817×10^{-5}	2.922×10^{-4}	0.7478
2000	0.1553	1264	0.11113	5.664×10^{-4}	6.630×10^{-5}	4.270×10^{-4}	0.7539

Note: For ideal gases, the properties c_p, k, μ, and Pr are independent of pressure. The properties ρ, ν, and α at a pressure P (in atm) other than 1 atm are determined by multiplying the values of ρ at the given temperature by P and by dividing ν and α by P.

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Original sources: Keenan, Chao, Keyes, Gas Tables, Wiley, 1984; and Thermophysical Properties of Matter, Vol. 3: Thermal Conductivity, Y. S. Touloukian, P. E. Liley, S. C. Saxena, Vol. 11: Viscosity, Y. S. Touloukian, S. C. Saxena, and P. Hestermans, IFI/Plenun, NY, 1970, ISBN 0-306067020-8.

TABLE 8–4

Nusselt number for fully developed laminar flow in an annulus with one surface isothermal and the other adiabatic (Kays and Perkins, Ref. 14)

D_i/D_o	Nu_i	Nu_o
0	—	3.66
0.05	17.46	4.06
0.10	11.56	4.11
0.25	7.37	4.23
0.50	5.74	4.43
1.00	4.86	4.86

(33)

B.Sc. Engg. (ME)/ 6th Sem. 13 April 2022(Wednesday)
BSc TE 2 year prog/ 2nd Sem

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester, A. Y. 2020-2021
Course No MCE 4621 / 4691 — Time: 3 hours
Course Title: Machine Tools — Full Marks: 150

There are **6(Six)** questions. Answer All of them. Only in Question no 1, one needs to answer Q1[a+b] or Q1[c+d]. Marks in the margin indicate full marks.

---

1. a) Write the features that differentiate Non-conventional Machining from the Conventional Machining. Describe working principle of Laser Beam Machining with figures. [12]
   b) Differentiate between a conventional lathe and turret lathe. Also compare between horizontal and vertical milling machine. [13]

OR

   c) Compare between shaper and planer machines. Describe the major five components of a shaper machine and its working principle with appropriate sketches. [3+5+4]
   d) Describe the working principle of a center less grinding machine with neat sketches and when it is used. Also illustrate the impact of grain size in the operation of grinding. [8+2+3]

2. a) Illustrate the main difference between NC and CNC machines. Write down the defining features of Industry 4.0 and its impact on sustainability. [10]
   b) Calculate the indexing and change gears required for 57 divisions using the appropriate indexing method. The change gears supplied with the dividing head are as follows: [15]
   24, 28, 32, 40, 44, 48, 56, 64, 72, 86
   The available index plate hole circles are as follows:

Plate No. 1	15	16	17	18	19	20
Plate No. 2	21	23	27	29	31	33
Plate No. 3	37	39	41	43	47	49

3. a) Describe any two methods that could be used to reduce noise and vibration during installation and operation of machine tools [2+10]
   b) Suppose you are going to do turning on a work piece and need to locate the work piece. Select one locator for this purpose and explain the reason behind this selection. After the locator selection, describe 3-2-1 principle that may be used locating with neat sketches. [2+11]

4. a) Write the differentiating features to be looked for while selecting between jigs and fixtures. Describe any one type of jigs or fixtures with a neat sketch. Explain/ Depict different types and parts of Bearings, slide ways, , clamps, dies, jigs/fixtures for engineering practice [3+9]
   b) Explain the necessity of bearings. Describe the main components of a ball bearing with necessary illustration. [13]

(34)

5. a) Classify Sideways and describe key features of each with appropriate figures. [15]
   b) Briefly describe about Toggle Clamp. Differentiate between V-bending and Edge bending with appropriate figures. [4+6]

6. a) Write down the impact of Service Factor. A 0.5 Hp electric motor is able to move 3000 pounds of potting mixture into a storage box. The motor has a Service Factor (S.F.) of 1.3 and an output of 550 watts. Is this motor capable of performing this task? [2+3]
   b) Draw a structural diagram, speed chart and kinematic diagram for a 6 speed gearbox for a head stock that could provide speed ranging from 160 rpm to 500 rpm. The power is supplied by an electric motor running at 1000 rpm, through a V-belt drive with a speed reduction to 400 rpm to the input shaft. [12]
   c) While selecting a drive, an engineer may prefer hydraulic drive while another engineers prefer pneumatic drive. Write down the advantages of Hydraulic drive and Pneumatic drive that may persuade these two engineers for their choice. Also describe the working principle of a gear pump with figures. [3+5]

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B.Sc. Engg. (ME) (6th Semester)/Production April 06, 2022 [A].

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination
Course No.: MCE 4627
Course Title: Tool Engineering

Summer Semester, A. Y. 2020-2021
Time: 3 Hours
Full Marks: 150

There are 6 (Six) Questions. Answer all the questions. Marks in the Margin indicate the full marks. Do not write on this question paper.

1.	a)	What will be design considerations for the design of the typical gating system in casting process and hence explain the analysis technique of pouring and filling of the mould?	15
	b)	What will be the requirements for defect free casting and explain the prevention techniques of impurities and turbulence in the gating system to get defect free casted products?	10
2	a)	Explain the basic machining principle of broaching tool and hence explain in your own words the design mapping of a broaching tool with necessary diagram.	14
	b)	Explain briefly the different types of broaching tools with the applications.	11
3	a)	Write down the different forming die components with schematic illustration and explain the different design considerations of the components?	17
	b)	What do you mean by Economic viability analysis and hence judging necessity of using Jigs and Fixtures of manufacturing for a lot of products?	8
4	a)	List the different types of Jigs and explain the basic differences between plate type jigs and leaf jigs.	12
	b)	Explain briefly the different factors that need to be considered for the estimation of a die.	13
5	a)	How the chip is formed in Machining processes and hence explain the merchant's model for orthogonal cutting considering the shear angle should minimize the work done during cutting?	15
	b)	Draw a mind map diagram for the design of single point cutting tool used in Turning processes.	10
6.	a)	How the rational method can used to map on the cross's model for the design of a new tools?	13
	b)	Write down the design and operating guidelines of milling and explain briefly the constructional details with neat sketches of a plain milling cutter.	12

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(36)

B. Sc.(M) 6th sem/DTE(2nd sem) Date: 11 April, 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Final Semester Examination **Summer Semester : 2020 - 2021**
Course Code: MCE 4653 **Full Marks: 150**
Course Title: Air Conditioning **Time : 3 Hours**

There are **6 (six)** questions. Answer **all** questions. The symbols have their usual meanings. Assume any missing data.

---

1. **a.** The outdoor summer design condition for the north cafeteria of IUT for 200 persons at a place is 35°C dry bulb temperature, and 24°C wet bulb temperature. The required design condition is 24°C dry bulb temperature, and 50 % relative humidity. The room sensible heat is 60 kW and the room latent heat is 15 kW. The ventilation requirement per person is 0.27m^3/min. The bypass factor is 0.15. Determine: i) grand total heat, ii) effective sensible heat factor, iii) apparatus dew point, and iv) volume flow rate of dehumidified air. **15**

   b. Explain the central air conditioning system. Why is the cooling tower used in this system? **10**

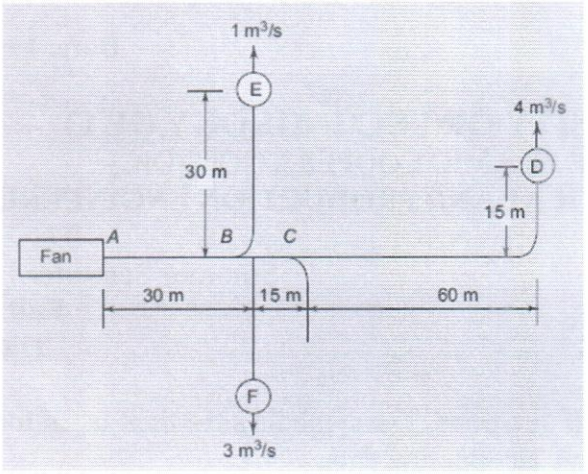
2. **a.** In a room, Dry bulb and wet bulb temperature is 30℃ and 25℃. Find out relative humidity and specific enthalpy using a psychrometric chart and by equation. Is there any difference between the values calculated from two methods? Give a proper explanation. **15**

   b. The air conditions at the intake of an air compressor are 28°C, 50% RH, and 101kPa. The air is compressed to 400 kPa, then sent to an intercooler. If condensation of water vapor from the compressed air is to be prevented, what is the minimum temperature to which the air can be cooled in the intercooler? **10**

3. **a.** What are the general rules of designing a duct? **10**

   b. What is hydraulic mean depth for a duct? Calculate the frictional pressure losses for straight duct if the air temperature is 33℃ manometer reading is 2.9 mm of water, velocity is 12.578 m/s and length is 200.5 in. assume friction factor 0.1. **15**

4 The Following figure shows a typical duct layout. Design the duct system using i) velocity method and ii) equal friction method. Take the velocity of the main duct as 7 m/s for both methods. Assume a dynamic loss coefficient of 0.5 for upstream to downstream and 0.9 For upstream to branch and for the elbow. The dynamic loss coefficient for the outlet may be taken as 1.0. Find the FTP required for each case and amount of damping required. Elaborate all calculations. **25**



5 a A fan draws in air freely and discharges through a test duct of cross section 0.07 m2 in which the static pressure is 20 percent of the dynamic pressure. If the total efficiency of the fan is 65 percent and the input power is 1 kW; find the quantity of air being delivered in m^3/min. **15**

b Classify radial flow fan in terms of blade types with proper diagram. Write down their advantages and disadvantages. **10**

6 An air conditioned room that stands on a well ventilated basement measures 3 m wide, 3 m high and 6 m deep. One of the two 3 m walls faces west and contains a double glazed glass window of size 1.5 m by 1.5 m, mounted flush with the wall with no external shading. There are no heat gains through the walls other than the one facing west. Calculate the sensible, latent and total heat gains on the room, room sensible heat factor from the following information. What is the required cooling capacity? **25**

Inside conditions : 25 °C dry bulb, 50 percent RH
Outside conditions : 43 °C dry bulb, 24 °C wet bulb
U-value for wall : 1.78 W/m^2 .K
U-value for roof : 1.316 W/m^2 .K
U-value for floor : 1.2 W/m^2 .K
Effective Temp. Difference (ETD) for wall: 25°C
Effective Temp. Difference (ETD) for roof: 30°C
U-value for glass ; 3.12 W/m^2 .K
Solar Heat Gain (SHG) of glass ; 300 W/m^2
Internal Shading Coefficient (SC) of glass: 0.86
Occupancy : 4 (90 W sensible heat/person) (40 W latent heat/person)
Lighting load : 33 W/m^2 of floor area
Appliance load : 600 W (Sensible) + 300 W(latent)
Infiltration : 0.5 Air Changes per Hour
Barometric pressure : 101 kPa

YORK®
A JOHNSON CONTROLS COMPANY

PSYCHROMETRIC CHART

Normal Temperature

SI Units

SEA LEVEL

BAROMETRIC PRESSURE: 101.325 kPa

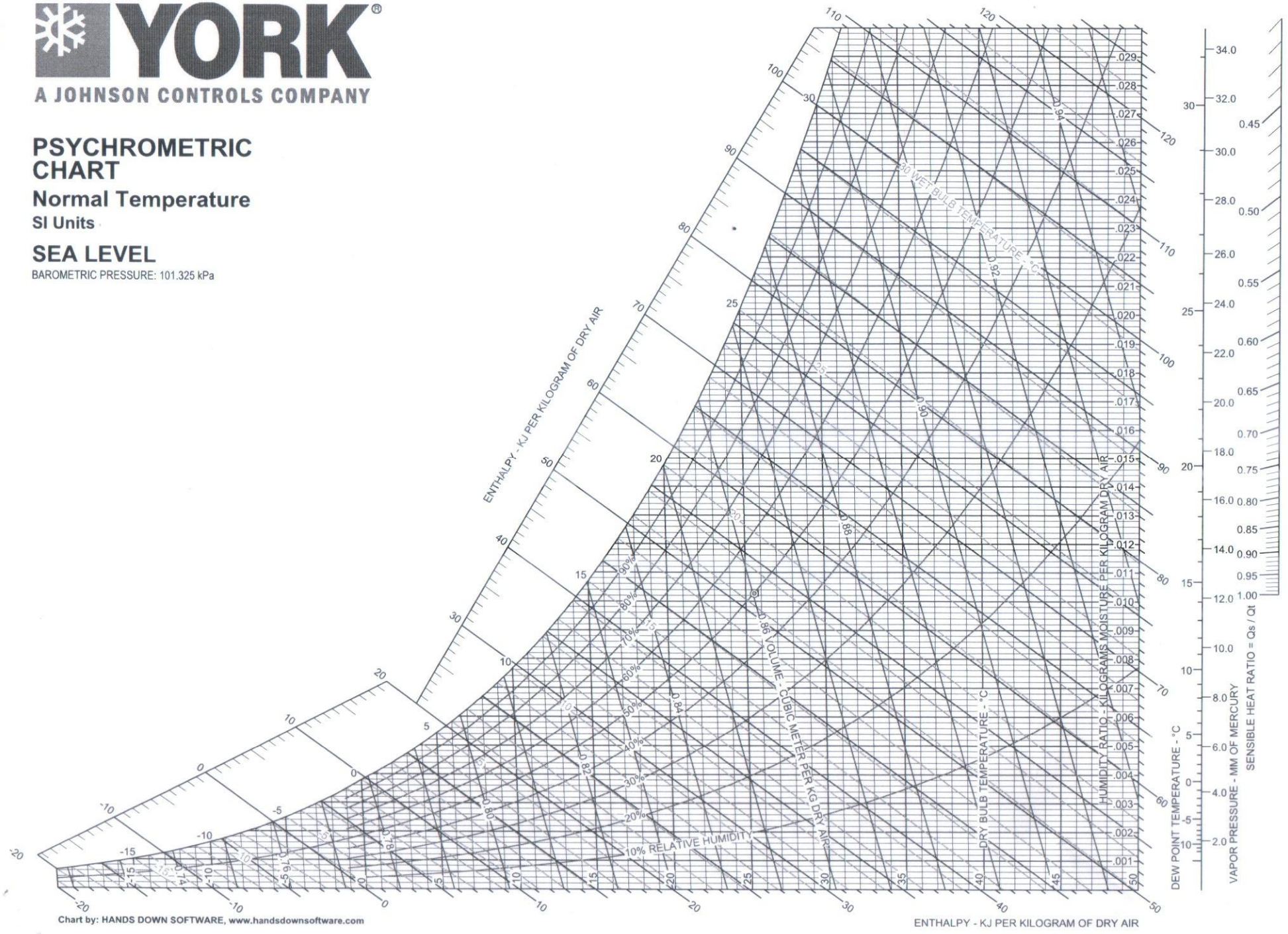


Chart by: HANDS DOWN SOFTWARE, www.handsdownsoftware.com

APPENDIX

Table A-1 Water: properties of liquid and saturated vapor

t, °C	Saturation pressure, kPa	Specific volume, m^3/kg		Enthalpy, kJ/kg		Entropy, kJ/kg · K	
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor
0	0.6108	0.0010002	206.3	-0.04	2501.6	-0.0002	9.1577
2	0.7055	0.0010001	179.9	8.39	2505.2	0.0306	9.1047
4	0.8129	0.0010000	157.3	16.80	2508.9	0.0611	9.0526
6	0.9345	0.0010000	137.8	25.21	2512.6	0.0913	9.0015
8	1.0720	0.0010001	121.0	33.60	2516.2	0.1213	8.9513
10	1.2270	0.0010003	106.4	41.99	2519.9	0.1510	8.9020
12	1.4014	0.0010004	93.84	50.38	2523.6	0.1805	8.8536
14	1.5973	0.0010007	82.90	58.75	2527.2	0.2098	8.8060
16	1.8168	0.0010010	73.38	67.13	2530.9	0.2388	8.7593
18	2.062	0.0010013	65.09	75.50	2534.5	0.2677	8.7135
20	2.337	0.0010017	57.84	83.86	2538.2	0.2963	8.6684
22	2.642	0.0010022	51.49	92.23	2541.8	0.3247	8.6241
24	2.982	0.0010026	45.93	100.59	2545.5	0.3530	8.5806
26	3.360	0.0010032	41.03	108.95	2549.1	0.3810	8.5379
28	3.778	0.0010037	36.73	117.31	2552.7	0.4088	8.4959
30	4.241	0.0010043	32.93	125.66	2556.4	0.4365	8.4546
32	4.753	0.0010049	29.57	134.02	2560.0	0.4640	8.4140
34	5.318	0.0010056	26.60	142.38	2563.6	0.4913	8.3740
36	5.940	0.0010063	23.97	150.74	2567.2	0.5184	8.3348
38	6.624	0.0010070	21.63	159.09	2570.8	0.5453	8.2962
40	7.375	0.0010078	19.55	167.45	2574.4	0.5721	8.2583
42	8.198	0.0010086	17.69	175.31	2577.9	0.5987	8.2209
44	9.100	0.0010094	16.04	184.17	2581.5	0.6252	8.1842
46	10.086	0.0010103	14.56	192.53	2585.1	0.6514	8.1481

Table A-1 (continued)

t, °C	Saturation pressure, kPa	Specific volume, m^3/kg		Enthalpy, kJ/kg		Entropy, kJ/kg · K	
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor
48	11.162	0.0010112	13.23	200.89	2588.6	0.6776	8.1125
50	12.335	0.0010121	12.05	209.26	2592.2	0.7035	8.0776
52	13.613	0.0010131	10.98	217.62	2595.7	0.7293	8.0432
54	15.002	0.0010140	10.02	225.98	2599.2	0.7550	8.0093
56	16.511	0.0010150	9.159	234.35	2602.7	0.7804	7.9759
58	18.147	0.0010161	8.381	242.72	2606.2	0.8058	7.9431
60	19.920	0.0010171	7.679	251.09	2609.7	0.8310	7.9108
62	21.84	0.0010182	7.044	259.46	2613.2	0.8560	7.8790
64	23.91	0.0010193	6.469	267.84	2616.6	0.8809	7.8477
66	26.15	0.0010205	5.948	276.21	2620.1	0.9057	7.8168
68	28.56	0.0010217	5.476	284.59	2623.5	0.9303	7.7864
70	31.16	0.0010228	5.046	292.97	2626.9	0.9548	7.7565
72	33.96	0.0010241	4.646	301.35	2630.3	0.9792	7.7270
74	36.96	0.0010253	4.300	309.74	2633.7	1.0034	7.6979
76	40.19	0.0010266	3.976	318.13	2637.1	1.0275	7.6693
78	43.65	0.0010279	3.680	326.52	2640.4	1.0514	7.6410
80	47.36	0.0010292	3.409	334.92	2643.8	1.0753	7.6132
82	51.33	0.0010305	3.162	343.31	2647.1	1.0990	7.5850
84	55.57	0.0010319	2.935	351.71	2650.4	1.1225	7.5588
86	60.11	0.0010333	2.727	360.12	2653.6	1.1460	7.5321
88	64.95	0.0010347	2.536	368.53	2656.9	1.1693	7.5058
90	70.11	0.0010361	2.361	376.94	2660.1	1.1925	7.4799
92	75.61	0.0010376	2.200	385.36	2663.4	1.2156	7.4543
94	81.46	0.0010391	2.052	393.78	2666.6	1.2386	7.4291
96	87.69	0.0010406	1.915	402.20	2669.7	1.2615	7.4042
98	94.30	0.0010421	1.789	410.63	2672.9	1.2842	7.3796
100	101.33	0.0010437	1.673	419.06	2676.0	1.3069	7.3554
102	108.78	0.0010453	1.566	427.50	2679.1	1.3294	7.3315
104	116.68	0.0010469	1.466	435.95	2682.2	1.3518	7.3078
106	125.04	0.0010485	1.374	444.40	2685.3	1.3742	7.2845
108	133.90	0.0010502	1.289	452.85	2688.3	1.3964	7.2615
110	143.26	0.0010519	1.210	461.32	2691.3	1.4185	7.2388
112	153.16	0.0010536	1.137	469.78	2694.3	1.4405	7.2164
114	163.62	0.0010553	1.069	478.26	2697.2	1.4624	7.1942
116	174.65	0.0010571	1.005	486.74	2700.2	1.4842	7.1723
118	186.28	0.0010588	0.9463	495.23	2703.1	1.5060	7.1507
120	198.54	0.0010606	0.8915	503.72	2706.0	1.5276	7.1293

Source: Abstracted by permission from Ref. 1.

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No. of Students about 50

B.Sc Engg.(M)(Prod.) 6th Sem. 11 April, 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)D
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Final Semester Examination — Summer Semester: A.Y. 2020-2021
Course No.: MCE 4663 — Time: 3 hour
Course Title: Automatic Control Engineering — Full Marks: 150

There are 5 (Five) Questions. Answer all of them.
Figures in the Margin indicate full marks. Don't write on this question paper. Symbols carry their usual meanings. Open Book. Assume reasonable values for any missing data. Programmable calculators are allowed.

1. A unity-feedback system has an open loop transfer function [30]

$$D(s) = \frac{K}{s(s+1)(s+5)}$$

Draw the root locus plot and determine the value of K that yields damping ratio of 0.3 for the dominant closed loop poles. A phase-lag compensator having a transfer function

$$D(s) = \frac{10s+1}{100s+1}$$

is now introduced in tandem. Find the new value of K that gives the same damping ratio of 0.3 for the dominant closed-loop poles. Compare the velocity error constant and settling time of the original and compensated system.

2. Consider the unity feedback-controlled system with open loop transfer function below. [30]

$$G(s) = \frac{K}{s(s+1)(s+5)}$$

Design a compensator D(s) to meet the following specifications:

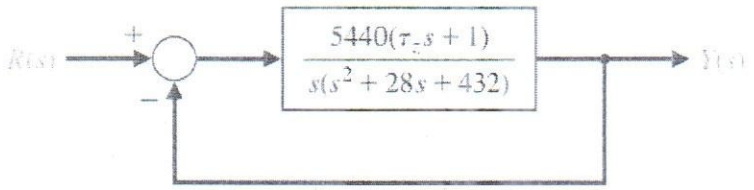
(i) Damping ratio, $\xi = 0.45$
(ii) Time constant, $\tau = 1/\xi\omega_n = 1/1.575$
(iii) Velocity error constant = 30 sec^{-1}

3. A unity feedback control system has an open loop transfer function: [30]

$$G(s) = \frac{K}{s(s+4)(s^2+8s+32)}$$

Make a rough sketch of the root locus plot of the system, explicitly identifying the centroid, asymptotes, the breakaway points, the departure angles from poles of G(s), and the $\pm j\omega$ cross-over points. Locate a point on the locus that gives dominant closed-loop poles with $\xi = 0.707$. Determine the value at this point. Locate the other two closed-loop poles and comment upon the dominant condition.

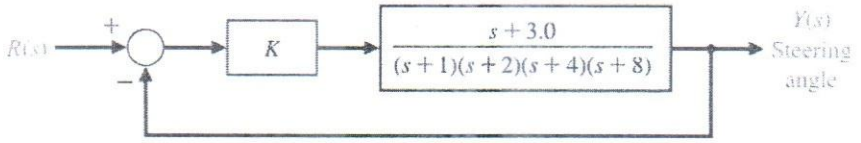
4. Block diagram of a control system is given below: [30]



(a) Determine the steady-state error for a unit step input.

(b) Assume that the complex poles dominate, and determine the percent overshoot(M_p) and settling time to within 2% of the final value.

5. A rover vehicle designed for use on other planets and moons. The block diagram of the steering control is shown in Figure below. [30]



(a) Sketch the root locus as K varies from 0 to 1000. Find the roots for K equal to 100, 300, and 600. Replacing values of given K find the roots of characteristics equations. From the location of dominant complex poles determine the values of damping ratio and undamped natural frequencies

(b) Predict the overshoot, settling time (with a 2% criterion), and steady-state error for a step input, assuming dominant roots.

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BSc Engg. (M) 6th Sem/DTE 2nd Sem | Date: 06 April 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Final-Semester Examination | Summer Semester, A. Y. 2020-2021

Course No. : ME 4671 | Time : 3 Hours

Course Title : Fossil Fuel Engineering | Marks : 150

There are **6 (Six)** questions. Answer all questions. All questions carry equal marks. Marks in the margin indicate full marks.

---

1. a) What are the major properties of fossil fuel? (05)

   b) How can the fossils fuel be utilized efficiently? Differentiate them with necessary diagrams. (10)

   c) How can oil shale, tar sands and heavy oils be formatted? Apply the required design methods with necessary schematic diagrams. (10)

   OR

   a) Define the cloud point and viscosity of petroleum with physical significance. (05)

   b) Illustrate the fossil fuels with classification. Differentiate them with their major advantages and disadvantages. (10)

   c) How can the coal, petroleum and natural gas be formatted? Apply the required design methods with necessary schematic diagrams. (10)

2. a) What are the onshore and offshore seismology used for the exploration of fossil fuels? (05)

   b) How can the fossil fuels be extracted? Differentiate them with necessary diagrams. (10)

   c) What are the procedures usually taken out to do the oil and gas well drilling? Apply the required design methods with necessary schematic diagrams in support of your answer. (10)

3. a) Illustrate the metering system of major fossil fuel with physical significance. (05)

   b) How can the major fossil fuels be stored and transported? Differentiate them with necessary schematic diagrams. (10)

   c) Describe the steps followed to do the processing of the major fossil fuels. Apply the required design methods with necessary schematic diagrams. (10)

(44)

4. a) What are the complete and incomplete combustions of fossil fuels? (05)

   b) How can the ideal and complete combustions of fossil gasoline fuel and fossil diesel fuel with air be differentiated? (10)

   c) Discuss the environmental effects of the fossil fuel combustion products such as CO_2, NOx, SOx, Particulate Matter and CO with physical significance. (10)

5. a) What are the arrangement of burners in the furnaces used for the fossil fuel combustion? (05)

   b) What are the functions of the chimney and stack? Illustrate the factors for correct amount of natural draft and differentiate it with the forced draft phenomenon. (10)

   c) You are asked to design a chimney that has flue gas flow rate of 75 m^3/s, cross-sectional area of 10 m^2, discharge coefficient of 0.65, gravitational acceleration of 9.807 m/s^2, absolute average temperature of the flue gas in the stack of 398K and absolute outside air temperature of 300K. Evaluate the height of the chimney. Use the following equation for the design. (10)

$$Q = CA\sqrt{2gH\frac{T_i - T_o}{T_i}}$$

6. a) Illustrate the terms with physical significance: Drilling mud and Blowout Preventer. (05)

   b) What is NFPA Standard 86? Differentiate the major parameters covered for the safe operation of furnace in the case of the fossil fuel combustion. (10)

   c) How can the insulation materials be classified in the fossil fuel combustion? Write down the characteristics of the insulation materials from the practical point of view. (10)

(45)

B.Sc.Engg. (M)/8th Sem. 28 March 2022 (Group A)
BScTE 1-Yr/2-Yr

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Fianl Examination — Summer Semester, A.Y. 2020-2021
Course No. MCE 4805/4893 — TIME : 3 Hour
Course Title: Power Plant Engineering — Full Marks : 150

Answer all the questions.

1. (a) Draw a schematic diagram and the corresponding T-s diagram of a *Kalina cycle* and briefly discuss the working principle. 10

   (b) Discuss *Drop* and *Circulation ratio* for circulation *drum-type* subcritical boilers with an appropriate diagram. 8

   (c) Draw an elementary *steam boiler unit* illustrating all the auxiliary components along with flue gas path through the stack. 7

2. (a) With the help of a figure, discuss the *forced convection boiling* in a *once-through boiler*. How do you calculate the *heat transfer* during this process? 10

   (b) What is the principle of operation of a *supercritical boiler*? Draw the *steam-water circuit* of a supercritical boiler. 8

   (c) Briefly discuss the function of *steaming economizer*. From commercial point of view, why *steaming* of feedwater is prohibited in the economizer? 7

3. (a) With a neat sketch, show a *direct firing* system for pulverized coal fired boiler and discuss its working mechanism. 13

   (b) With the help of a neat sketch, describe the working principle of a typical *PFBC boiler*. 12

4. (a) Discuss the change in pressure and velocity in *impulse turbines and reaction steam* turbines. 10

   (b) With the help of a flow diagrams, briefly describe the working principle of *dual pressure HRSG*. 8

(c) Write a short note on *Cheng cycle* with a neat sketch. 7

5. (a) With neat diagrams, discuss the different types of hydroelectric power plants. 13

(b) With the help of a schematic diagram, discuss *Pressurized Heavy Water Reactor (PHWR).* 12

6. (a) What is *Load Duration Curve* used in power plant economics and its application in *Industrial load* and *Residential Load*? Write down the importance of *load duration curve.* 10

(b) Write short notes on (i) Demand Factor, (ii) Load factor, (iii) Diversity factor, (iv) Plant capacity factor, (v) Plant capacity factor 10

(c) Briefly discuss the different types of *loads* used in in *power plant economics.* 5

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No. of students 90

B.Sc Engg.(M) 8th Sem./
BSc. TE (2year Prog.)4th Sem./
BSc. TE (1year Prog.)1st Sem

06 April, 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester: A.Y. 2020-2021
Course No.: MCE 4807 — Time: 3 hours
Course Title: Mechatronics — Full Marks: 150

There are 6 (six) Questions. Answer all of them.

Marks in the Margin indicate full marks. Don't write on this question paper. Symbols carry their usual meanings. Assume reasonable values for any missing data. Programmable calculators are allowed.

1. An 8085 microprocessor based system is designed to monitor and control the temperature of a water bath, by controlling a heater ON/OFF. The temperature range is from 20^0C to 100^0C. There is a provision to set desired temperature by microswitching and display temperature using LED display. Sketch the architecture of the system showing all the required elements and their inter connections. [25]

2. Sketch the pin diagrams of microprocessor 8085 and programmable peripheral interface 8255PPI [30]

3. A mechatronics system has to be installed for controlling a production process having six variable parameters using microprocessor 8085. An 8 channel ADC will be used for input the values from the sensors through a programmable peripheral interface 8255PPI. Draw the interface connections between microprocessor 8085 with ADC 0808 through 8255PPI. [25]

4. Draw the interface diagram of a 2k×8bit PROM and a 4k×8bit RAM with microprocessor 8085. Initial address of the PROM is 2000H. [25]

5. Two hydraulic pumps are connected among themselves. The flows of the pumps are measured by two separate flow sensors and the values are stored as 8bit data in the memory location of 3000H and 3001H. Another system which is also connected with the same microprocessor will use the data of total flow taking the data from the location 3002H and 3003H. Write a microprocessor 8085 assembly language program of addition of two 8bit numbers stored in the memory location 3000H and 3001H. Store the result in memory location 3002H and 3003H. Compare the program with the program of addition using memory pointer. [20]

6. Write a microprocessor 8085 assembly language program for division of two 8bit numbers. Dividend and divisor are stored in memory location 2000H and 2001H respectively. Store the quotient and reminder in the memory location 2002H and 2003H respectively. [25]

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BSc. Engg. (M) 8th Sem **11 April 2022**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

SEMESTER FINAL EXAMINATION — SUMMER SEMESTER: 2020-21

Course No: MCE 4811 — TIME : 3 HRS

Course Name: Fluid Mechanics II — FULL MARKS: 150

There are **Six** Questions. Answer all of them. However, you can choose options in Question no 1 and Question no 5 . Assume reasonable value for missing data. Figures in the margin indicate full marks.

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1. For the following velocity distribution in the boundary layer find the displacement thickness, momentum thickness and energy thickness. (25)

$$\frac{u}{U_0} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$

Notation's have their usual meaning.

OR The velocity distribution in the boundary layer is given by $\frac{u}{U} = \frac{y}{\delta}$, where u is the velocity at y from the plate and u=U at , y = δ ,δ being boundary layer thickness. (25)

Find

i. The displacement thickness ,
ii. The momentum thickness ,
iii. The energy thickness and
iv. The value of $\frac{\delta^*}{\theta}$.

2. (a) Derive an expression for Power and Torque for Collar bearing with necessary assumptions and sketch. (10)

(b) In a Journal bearing of diameter 60.16 mm and length 100 mm, a shaft of diameter 60 mm rotates concentrically at a speed of 700 rpm. The annular space between the shaft and the bearing is filled with an oil having viscosity 0.01 Ns/m^2. (15)

Find the torque and Power required to rotate the shaft. If the working fluid is 10% lighter than the above, find the torque and power.

3. Consider a cylindrical pipe of uniform cross-section so that the geometry of the pipe is completely defined by the inner diameter (D) of the pipe and its axial length (L). Let the fluid motion be steady and consider the inertia and viscosity as represented by the fluid density(ρ) and dynamic viscosity (μ). In addition, the experimental measurement show that it depends of the gravity (g) and the composition of the inner surface affects the flow, particularly the pressure drop along the axis of the pipe. Let the composition of the inner surface be denoted by an absolute roughness (ε), lastly, the average fluid velocity, V_{avg} over the pipe cross-section can vary in the experiment. (25)

Using the Buckingham π-theorem, find the number of π parameters for above experiment.

4. Atmospheric air flows through the converging diverging nozzle into a vacuum tank. The pressure inside the tank is reduced to a magnitude to create a flow with an exit Mach number of 2.0 (refer to the Fig. 1). The tank is evacuated by closing the control valve until it satisfies the given condition. When the valve is opened, atmospheric air will start to flow through the converging-diverging nozzle into the tank. (25)

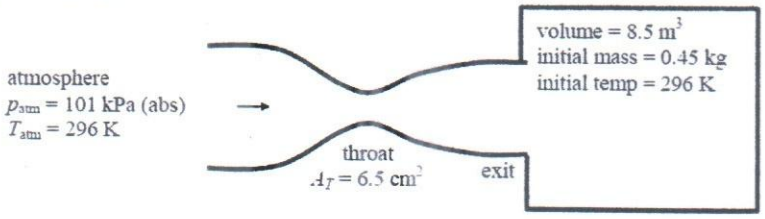

Figure 1

i. Calculate the design exit area.

ii. Determine the initial mass flow rate through the nozzle.
iii. Determine the tank pressure at which a normal shock wave will stand in the nozzle exit plane.
iv. Determine the exit Mach number when the shock is in the nozzle at a point where the cross-sectional area is 15% greater than the throat area.
v. Determine the time until the flow in the nozzle becomes entirely subsonic.

5. (a) Find expression for the area-velocity relationship of a supersonic flow through a duct with appropriate diagrams. (10)

OR Find expression for Stagnation Temperature in terms of Mach number for a compressible flow. List all assumptions.

(b) The Jet engine is tested on the ground at standard atmospheric pressure of 101.3 kPa (refer to the Fig. 2). If the fuel air mixture enters the inlet of the 300 mm diameter nozzle at 250 m/s with an absolute pressure of 300 kPa and temperature of 800 K, determine the required diameter of the throat D_T, and the exit diameter D_E, so that the flow exits with isentropic supersonic flow. Evaluate the exit condition of the same engine while operating at an altitude of 9000 m from the ground. Make reasonable assumptions, if any. (15)

OR Describe the governing equation for flow through parallel plates separated by a distance h. The bottom plate is fixed, and the upper plate is moving at U velocity. Find also the expression of the governing equation in non-dimensional form. (15)

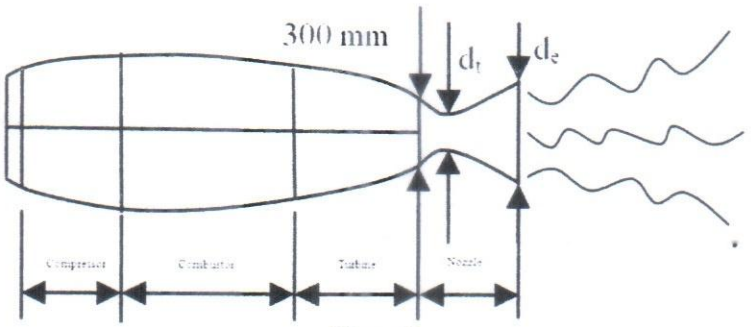

Figure 2

6. A ship is 300 m long moves in sea water, whose density is 1030 kg/m^3. A 1:100 model of this to be tested in a wind tunnel. The velocity of air in the wind tunnel around the model is 30 m/s and the resistance of the model is 60 N. Determine the velocity of ship in sea water and also the resistance of the ship in sea water. The density of air is given as 1.24 kg/m^3. Take the Kinematic viscosity of sea water and air as 0.012 stokes and 0.018 stokes, respectively. (25)

(50)

B.Sc. Eng. (ME)/8th Sem Jummat/Friday, 1 April 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester: A.Y.2020-2021
Course No.: MCE 4821 — Time: 3 hours
Course Title: Materials Handling — Full Marks: 150

There are **6 (Six)** Questions. Answer all of them.
Marks in the Margin indicate full marks. Do not write on this question paper.

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1 Describe any **five** of the following topics adequately (meaning, scope, and applications): 20

i. Take-ups for conveyors
ii. Flexible belt construction
iii. Applications of belt and apron conveyors
iv. Pros and cons of screw conveyors
v. Package testing
vi. Centrifugal and gravity discharging
vii. Components of AS/RS

2 a. For a belt supported by troughing idlers [Figure Q2a] derive the expression for determining the width of the belt (B) in terms of capacity of the conveyor (Q), belt speed (v), bulk weight (γ) and angle of repose (ϕ). Assume that slope of the conveyor is within 10 degrees. Now, if capacity of the conveyor Q = 20 tons/hr, belt speed v = 0.5 m/sec, bulk weight γ = 1 ton/m^3 and angle of repose ϕ = 50°, compute the value of belt width, B. 10

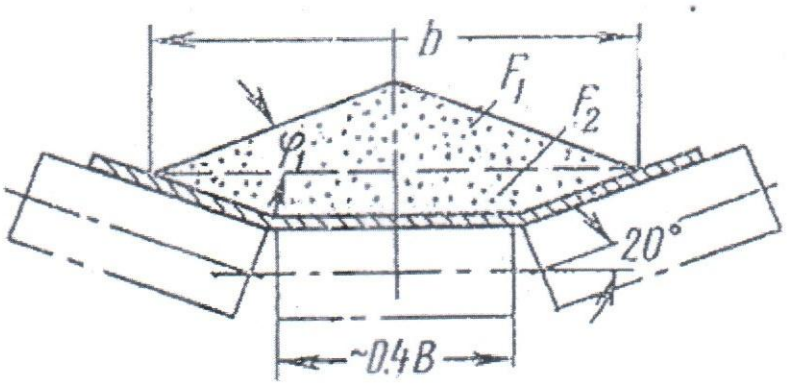

Figure for Q2a.

b. For a bucket elevator, derive the equation for relationship between rotational speed of the discharge bucket and polar distance. Provide the necessary sketches. Also explain how the position of its polar distance influence discharging. 10

3 a. Discuss different types of apron conveyor geometries. For the apron conveyor shown in 10

Figure Q3a, tensions at points 1 to 12 are 914 kg, 1122 kg, 1169 kg, 193 kg, 200 kg, 616 kg, 666 kg, 1602 kg, 1667 kg, 6670 kg, 6940 kg, and 7408 kg respectively. Draw the chain's tension diagram.

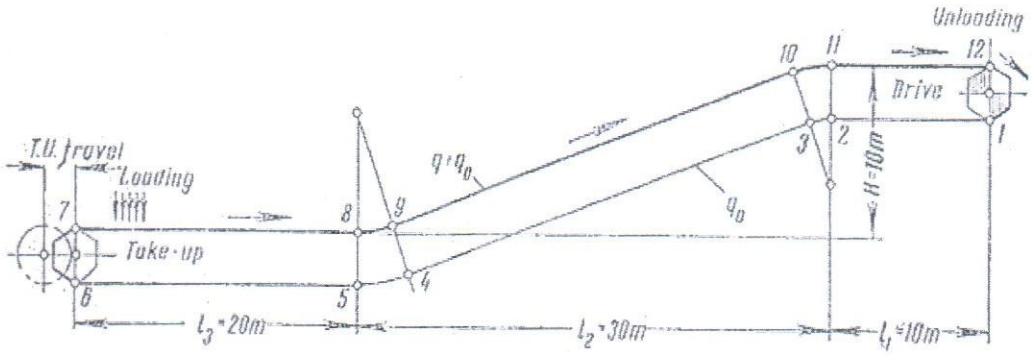

Figure for Q3a.

b. If resistance on the driving sprocket shown in Figure Q3a is 3% of the summary tensions of tight and slack sides, calculate its actual value and finally determine the pull by driving sprocket. Use tension data provided in Question 3a. 10

4 a. Compare and contrast powered and unpowered roller conveyors. Derive the equation for the power required to move the load on a horizontal unpowered roller conveyor and resistance to motion factor of the load. 12

b. In a factory, materials in boxes of 40 cm x 40 cm x 40 cm will be conveyed by a roller conveyor and you are asked to employ the right type of rollers. Select the appropriate type of rollers for this purpose? Justify your answer. What should be your recommended length for the rollers and the distance between two adjacent roller axles? Explain in short. 8

5 a. In a food industry, materials will be conveyed over few meters by a screw conveyor. The conveyor must have the capabilities of blending, churning and homogenous mixing of several grades of material. Recommend screws for this conveyor with necessary drawing. 5

b. Each aisle of a four-aisle AS/RS is to contain 60 storage compartments in the length direction and 12 compartments vertically. All storage compartments will be the same size to accommodate standard size pallets of dimensions: x = 42 in. and y = 48 in. The height of a unit load z = 36 in. Using the allowances, a = 6 in, b = 8 in, and c = 10 in, determine: 6

(i) how many unit loads can be stored in the AS/RS, and
(ii) the width, length, and height of the AS/RS.

c. Consider the AS/RS from question 5b, in which an S/R machine is used for each aisle. The length of the storage aisle = 280 ft and its height = 46 ft. Suppose the horizontal and vertical speeds of the S/R machine are 200 ft/min and 75 ft/min, respectively. The S/R machine requires 20 sec to accomplish a P&D operation. Find: 9

(i) the single command and dual command cycle times per aisle. and
(ii) throughput per aisle under the assumptions that storage system utilization = 90% and the number of single command and dual command cycles are equal.

(52)

6 In an amazon warehouse, a belt conveyor is intended to move 1600 cartons per hour with 25% irregularity between two workstations 60 meters apart as shown in Figure Q6. Each unit load weighs 10 kg and has a dimension (length, width, and height) of 220 mm x 180 mm x 200 mm. The belt will be supported by idlers with spacing of 1.4 m and 2.8 m on the loaded and unloaded strands respectively. To avoid sagging loaded side is also supported by a sheet steel runway having friction factor of 0.4. Assume 50% of the belt and load weight is carried on the idlers and 50% on the runway. 50

(i) What should be your recommended belt speed for this case? Show that your recommended speed support required capacity of the conveyor?

(ii) How much clearances will you prefer on both sides of the loads on the conveyor belt? What will be your recommended belt width?

(iii) What are the loads per running meter for the actual load, belt, rotating parts on the loaded and idle strands? Assume number of plies of the belt i, δ, δ_1 and δ_2 are 4, 1.25 mm, 3 mm and 1.5 mm respectively.

(iv) If average resistance to motion factor, w' = 0.022, resistance on the pulley K' = 1.07 times the tension of tight side, angle of wrap $\alpha = 210^{\circ}$, driving pulley friction factor μ = 0.20, what will be the tensions at different points (at least 4 important points) on the belt to run properly. Show the tensions using a diagram.

(v) If effort of the take-up pulley traveling on slides is 15 kg, what will be the weight of the take-up?

(vi) If resistance on the driving pulley is 3% of the summary tensions of tight and slack sides, calculates its actual value and finally determine the pull by driving pulley.

(vii) What should be the required motor power in kW? Assume reasonable values for efficiency of spur gears, bearings and couplings normally used with driving pulley.

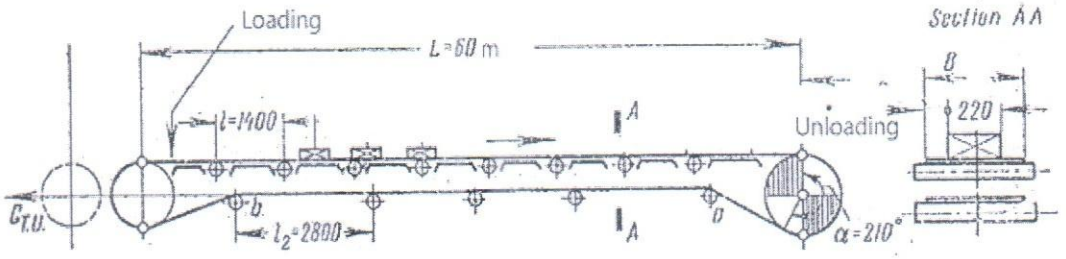

Figure for Q6

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M.Sc.Engg/ (MSc.TE)
PhD

29 March 2022 (Group B)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination
Course No. MCE 6153
Course Title: Boiling and Condensation Heat Transfer

Summer Semester, A.Y. 2020-2021
TIME : 3 hours
Full Marks : 150

Answer all the questions.

1	(a) Briefly describe the Hydrodynamic Theory of Boiling and Critical Heat Flux for *a horizontal flat surface.*	10
	(b) Briefly describe the various *regimes* of *Nucleate boiling* observed during pool boiling in *Binary liquid mixtures.*	8
	(c) Elaborate the terms: *Minimum film boiling* and *Transition boiling.*	7
2	(a) With a diagram, demonstrate *Flow patterns* and *temperature variation* in subcooled flow boiling. Draw the *boiling curve* at the vicinity of the subcooled boiling region.	10
	(b) Elucidate the effects of *local quality* and *mass flux* on the flow boiling curve for a *vertical pipe.*	8
	(c) What are the *Characteristics* of *Saturated Flow Boiling?*	7
3	(a) Describe the *Critical Heat Flux* mechanism in forced flow boiling. Describe the three different phenomenological arguments to model the *Critical Heat Flux* mechanism.	13
	(b) Explain the effect of *mass flux* and *exit quality* on critical heat flux in a uniformly heated *round tube.*	12
4	(a) Describe *Nusselt's analysis* of *Laminar condensation* on an *isothermal flat vertical surface.*	10
	(b) Describe the phenomenon of *Laminar condensation* on *Horizontal tubes.*	8
	(c) Explain the effect of the *Presence of a Noncondensable* during the condensation process.	7
5	(a) Describe the *Heterogeneous Bubble Nucleation and Active Nucleation Sites* observed in Pool boiling.	10
	(b) Describe the phenomenon of *transition* from *partial boiling* to fully developed *subcooled boiling.*	8
	(c) Write short notes on *Hydrodynamics of Subcooled Flow Boiling.*	7
6	(a) Explain the effect of *Diameter* on critical heat flux in forced flow boiling for small channels.	10
	(b) Briefly discuss the various flow regimes of *Post-Critical Heat Flux Heat Transfer*	8
	(c) Elucidate *Film, Dropwise,* and *Direct contact Condensation Process.*	7