

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 3rd Year 2nd Term Examination, 2022

ME 3205

(Heat Transfer II)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

ii) Figures in the right margin indicate full marks.

iii) Assume reasonable data if missing any.

SECTION-A

- 1(a) Derive the expression of thermal boundary layer thickness when a fluid is flowing over a heated flat plate. 18
- 1(b) Water at 30°C and 1 atmosphere flows over a flat plate at a velocity of 2.80 m/sec. Consider that the plate is heated over its entire length to a temperature of 70°C. Calculate the heat transferred in the first 40 cm of the plate. 17
- 2(a) Derive an expression that relates the fluid friction with heat transfer for laminar flow over a flat plate. 18
- 2(b) Consider a rectangular plate of 60×50 cm with one surface insulated and other surface maintained at uniform temperature of 88°C, which is placed in a quiescent air at atmospheric pressure and at 22°C. Calculate the average heat transfer coefficient, if the plate is inclined at 69° and the hot surface faces upward. 17
- 3(a) Show that $\dot{Q} = hA\Delta T_{LMTD}$ in case of internal flow with constant surface temperature. 13
- 3(b) Determine temperature profile along the radial direction in case of fully developed internal pipe flow with constant surface heat flux. Start from governing equation. 10
- 3(c) Hot air at 60°C leaving the furnace of a house enters a 12 m long section of a sheet metal duct of cross section 20 cm × 20 cm at an average velocity of 4 m/s. The thermal resistance of the duct is negligible. The outer surface is exposed to the cold air at 10°C in the basement, with convective heat transfer coefficient of 10 W/m²K. Determine (i) the temperature at which the hot air will leave from the duct and (ii) the rate of heat loss from the hot air in the duct to the basement. Evaluate air properties at a bulk mean temperature of 50°C. Is this a good assumption? 12
- 4(a) Simplify Navier-Stokes equation of natural convection flow in boundary layer flow. 10
- 4(b) Why natural convection heat transfer is higher from upper surface rather than lower surface when an inclined hot plate placed in cooled air. 05
- 4(c) A 12 cm wide and 18 cm high vertical hot surface in 30°C air is to be cooled by a heat sink with equally spaced fins of rectangular profile. The fins are 0.1 cm thick and 18 cm long in the vertical direction and have a height of 2.4 cm from the base. Determine the optimum fin spacing and the rate of heat transfer by natural convection from the heat sink if the base temperature is 80°C. 08
- 4(d) The vertical 0.8 m high, 2 m wide double-pane window consists of two sheets of glass separated by a 2 cm air gap at atmospheric pressure. If the glass surface temperatures across the air gap are measured to be 12 °C and 2 °C, determine the rate of heat transfer through the window. 12

SECTION-B

- 5(a) Write the advantage of drop-wise condensation. 05
- 5(b) Drive the expression of mean heat transfer rate for laminar flow of condensation over a vertical plate. 15
- 5(c) A vertical rectangular plate 60×50 cm is exposed to steam at atmospheric pressure. The plate is at 370K. Calculate the heat transfer and the mass of steam condensed per hour. 15
- 6(a) What is meant by bubble dynamics? Describe the growth of bubble when water is converted to steam. 12
- 6(b) What are heat transfer models associated with film boiling? Explain. 06
- 6(c) Saturated water at 100°C is boiled with a heating element whose heating surface area is 0.009 m². The surface maintained at a uniform temperature of 114°C. Calculate the surface heat flux and the rate of evaporation. Assume $n=1$, $C_{sf} = 0.013$ and $\delta^* = 67.8 \times 10^{-3}$ N/m. 17
- 7(a) Define effectiveness of heat exchanger. Derive an expression of effectiveness of counter flow heat exchanger. 18
- 7(b) A counter flow heat exchanger of heat transfer area 13 m² is to cool oil ($C_p=2000$ J/kg.sec) with water. The oil enters at 106°C with mass flow rate of 2.0 kg/sec, while the water enters at 22°C with a mass flow rate of 0.65 kg/sec. The overall heat transfer coefficient is $U = 400$ W/m²°C. Calculate the exit temperature of water and the total heat transfer rate. 17
- 8(a) What is meant by mass transfer? Derive an expression for one dimensional unsteady state diffusion of liquid for constant mass diffusivity in rectangular coordinate. 18
- 8(b) Determine the diffusion rate of water from the bottom of a flask of 5.5 cm in diameter and 30 cm high into dry atmospheric air at 34°C. Assume diffusion coefficient for water is $D = 0.256$ cm²/sec. 17

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 3rd Year 2nd Term Examination, 2022

ME 3225

(Measurement and Industrial Instrumentation)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

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iii) Assume reasonable data if missing any.

SECTION-A

- 1(a) Draw a characteristics graph of a sensor and explain the parameters: 10
(i) Sensitivity (ii) Resolution (iii) Range (iv) Accuracy and (v) Precision.
- 1(b) What are the different types of measurement errors? Show that the error for alignment 15
of spherical end gauges is $-\frac{h^2}{2(R_1+R_2)}$, where the symbols have their usual meanings.
- 1(c) What are the line and end standard? State the functions of Sine bar and mention the 10
factors affecting the accuracy of a sine bar.
- 2(a) What is meant by pitch and lead of a screw thread? Describe different types of pitch 12
error.
- 2(b) Define a Sine bar. State its functions. On what factors the accuracy of sine bar depends? 10
- 2(c) What are the important points to be remembered during gauges design? Discuss. 06
- 2(d) What is best size wire? How is it obtained? 07
- 3(a) Mention the differences between measuring instrument and gauge. Describe different 10
types of gauge with example.
- 3(b) What is meant by comparator? Mention its application. Describe the merits and 09
demerits of mechanical comparator.
- 3(c) Mention the different methods of measuring tooth thickness of a gear and describe any 10
one of them.
- 3(d) Calculate the chord length and its distance below the tooth tip for a gear module 4.00 06
and 20-degree pressure angle.
- 4(a) Describe the steps of industrial revolution from 1IR to 4IR. 10
- 4(b) "Industrial automation is the basic of 4IR and industrial metrology is the first building 15
block of industrial automation". Justify this statement with necessary examples.
- 4(c) Differentiate sensors and transducers. Classify active and passive sensors. 10

SECTION-B

- 5(a) What are the displacement measurement sensors those can be used for mobile robot? Describe the working principle of a contactless displacement sensor used for long range. 13
- 5(b) How to measure the angular displacement of a rotating shaft with rotating direction? 10
- 5(c) How the velocity of a flying aeroplane can be measured? Explain with necessary sketch. 12
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- 6(a) Explain the working principle of a non-contact temperature measurement sensor. 09
- 6(b) How hair hygrometer works to measure the relative humidity of air? 08
- 6(c) How thermocouple wires measure the temperature of an object. Explain with neat sketch. 10
- 6(d) What are the different humidity sensors? How capacitive humidity sensor works? 08
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- 7(a) What are the force measurement techniques widely used in industrial application? Explain the working principle of a strain gauge load cell. 12
- 7(b) Torque can be measured by eddy current. Explain the working principle of it. 10
- 7(c) Zero-compliance method is a new dimension of measuring micro-newton level forces. Explain the principle of zero-compliance force measurement method. 13
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- 8(a) Describe the procedure for measuring flow rate of fluid through a pipe by venturi meter and write down all necessary calculations. 13
- 8(b) How bourdon pressure gauge measures the pressure of fluid? Describe its construction and working principle. 12
- 8(c) What are the commonly used viscometers? Explain the working principle of falling sphere viscometer. 10

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 3rd Year 2nd Term Examination, 2022

ME 3223

(Power Plant Engineering)

Time: 3 Hours

Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.

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iii) Assume reasonable data if missing any.

SECTION-A

- 1(a) What is meant by load curve? Prove that an increase in diversity of load improves the load factor of the power system? 08
- 1(b) What factors should be considered while selecting the capacity of a power plant? 07
- 1(c) Explain the present power generation situation of Bangladesh with latest information. Also discuss the power consumption pattern of various sectors. 12
- 1(d) A power station supplies the following loads to various consumers: Industrial consumers = 2000 kW; commercial consumers = 500 kW and domestic consumers = 1200 kW. If the maximum demand on the steam is 2300 kW and the annual electricity generation is 75×10^5 kWh, calculate diversity factor and load factor. 08
- 2(a) Distinguish between base load and peak load power plant. 06
- 2(b) List the various fixed costs and operating costs of a power plant. 12
- 2(c) What is meant by depreciation? What factors influence the depreciation of a power plant? 08
- 2(d) What are the objectives of meter rate? Write a short note on the meter rate of Bangladesh. 09
- 3(a) What are the importance of thermal power plant? Draw a general layout of a coal-based steam power plant. 08
- 3(b) Describe any process of separating dust from exhaust gas of a power plant. 10
- 3(c) What are the advantages and disadvantages of using pulverized coal in furnace? 09
- 3(d) Explain the 'Over-feed' and 'Under-feed' principle of firing with necessary sketch. 08
- 4(a) Explain fields of use of diesel engine power plant. 07
- 4(b) Describe the auxiliary equipment of diesel engine power plant. 06
- 4(c) Discuss the various problems that may be caused by the impurities present in the feed water. Explain the working principle of zeolite process for the softening of feed water. 12
- 4(d) Describe the various methods used for starting diesel engine. State the correct sequence of the steps for starting and stopping procedure. 10

SECTION-B

- 5(a) Explain the following terms related with the hydro-electric power plant. 10
(i) Catchment area (ii) Surge tank and (iii) Penstock and draft tube
- 5(b) What factors should be considered while selecting turbine for a hydro-electric power plant. 07
- 5(c) Write a short note on pump storage hydro-electric power plant. 06
- 5(d) Annual rainfall in a location is 1600 mm. Survey report says that the total catchment area can be 120 km² and the effective head expected to be 28 m. Load factor forecasted to be 40%. Runoff and evaporation loss is allowed by a yield factor of 50%. The plant to be installed has design efficiency at 28 m head of 80%. Determine- (i) the average power that can be produced and (ii) plant capacity that can be installed. 12
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- 6(a) What are the advantages and disadvantages of nuclear power plant? 08
- 6(b) Explain the following terms related with nuclear power plant: 06
(i) Moderator (ii) Control rod and (iii) Reflector.
- 6(c) Explain the working principle of sodium Graphite reactor. What are its advantages. 11
- 6(d) How waste is disposed off in a nuclear power station? What are the main difficulties in handling radioactive waste? 10
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- 7(a) What are the functions of cooling tower in a power plant? Explain the operation of a cooling pond of a power plant. 08
- 7(b) What are the purposes of chimney? Discuss the various pollutants from steam power plant. 06
- 7(c) What is combined cycle power plant? What are its advantages. 10
- 7(d) A boiler is equipment with a chimney of 32m height. The flue gases which pass through the chimney are at temperature of 290°C, whereas the atmospheric temperature is 22°C. If the air flow through the combustion chamber is 18 kg/kg of fuel burnt, find: 11
(i) The theoretical draught produced in mm of water and in height of hot gases column, and
(ii) Velocity of flue gases passing through the chimney, if 50% of theoretical draught is lost in friction at the grate and passage.
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- 8(a) Write the functions of following electrical equipment in power plant: 09
(i) Switch-gear (ii) Relay and (iii) Reactor.
- 8(b) What is dry cooling tower? Explain its working principle. 10
- 8(c) What are the types of stokers? Explain the spreader grate stoker with neat sketch. 09
- 8(d) What is meant by furnace? Mention the conditions of furnace to burn the fuels completely. 07

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