Khulna University of Engineering & Technology

Department of Mechanical Engineering

B. Sc. Engineering Backlog Examination, 2018

ME 3105

(Heat Transfer I)

Time: 3 hours Total Marks: 210

N. B.: 1) Answer any THREE questions from each section in separate scripts.

2) Figures in the right margin indicate full marks.

3) Assume reasonable data if any missing

SECTION-A

1(a) Derive expressions for one dimensional radial, steady state temperature distribution and heat flux in a solid cylinder of radius r in which energy is generated at a constant rate of q_0 w/m^3 while the boundary surface is maintained at a constant temperature T_s. 18

1(b) A rectangular wall of size 3.0 m × 2.5 m is made of common brick with thickness 0.3 m, followed by 0.15 m layer of cement mortar. Both sides of the wall are exposed to air having inner and outer surface convective heat transfer coefficient of h_i = 20 W/m^{2}K and h_0 = 18 W/m^{2}K respectively. Calculate the heat transfer from the wall. Consider K_{brick} = 0.80 W/mK and $K_{cement\ mortar}$ = 0.30 W/mK. 17

2(a) Develop an expression of radial heat flow and one-dimensional steady state temperature distribution of a hollow sphere having inner and outer radii r_i and r_o respectively. The thermal conductivity of the material of sphere is considered to be constant. 18

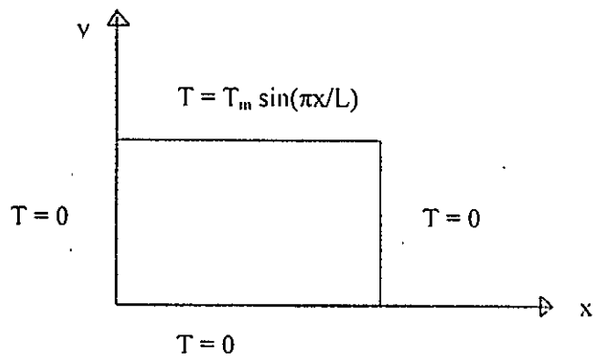
2(b) A brass plate (K = 115 W/mK) of thickness 6 cm is subjected to a constant uniform heat flux 10 kW/m^2 at the boundary surface at x = 0. Heat is dissipated by convection from the other boundary surface into a fluid at a temperature of 90°C with a convective heat transfer coefficient of 400 W/m^{2}K. Calculate the surface temperatures of the slab. 17

3(a) Justify the use of fins. 05

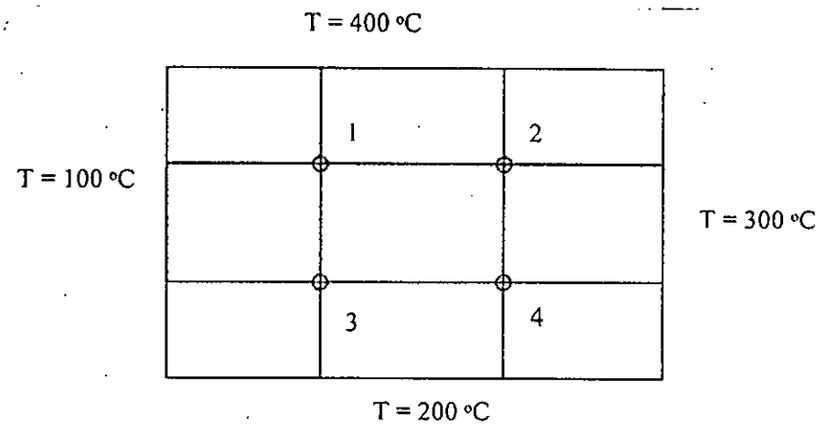
3(b) Derive an expression for heat flow rate through a fin of uniform cross-section when the temperature at the fine tip approaches the surrounding fluid temperature. 15

3(c) Circular disk fins of constant thickness are attached on a 2.5 cm OD tube with a spacing of 100 fins per 1m length of tube. Fins are made of aluminum, K = 160 W/m.°C, thickness t =1 mm, and length L = 1 cm. The tube wall is maintained at T_0= 170 °C, and heat is dissipated by convection into the ambient air at T_∞ = 30 °C with a heat transfer coefficient h = 200 W/m.°C. The radiation effects are considered negligible. Calculate (i) the heat loss to the ambient air per 1m length of the tube: (ii) compare this heat loss with that if there were no fins on the tube. 15

4(a) Derive an expression of temperature distribution T(x,y) for a rectangular plate for the boundary condition as shown. 15



4(b) Calculate the temperatures at point 1, 2, 3 and 4 using the finite difference technique. 20



SECTION-B

5(a) Discuss the assumptions considered in lumped heat capacity analysis. Derive an expression using lumped-heat capacity method for temperature distribution in unsteady heat transfer in terms of Biot number and Fourier number. 20

5(b) A short, iron cylinder [K= 60 W/m.°C, $\alpha = 1.6 \times 10^{-5}$ m^2/s] of diameter 5 cm and height 4 cm is initially at a uniform temperature of 225 °C. Suddenly the boundary surfaces are exposed to an ambient at 25 °C with a heat transfer coefficient of 500 $W/m^2.°C$. Calculate the center temperature at time 2 min after the start of cooling. 15

6(a) What is thermal radiation? Explain the typical spectrum of electromagnetic radiation. 08

6(b) Define the following terms: 10

(i) Emissivity, (ii) Gray body, (iii) Diffuse solar radiation and (iv) Absorptivity.

6(c) Consider an enclosure consisting of two parallel infinite opaque plates. Surface 1 and 2 are gray and kept at uniform temperature T_1 and T_2 with emissivities ε_1 and ε_2 reflectivity ρ_1 an ρ_2 respectively. Develop an expression for radiation exchange between the surfaces. 07

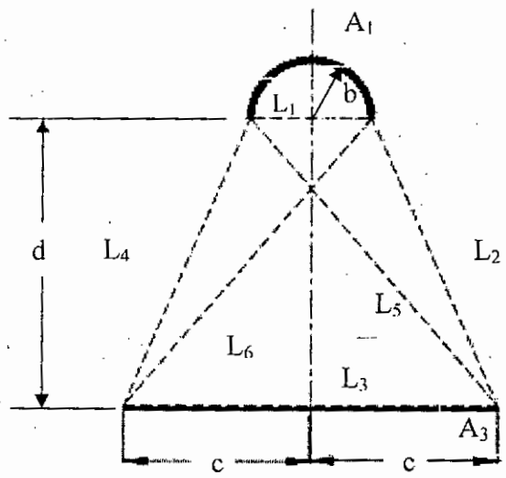
6(d) State and explain the Kirchhoff's law of radiation. Show that this law is valid for monochromatic radiation. 10

7(a) Discuss the effects of atmospheric attenuation on the spectral distribution of the solar radiation. 07

7(b) What is reradiating surface? Using radiation network method, drive an expression for radiation heat exchange between two long parallel gray plates. 15

7(c) An infinitely long semi-cylindrical surface A_1 of radius b and an infinitely long flat plate A_3 of half-width c are located a distance d apart, as illustrated in the figure. 13

Determine the view factor F_{1-3} between surfaces A_1 and A_3 for b = 5, c = 10, and d = 8 cm.



8(a) What is meant by view factor? State and explain reciprocity rule and summation rule of radiation angle factor. 12

8(b) Show that the radiative heat flow reduces to one half, if one radiation shield is used between two infinite parallel plates. 08

8(c) Two large parallel plates of 800K and 600K have emissivities of 0.6 and 0.8 respectively. A radiation shield with an emissivity 0.09 on one side and an emissivity 0.03 on the other side is placed between the plates. Calculate the heat transfer rate by radiation per square meter with and without the radiation shield. 15

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Khulna University of Engineering & Technology

Department of Mechanical Engineering

B. Sc. Engineering Backlog Examination, 2018

ME 3109/ME 3209 (Old)

(Engineering Mechanics III)

Time: 3 hours | Total Marks: 210

N. B.: 1) Answer any THREE questions from each section in separate scripts.

2) Figures in the right margin indicate full marks.

3) Assume reasonable data if any missing

SECTION-A

1(a) Define the terms "coefficient of fluctuation of energy" and "coefficient of fluctuation of speed". 06

1(b) Prove that the maximum fluctuation of energy $\Delta E = E \times 2C_s$, where E is the mean kinetic energy of the fly wheel and C_s is the coefficient of fluctuation of speed. 12

1(c) The turning moment diagram of a multi-cylinder engine has been drawn to a vertical scale of 1 mm = 650Nm and a horizontal scale of 1 mm = 4.5°. The areas above and below the mean torque line are -28, +380, -260, +310, -300, +242, -380, +265, and -229 mm^2. The fluctuation of speed is limited to ±1.8% of the mean speed which is 400 rpm. The density of the rim material is 7000 kg/m^3. Determine the mass of the flywheel. 17

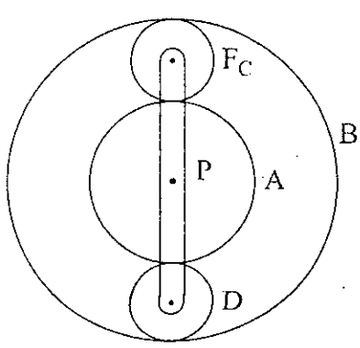
2(a) What is the function of a governor? How does it differ from that of a flywheel? 06

2(b) Derive the expression which illustrates the relation between height of the Porter governor and the angular speed of the balls. 12

2(c) A Hartnell governor having a central sleeve spring and two right-angled bell crank levers moves between 300rpm and 320 rpm for a sleeve lift of 15 mm. The sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of each ball is 2.5 kg. The ball arms are parallel to the governor axis at the lowest equilibrium speed. Determine: (i) loads on the spring at the lowest and the highest equilibrium speeds and (ii) stiffness of the spring. 17

3(a) What is a gear train? What are its main types? Discuss. 10

3(b) An epicyclic gear train is shown in figure. The number of teeth on A and B are 80 and 200. Determine the speed of the arm P, (i) if A rotates at 100 rpm clockwise and B at 500 rpm counter-clockwise. (ii) if A rotates at 100 rpm clockwise and B is stationary. 25



4(a) What is meant by static and dynamic balancing in machinery? Why is balancing necessary for rotors of high speed engines? 15

4(b) Four masses A, B, C and D carried by a rotating shaft at radii 80 mm, 100 mm. 160 mm and 120 mm respectively are completely balanced. Masses B, C and D are 8 kg, 4 kg and 3 kg respectively. Determine the mass A, and the relative angular position of the four masses if the planes are spaced 500 mm apart. 20

SECTION-B

5(a) Discuss different types of follower. 05

5(b) A cam is to be designed for a knife edge follower with the following data: 30

(i) The follower is lifted 40 mm during 90° of cam rotation with simple harmonic motion.

(ii) Dwell for the next 30°.

(iii) During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion.

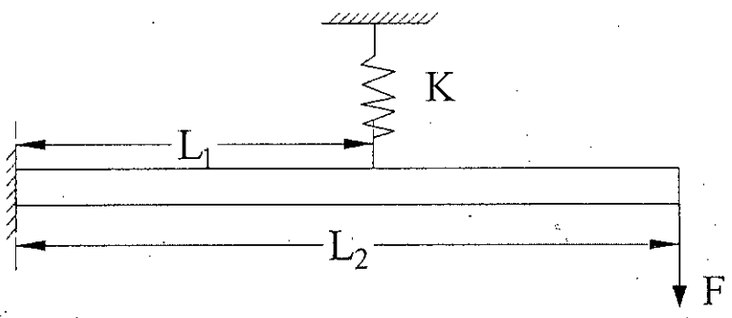
(iv) Dwell during the remaining 180°,

Draw the profile of the cam when the line of stroke is offset by 20 mm from the axis of the cam shaft.

6(a) What is meant by vibration? Explain the causes and effect of mechanical vibrations. 10

6(b) Discuss the effect of inertia of the shaft in transverse vibrations. 12

6(c) Find the value of natural frequency of the bar shown below. Assuming that the bar is weightless. 13



7(a) What is magnification factor? Derive the expression of magnification factor for a forced vibration system. 16

7(b) A vibrating system consists of a mass 50kg, a spring with a stiffness of 30 KN/m and a damper. The damping provided is only 20% of the critical value. Determine 19

(i) damping factor (ii) critical damping coefficient (iii) natural frequency of damped vibration (iv) logarithmic decrement (v) ratio of two consecutive amplitudes.

8(a) What is whirling speed of a shaft? Derive the expression for the equivalent length of a shaft which has several steps. 15

8(b) A motor drives a centrifugal pump through gearing, the pump speed being one-third of that of the motor. The shaft from the motor to the pinion is 60 mm diameter and 300 mm long. The moment of inertia of the motor is 400 kg-m^2. The impeller shaft is 100 mm diameter and 600 mm long. The moment of inertia of the impeller is 1500 kg-m^2. Neglecting inertia of the gears and the shaft, determine the frequency of torsional vibration of the system assuming the modulus of rigidity of the shaft material is 80 GN/m^2. 20

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Khulna University of Engineering & Technology

Department of Mechanical Engineering

B. Sc. Engineering Backlog Examination, 2018

ME 3117

(Machine Design I)

Time: 3 hours Total Marks: 210

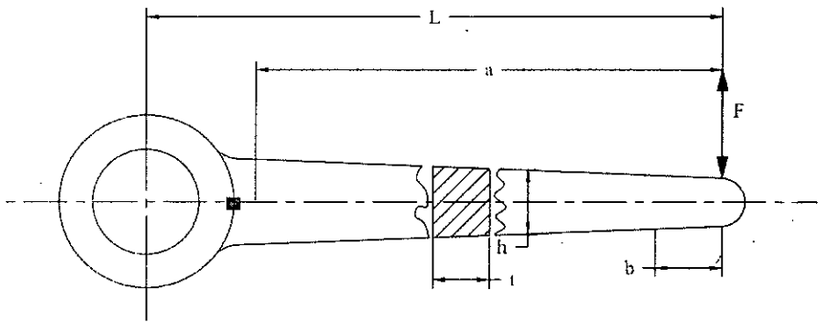
N. B.: 1) Answer any THREE questions from each section in separate scripts.

2) Figures in the right margin indicate full marks.

3) Assume reasonable data if any missing.

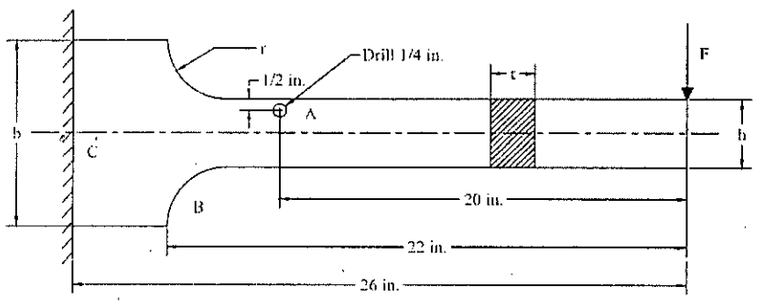
SECTION-A

1(a) A lever keyed to a shaft is L = 15 in. long and has a rectangular cross section of h = 3t. A 2000 lb load is gradually applied and reversed at the end as shown; the material is AISI C1020, as rolled. Design for both ultimate and yield strengths. (i) What should be the dimensions of a section at a = 13 in.? (ii) at b = 4 in.? (iii) What should be the size where the load is applied? 18



1(b) A cast iron gear is to be shrunk into a 3 inch stut shaft. (i) Determine the tolerance and the maximum, minimum, and average interferences of metal for class FN1 fit. (ii) Compute the stress for the maximum and minimum interferences. 17

2 A cantilever beam as shown is to be subjected to a reversing load of 3000 lb. Let the radius of the fillet be r = 1/8 in. and the material is cold rolled SAE 1015. Determine the dimensions t, h (b = 1.3 h) for a design factor of 1.8 based on variable stresses. Consider sections at A and B indefinite life. 35

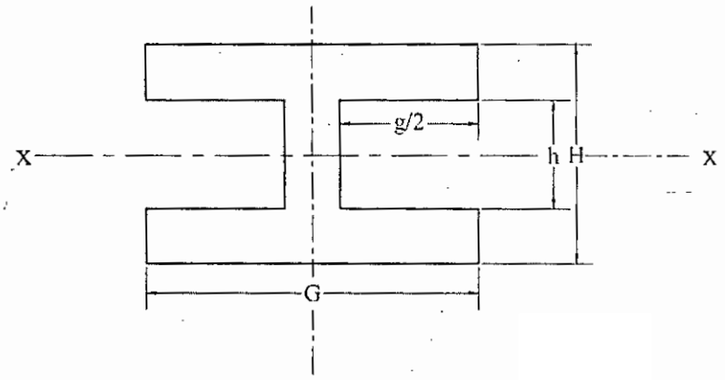


3 The cylinder head of a 10×18 in. Freon compressor is attached by 10 stud bolts (lubricated) made of SAE Grade 5. The cylinder pressure is 200 psi. (i) What size bolts should be used where Jar and vibration are important? (ii) In this case, compute tightening torque when no proof stress is available. 35

4 A spring subjected to a load varying from 100 lb to 250 lb is to be made of oil-tempered, cold-drawn wire. Determine the diameter of the wire and the mean diameter of the coil for a design factor of 1.25 based on Wahl's line. The spring index is to be at least 5. Conform to good practice, showing checks for all significant parameters. Let the free length be between 6 and 8. 35

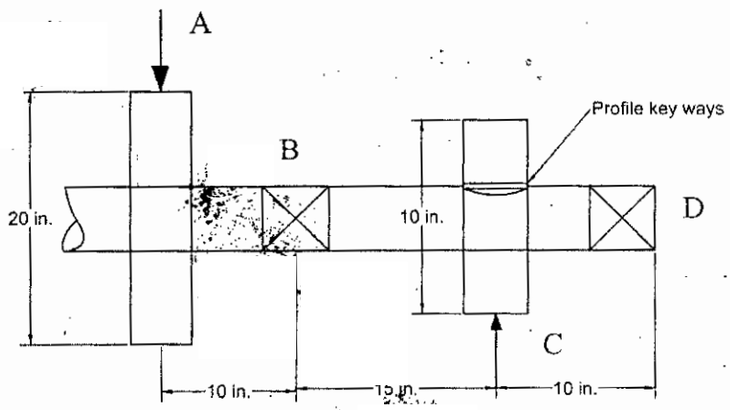
SECTION-B

5 A column is to be made of ½ in. structural steel plates (AISI 1020, as rolled) welded into an I-section as shown with G = H. The column 15 ft long is to support a load of 125 kips. (i) Determine the cross sectional dimensions from the straight line equation. (ii) Using Euler's equation, compute the equivalent stress and the factor of safety. (iii) Compute N from the Sacant formula. 35



6 A square-thread screw 2 in. in diameter is used to exert a force of 2400 lb. in a shaft-straightening press. The maximum unsupported length of the screw is 16 in. and the material is AISI C 1040 annealed. (a) What is the equivalent compressive stress in the screw? Is this a satisfactory value? (b) What torque is necessary to turn the screw against the load for f = 0.15? (c) What is the efficiency of the screw? (d) What torque is necessary to lower the load? 35

7 A cold-finished shaft, AISI 1141 is to transmit power that varies from 200 to 100 and back to 200 hp in each revolution at a speed of 600 rpm. The power is received by a 20 in. spur gear A and delivered by a 10 in. spur gear C. The tangential forces have each been converted into a force (A and C shown) and a couple (not shown). The radial component R of the tooth load is to be ignored. Let N = 2 and considering varying stresses with the maximum shear theory, compute the shaft diameter. 35



8 A $1\frac{11}{16}$ in. shaft rotating at 200 rpm carries a cast iron gear to it by a $\frac{1}{4}\times 1\frac{1}{4}$ in Woodruff key; shaft material is cold finished SAE 1045. The power is transmitted with mild shock. What horse power may be safely transmitted by the key- 35

(i) If it is made of cold drawn SAE 1118?

(ii) If it is made of SAE 2317, OQT 1000 °F?

(iii) How many keys of each material are needed to give a capacity of 25 hp? Specify a choice.

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Khulna University of Engineering & Technology

Department of Mechanical Engineering

B. Sc. Engineering Backlog Examination, 2018

ME 3217

(Machine Design II)

Time: 3 hours Total Marks: 210

N. B.: 1) Answer any THREE questions from each section in separate scripts.

2) Figures in the right margin indicate full marks.

3) Assume reasonable data if any missing.

SECTION-A

1 A 2×2 in. full bearing ring-oiled has a clearance ratio $C_d/D = 0.001$. The journal speed is 500 rpm. $\mu = 3.4\times10^{-6}$ reyns, and $h_o = 0.0005$ in. The ambient temperature is 100°F, A_b = 25DL and the transmittance is taken as $h_{cr} \approx 2$ Btu/hr-sq.ft.°F. Calculate: 35

i) the total load for these conditions

ii) the frictional loss

iii) the average temperature of the oil for steady state operation. Is this temperature satisfactory?

iv) Compute the temperature rise Δt_o of the oil.

v) What the minimum quantity of oil should the ring deliver to the bearing.

2 The load on an electric-motor bearing is 350 lb, radial, 24 hr service, n = 1200 rpm, compressor drive. outer race stationary. 35

i) Decide upon a deep groove ball bearing giving its significant dimensions.

ii) Compute the selected bearing 90% life and probable percentage of failure that would occur during the design life.

iii) What is the approximate median life of this bearing?

iv) The same as (i) except that a 200 series roller bearing is to be used.

3 Design the teeth for two helical herringbone gears for a single reduction speed reducer with $m_w = 3.80$. The capacity is 36 hp at 3000 rpm of the pinion, $\psi = 30°$, F.D. teeth with $\varphi_n = 20°$. Since space is at a premium, the initial design is for N_p = 15 teeth and carburized teeth of AISI 8620, preferably $b < 2D_p$. 35

4 A pair of straight bevel gears are to transmit a smooth load of 45 hp at 5000 rpm of the pinion, $m_g = 3$. A proposed design is $D_g = 1.5$ in, $b = 2\frac{3}{8}$ in, $P_d = 4$. Teeth are carburized AISI 8620 SOQT 450°F. The pinion overhangs the gear is straddle mounted. Would these gears be expected to perform with high reliability in continuous service? If not, would you expect more than 1 failure in 100? 35

SECTION-B

5 The input to a worm-gear set is to be 25 hp at 600 rpm of the worm with $m_w = 20$. The hardened-steel worm is to be shell type diameter and a minimum of 4 threads, the gear is to be chilled phosphor bronze. 35

i) Considering wear and strength only, determine suitable values of the pitch, and face width

ii) Compute the efficiency.

iii) Estimate the radiating area of the case and compute the temperature rise of lubricant.

iv) Is special cooling needed?

6 A 200 hp, 600 rpm induction motor is to drive a jaw crusher at 125 rpm; starting load is heavy, operating with shock; intermittent service; C = 113 to 123 in. Determine the details of a multiple V-flat belt for this application. The B. F. Goodrich company recommended eight D480 V-belts with a 26 in. sheave and a 120.175 in. pulley; $C \approx 116.3$ in. 35

7 The wire rope hoist with a short lift handles a total maximum load of 14 kips each trip. It is estimated that the maximum number of trips per week will be 1000. The rope is 6×37 IPS, $1\frac{3}{8}$ in. in diameter with steel core. 35

i) On the basis of N = 1 for fatigue, what size drum should be used for a 6-year life?

ii) Because of space limitations the actual size used was a 2.5ft drum. What is the factor of safety on a static basis? What life can be expected (N = 1)?

8 A single-block brake has the dimensions: cast iron wheel of D = 15 in.. a = $32\frac{1}{2}$ in., c = $9\frac{3}{8}$ in., e = $4\frac{11}{16}$ in., width of contact surface = 2 in. The brake block lined with molded asbestos, subtends 80°, symmetrical about the centre line, it is permitted to absorb energy at the rate of 0.4 hp/in^2; n = 200 rpm. Assume that p is constant, that F and N act at K. Compute 35

i) PV_m and approximate breaking torque.

ii) the force W to produce this torque.

iii) the mechanical advantage

iv) the temperature rise of the $\frac{3}{8}$ in. thick rim, if it absorbs all the energy with operation as specified in 1 min.

v) how long could this brake be applied for $\Delta t = 400°F$?

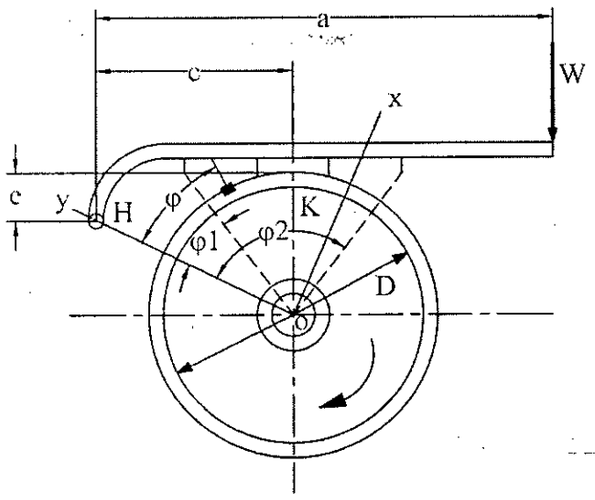

Figure of Question No. 8.

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Khulna University of Engineering & Technology

Department of Mechanical Engineering

B. Sc. Engineering Backlog Examination, 2018

ME 3223

(Power Plant Engineering)

Time: 3 hours | Total Marks: 210

N. B.: 1) Answer any THREE questions from each section in separate scripts.

2) Figures in the right margin indicate full marks.

3) Assume reasonable data if any missing.

SECTION-A

1(a)	Define the following terms: (i) Demand factor (ii) Plant use factor (iii) Diversity factor	09
1(b)	What is meant by power plant? Discuss the classification of power plant.	11
1(c)	Describe the effect of variable load on power plant design and operation.	10
1(d)	What is interconnected grid system?	05
2(a)	What is the difference between base load and peak load power plant? What type of power plant is preferred as peak load power plant?	10
2(b)	What are the various types of meter rate in common use? Explain the step meter rate.	10
2(c)	Find the cost of generation per kWh from the following data: Capacity of the plant = 150 MW; Capital cost = TK 50000 per kW installed; Interest and depreciation = 10% on capital; Fuel consumption = 1.2 kg / kWh; Fuel cost = TK 4000 per tonne; Salaries, wages, repair and maintenance = TK 500×10^6 per year; Maximum demand = 120 MW; Load factor = 50%.	15
3(a)	Define stokers. Make a classification of stokers.	06
3(b)	Write down the differences between mechanical firing and hand firing.	07
3(c)	Describe functions of different accessories used in steam power plant.	09
3(d)	Describe various steps of coal handling system in a power plant.	13
4(a)	Sketch a diesel engine ..ver plant with all major auxiliary equipments.	12
4(b)	Distinguish between e.. ..ed fuel tank and underground fuel tank.	08
4(c)	What are the effects ..npurities in feed water on the boiler of a steam power plant?	07
4(d)	Write short notes on the followings for diesel power plant: (i) Supercharging and (ii) firing order.	08

SECTION-B

5(a) What are the essential features of a hydroelectric power plant? Briefly describe them with neat sketches. 12

5(b) How water turbines are classified? Which type of turbine is used in Kaptai-Karnafuli power plant? Sketch the turbine. 10

5(c) For a hydro-electric power station following data are given: 13

Reservoir area = 2.8 sq. km.

Capacity = 5.5×10^6 m^3

Net head of water at turbine = 80 m

Turbine efficiency = 76%

Generator efficiency = 83%

(i) Calculate the total energy in kWh which can be generated.

(ii) Also find by how many meters the level of reservoir will fail if a load of 25 MW is supplied for 6 hours.

6(a) What are the advantages and disadvantages of nuclear power plant? 09

6(b) What are the factors to be considered while selecting the site for a nuclear power plant? 09

6(c) Draw the neat sketch of a nuclear reactor and label its important components. 09

6(d) What are the desirable properties of a good moderator? 08

7(a) How waste is disposed off in a nuclear power plant? 08

7(b) What are the advantages of gas turbine power plant as peak load plant? 07

7(c) What are the different ways for improving the performance of a gas turbine power plant? 10

7(d) Draw the neat sketch of a combined cycle power plant. What are the advantages of combined cycle? 10

8(a) What is the function of a cooling tower? Explain the working principle of cooling tower. 11

8(b) What is chimney? Derive an expression for determining the height of chimney. 12

8(c) Write short notes on: 12

(i) Circuit breaker

(ii) Cyclone dust collector

(iii) Underground power transmission.

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Khulna University of Engineering & Technology

Department of Mechanical Engineering

B. Sc. Engineering Backlog Examination, 2018

ME 3225

(Measurement and industrial Instrumentation)

Time: 3 hours Total Marks: 210

N. B.: 1) Answer any THREE questions from each section in separate scripts.

2) Figures in the right margin indicate full marks.

3) Assume reasonable data if any missing

SECTION-A

1(a)	Discuss the relative advantages of micrometer and vernier calipers.	10
1(b)	Describe the method to measure the bore of a object and deduce the equation with necessary calculation.	15
1(c)	The diameter of the bore in a plain ring was measured by laying it on a flat surface and placing three 20 mm diameter balls equally spaced inside it with a 30 mm diameter ball resting on them. The distance from surface to the top of the 30 mm ball was measured as 42.66 mm. Calculate the diameter of the bore and amount of error in the measurement.	10
2(a)	Describe the procedure for measuring radius of a convex arc by fixed roller micrometer and deduce the expression to calculate the radius of the arc.	15
2(b)	Describe the method of measuring angle by three rollers of equal diameter. Show all necessary calculations.	10
2(c)	The radius of a convex arc on a segmental gauge was measured by using a surface plate, two rollers, and a micrometer. If the rollers were 20 mm in diameter and the measurement over them was 194.13 mm, calculate the radius. If the accuracy of measurement was ±0.01 mm, determine the possible error in the calculated value of the radius.	10
3(a)	What are the different ways of measuring rotational speed? Explain with neat sketch.	10
3(b)	Describe one important method of measuring flow rate through a pipe.	10
3(c)	How strain gauge may be used to measure the temperature of an object.	10
3(d)	Sketch and label a turbine meter.	05
4(a)	Describe how resistive temperature detector measures the temperature of an object?	10
4(b)	Write a brief note on J-type thermocouple wire.	08
4(c)	What is thermistor? What are the advantages and disadvantages of thermistor?	08
4(d)	Describe the procedure of measuring the humidity of air by Sling psychrometer.	09

SECTION-B

5(a)	What are meant by precision and accuracy? Explain with example.	08
5(b)	Mention the important points to be considered during gauge design. Discuss in brief.	09
5(c)	Define comparator and mention its uses. Describe the merits and demerits of mechanical comparator.	08
5(d)	Describe a suitable method to determine the diameter of the small end of a taper plug gauge.	10
6(a)	Explain Taylor's principle as applied to limit gauge.	07
6(b)	Define gauge. Distinguish between worker gauge, inspection gauge, and reference gauge.	10
6(c)	How ultrasonic frequency shift flow meter measures the flow rate through a pipe.	10
6(d)	What is meant by fit? Discuss different types of fit.	08
7(a)	How does Resistance Temperature Detector measure the temperature of an object? What are the merits and demerits of Resistance Temperature Detector?	10
7(b)	How does moving coil type transducer measure the velocity of an object? Explain with neat sketch.	10
7(c)	How does Particle Image Velocimeter (PIV) measure the velocity of fluid? Explain with neat sketch.	15
8(a)	What is Strobotron? How does Strobotron measure the angular velocity of a shaft? Explain in details.	10
8(b)	List the causes of ISO 9000: 1994.	09
8(c)	Write a brief note on management responsibility of ISO 9000: 2000.	06
8(d)	Write a brief note on Statistical methods for data analysis.	10

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