KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year Special Backlog Examination, 2018
EE 1205
(Electrical Engineering & Electrical Machines)

Time: 3 Hours. Full 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 any missing.

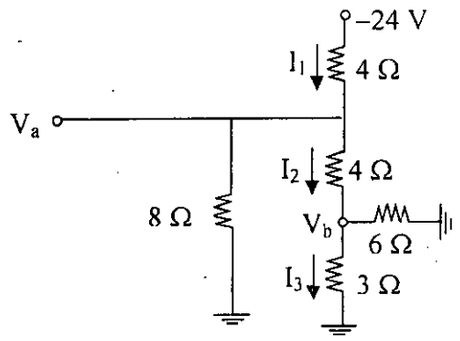
SECTION – A

1(a) Define the following terms: 08
(i) Electrical circuit, (ii) Node, (iii) Loop, and (iv) Mesh.

1(b) State and explain KCL and KVL. 10

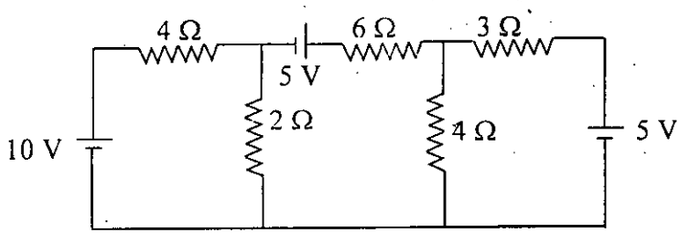
1(c) Define 'one volt' and 'one ampere'. 04

1(d) For the network of figure as shown below, calculate the current I_1, I_2, and I_3 and also determine the voltage V_a and V_b. 13



2(a) Transform a network containing resistors connected in delta configuration to an equivalent network of resistors connected in wye configuration. 10

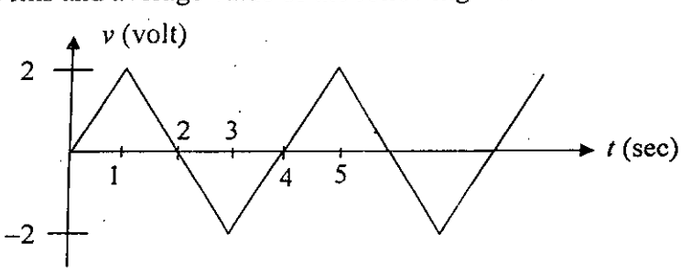
2(b) Find all the branch currents in the circuit shown in figure using nodal analysis. 12



2 (c) Explain phase and frequency. If $v = 100\sin(wt - 30)$ is applied against a series circuit and then $i = -10\cos(wt - 60)$ is flowing through it. Find phase difference between voltage and current. 13

3(a) The current $i = I_m \sin(wt + \theta)$ flows through an RLC series circuit. Find the expression of voltage, power and the value of impendence. 12

3(b) Find the rms and average value of the following wave. Also find the crest factor. 13



3(c) Find all possible roots– 10

$$\sqrt[4]{\frac{10\angle 45^{\circ}.5e^{j60}(-4.047-j2.94)}{1-j1.732}}$$

4(a) Define step up and step down transformer. Derive the emf equation of a transformer. 11

4(b) Draw the equivalent circuit of a single phase transformer. Also draw the vector diagram with a load having legging power factor. 12

4(c) Describe open circuit and short circuit test of a transformer. 12

SECTION – B

5(a) Briefly describe the working principle of DC generator. 09

5(b) Why does the terminal voltage of DC shunt generator describe with the increase of the load applied to it. 09

5(c) Explain Fleming Left and Right hand rule. 08

5(d) In a long shunt compound generator, the terminal voltage is 230 V when the generator delivers 150 A. Determine (i) induced emf, (ii) total power generated and distribution of this power. Given that the shunt field, series field and armature resistance are 92 Ω, 0.015 Ω and 0.032 Ω respectively. 09

6(a) Explain the significance of back emf. How it reduces the armature current of the DC motor? 09

6(b) Explain the factors on which the speed of a DC motor depends. Describe the speed control mechanism of a DC motor. 11

6(c) Write down the application of DC motor in industries. 05

6(d) A 25 kW; 250 V DC shunt machine has armature and field resistances of 0.06 Ω and 100 Ω respectively. Determine the total armature power developed when working (i) as a generator delivering 25 kW output and (ii) as a motor taking 25 kW input. 10

7(a) Write down the difference between AC generator and DC generator. 06

7(b) What is meant by armature reactions? Explain armature reaction for different types of load of alternator. 11

7(c) What is meant by synchronization of alternator? Write down the condition of synchronization of alternator. 09

7(d) "Synchronous motor is not self starting" explain. 09

8(a) How rotating field is developed in induction motor? Describe with neat sketch. 10

8(b) What is slip? Explain. 06

8(c) How does rotor rotate in an induction motor? 09

8(d) A 3Φ induction motor is wound for 4 poles and is supplied from 50 Hz system. Calculate (i) synchronous speed, (ii) rotor speed when slip is 5% and (iii) rotor frequency when rotor runs at 500 rpm. 10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year Special Backlog Examination, 2018

ME 1209

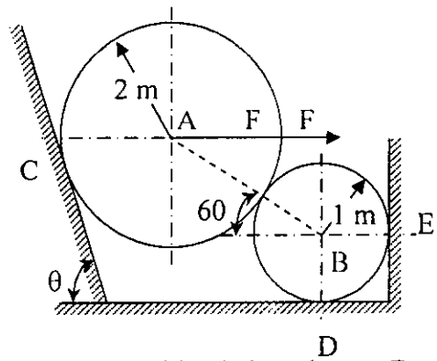
(Engineering Mechanics I)

Time: 3 Hours | Total Marks: 210

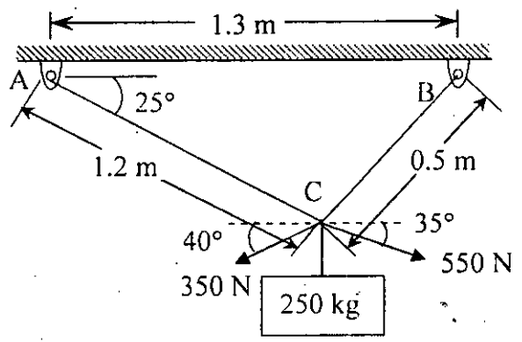
N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

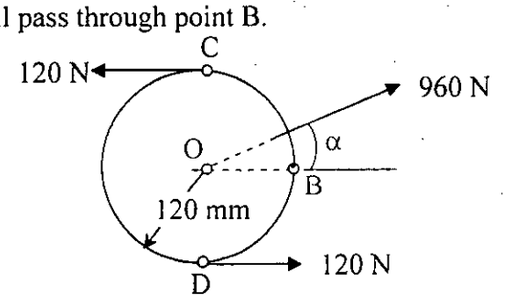
1(a) Two spheres are at rest against smooth surfaces as shown in figure. Sphere A weighs 1325 kg and sphere B weighs 180 kg. Let the horizontal force F is 4000 N and θ = 70°. Find the reactions at C, D and E. 18



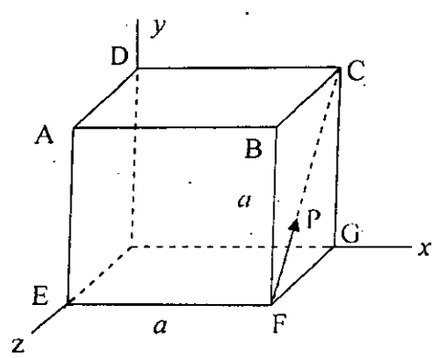
1(b) Two cables are tied together at C and loaded as shown. Determine the tension in cable AC and BC. 17



2(a) The force and couple shown are to be replaced by an equivalent single force. Determine the required value of α so that the line of action of the single equivalent force will pass through point B. 17

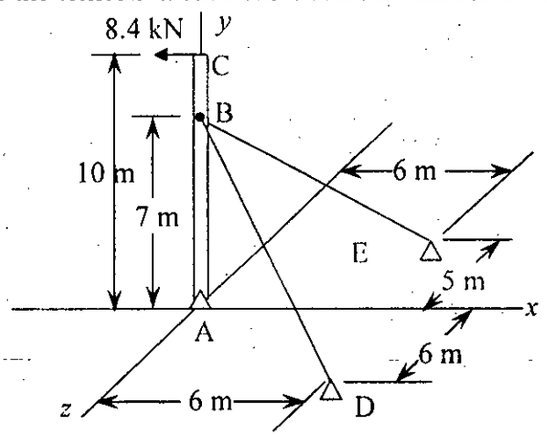


2(b) A cube of side 'a' is acted upon by a force P as shown. Determine the moment of P (i) about point A, (ii) about edge AB, (iii) about diagonal AG of the cube, and (iv) the perpendicular distance from the diagonal AG to the line of action of the force. 18

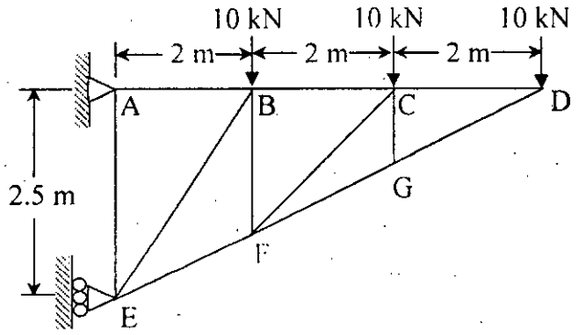


3(a) State and explain Varignon's theorem. 05

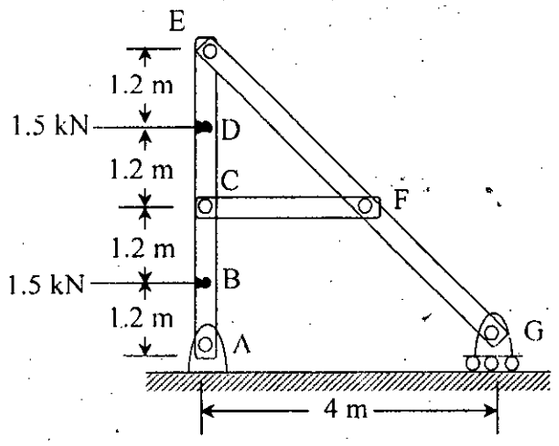
3(b) The 10 m pole is acted upon by an 8.4 kN force as shown in figure. It is held by a ball and socket at A and by two cables BD and BE. Neglecting the weight of the pole, determine the tension in each cable and the reaction at A. 30



4(a) Determine the forces in each member of the truss shown in figure. 18

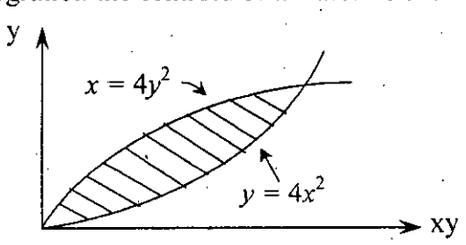


4(b) Determine the components of all forces acting on each member of the frame shown in figure. 17

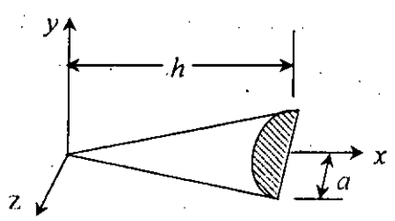


SECTION-B

5(a) Determine by direct integration the centroid of the area as shown in figure. 18

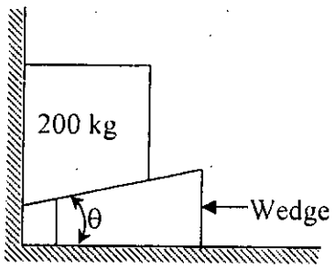


5(b) Determine the location of the centroid of the half right circular cone as shown in figure. 17

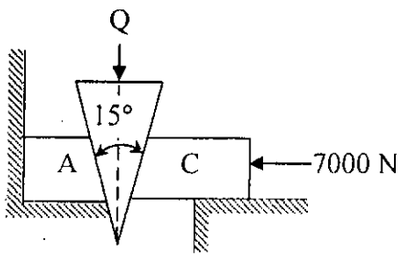


6(a) For a V-belt, show that $\frac{T_2}{T_1} = e^{\left\{\frac{\mu_s \beta}{\sin(\alpha/2)}\right\}}$, where β is the angle of contact, α is the angle of V and other symbols have their usual meanings. 18

6(b) A 200 kg block rests as shown on a wedge of negligible weight. Knowing that the coefficients of static friction is 0.25 at all surfaces of contact, determine the angle θ for which sliding is impending and compute the corresponding values of the normal force exerted on the block by the vertical wall. 17

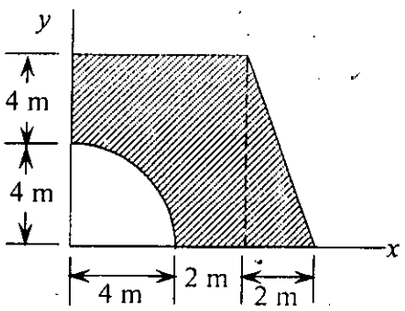


7(a) Determine the minimum value of Q that must be applied to the wedge in order to move the block C. $\mu_s = 0.30$ at all surface of contact. Weight of B is 10 kg. 18

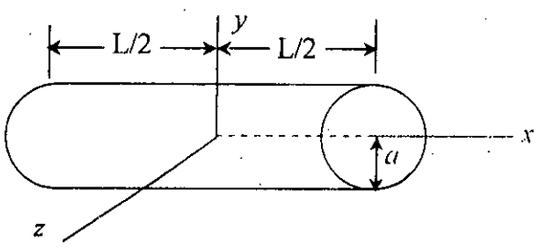


7(b) Prove that for a disk friction $M = \frac{2}{3}\mu_k P \frac{R_2^3 - R_1^3}{R_2^2 - R_1^2}$. The symbols have their usual meanings. 17

8(a) Compute I_x and I_y for the shaded area as shown in figure. 18



8(b) Determine the mass moment of inertia of the right circular cylinder with respect to y-axis and z-axis by direct integration. 17



KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year Special Backlog Examination, 2018

ME 2105

(Thermodynamics)

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) Steam table, Mollier diagram etc. may be supplied on request.
iv) Assume reasonable data if any missing.

SECTION-A

1(a) Define and explain the following: 07
(i) System and surroundings. (ii) State and process, and (iii) Cycle and equilibrium.

1(b) Define internal energy. Show that any quantity of heat supplied to a system is utilized to increase the internal energy of the system plus the work done by the system. 10

1(c) What are the two view points of thermodynamics? Explain. 06

1(d) A closed system executes a reversible process where in the pressure and volume vary in accordance with $pv^n = C$; Q = 16.247 kJ, ΔU = 47.475kJ. If p_1= 138 kPa, v_1= 141.6 litre and p_2=827.4 kPa, find n and v_2. 12

2(a) What are the limitations of 1st law of thermodynamics? Write the two statements for 2nd law of thermodynamics. 07

2(b) What is reversibility? What factors render a process irreversible? Explain. 08

2(c) Why a ship cannot be run by taking energy from the sea-water? In what condition it can run? 05

2(d) A turbo-compressor delivers2.33 m^3/secat 0.275 MPa, 45°C, which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 1850 kW. During the expansion, there is a heat transfer of 0.09 MJ/sec to the surroundings. Calculate the turbine exhaust temperature, if change in kinetic and potential energy are negligible. 15

3(a) State and prove Clausius inequality principle. 10

3(b) Prove the following Maxwell's relations: 06
(i) $\left(\frac{\partial p}{\partial T}\right)_v = \left(\frac{\partial s}{\partial v}\right)_T$, (ii) $\left(\frac{\partial T}{\partial p}\right)_s = \left(\frac{\partial v}{\partial s}\right)_p$.

3(c) Show that the work done by a system between two states at the same temperature during which the system exchanges heat only with environment is equal to or less than a decrease in the Helmholtz's function of the system. 10

3(d) Define entropy. Prove that the entropy of this universe is increasing towards a maximum. 09

4(a) What is meant by air standard cycle? Draw the following cycles on *p-v* and *T-s* plane indicating heat and work transfer: 08
(i) Carnot cycle, (ii) Brayton cycle, (iii) Erricsson cycle, and (iv) Duel cycle.

4(b) Derive an expression, in terms of different ratios, for the efficiency of a Duel cycle operating on an air standard cycle. 12

4(c) An engine operating on an air standard diesel cycle, the compression ratio is 17 and at the beginning of isentropic compression, the temperature is 25°C and the pressure is 100kPa. Heat is added until the temperature at the end of constant pressure is 1550°C. Calculate– (i) Cut off ratio, (ii)Heat added, (iii) Heat rejected and (iv) efficiency. 15

SECTION-B

5(a) What are the characteristics of a vapourpower cycle? 06

5(b) Why superheated steam in used in vapourpower cycle? Explain with T-s diagram. 06

5(c) Describe the advantages of using reheat cycle in steam power plant. 05

5(d) A simple Rankine cycle uses steam as working fluid and operates between 50 kPa and 2000kPa. Determine the quality of steam as it leaves the turbine, the thermal efficiency of the cycle and mass flow rate of steam to produce 10,000 kW. Also, compare the efficiency of the cycle with that of Carnot cycle operating within the same temperature limits. 18

6(a) Why an economizer is not suitable in regenerative vapour power cycle? 06

6(b) Why binary vapour cycle isuseful in power generation? Explain a typical binary vapour cycle with a schematic diagram. 12

6(c) In a regenerative cycle, steam enters a single turbine at 40 bar and 450°C and is condensed at 0.5 bar. Some steam is bled at a pressure of 5.0 bar and is passed to single feed heater. Calculate the amount of bleed steam, the ssc and efficiency of the cycle. 17

7(a) Define the terms: 10
(i) Specific humidity, (ii) Relative humidity, (iii) Dew point temperature, and (iv) Degree of saturation.

7(b) Why we feel sweat in summer and dry in winter? Explain. 05

7(c) Show that the enthalpy of the mixture remains constant during an adiabatic saturation process. 10

7(d) Derive an expression for specific humidity and show that it is a function of vapour pressure and barometric pressure. 10

8(a) How coal is formed? Briefly explain the classification of coal according to ASTM. 10

8(b) Why do we need modification of solid wastage's to use as a fuel? Describe any one process of modification of solid wastage's to convenient solid fuel. 10

8(c) A gaseous mixture of CH_4, N_2, CO and O_2, occupies in a vessel at the respective partial pressure of 140, 60, 65 and 15 kPa. Find (i) the volumetric and gravimetriccomposition of each constituent, (ii) M_m and R_m of the mixture. 15

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year Special Backlog Examination, 2018

Math 2205

(Mathematics IV)

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 any missing.

SECTION-A

1(a) Write down the conditions for validity of Fourier series expansion. Obtain the Fourier series expansion of $f(x)=x\sin x$ in the interval $-\pi<x<\pi$, hence deduce that $\frac{\pi}{4}=\frac{1}{2}+\frac{1}{1.3}-\frac{1}{3.5}+\frac{1}{5.7}-\cdots\cdots\cdots$ 20

1(b) Define odd and even function. Find the half range sine series of the function $f(x) = x^2$ in the interval $0 \le x \le 1$. 15

2(a) Write down the complex form of Fourier series. Find a Fourier series of the function $f(x) = \cos\alpha x$ in the interval $-\pi \le x \le \pi$, $\alpha \neq 0, \pm 1, \pm 2 \cdots\cdots$ Also, prove that $\sin x = x\left(1-\frac{x^2}{\pi^2}\right)\left(1-\frac{x^2}{4\pi^2}\right)\cdots\cdots$ 20

2(b) Use Parseval's identity to the function $f(x)=\sin x$ in the interval $0 < x < \pi$ and hence show that $\frac{1}{1^2-3^2}+\frac{1}{3^2-5^2}+\frac{1}{5^2-7^2}+\cdots\cdots\cdots=\frac{\pi^2-8}{16}$. 15

3(a) Form the of partial differential equation by eliminating arbitrary function f, where $f\left(x^2+y^2+z^2,\ z^2-2xy\right)=0$, what is the order of the partial differential equation. 15

3(b) If an infinite bar of small cross-section is insulated such that there is no transfer of heat at the surface and the temperature of the bar at $t = 0$ is given by an arbitrary function F (x) of x (taking the bar along x-axis) then find the temperature of the rod at any point of the bar at any time t. 20

4(a) A rectangular plate bounded by the lines $x = 0$, $y = 0$, $x = a$, and $y = b$ has an initial distribution of temperature given by $F(x, y)= B\sin\frac{\pi x}{a}\sin\frac{\pi y}{b}$. The edges are maintained at zero temperature and the plane surface are impervious to heat. Find the temperature at any point at any time. 18

4(b) A semicircular plate of radius a has its circumference kept at temperature $u(a,\ \theta)=K\theta(\pi-\theta)$ while the boundary diameter is kept at zero temperature. Find the steady state temperature distribution $u(r,\ \theta)$ of the plate, assuming the lateral surface of the plate to be insulated. 17

SECTION-B

5(a) Define Laplace transformation. Find the Laplace transformation of the periodic function given by: 13

$$F(t)=\begin{cases} \sin t & , \ 0<t<\pi \\ 0 & , \ \pi<t<2\pi. \end{cases}$$

5(b) Evaluate $L^{-1}\left\{\dfrac{3s+7}{(s+1)(s-3)}\right\}$. 10

5(c) Using convolution theorem, evaluate $L^{-1}\left\{\dfrac{3}{s^2(s+2)}\right\}$. 12

6(a) Solve the following ordinary differential equation by using the Laplace transformation: 17

$Y''-3Y'+2Y=e^{2t}$, with conditions: $Y(0)=-3$, $Y'(0)=5$.

6(b) Using Laplace transformation solve the following boundary value problem: 18

$$\frac{\partial U}{\partial t}=\frac{\partial^2 U}{\partial x^2}$$

$U(x, 0)=3\sin 2\pi x$

$U(0, t)=0$, $U(1, t)=0$, where $0<x<1$, $t>0$.

7(a) Prove that $1+\dfrac{1}{2}P_1(\cos\theta)+\dfrac{1}{3}P_2(\cos\theta)+\cdots\cdots=\log\dfrac{1+\sin\frac{\theta}{2}}{\sin\frac{\theta}{2}}$. 10

7(b) Deduce from Rodrigue formula $\int_{-1}^{1} f(x)P_n(x)\,dx=\dfrac{(-1)^n}{2^n n!}\int_{-1}^{1}(x^2-1)^n f(x)\,dx$. 15

7(c) Prove that, $\int_{-1}^{1} P_m(x)P_n(x)\,dx=\dfrac{2}{2n+1}\delta_{mn}$, where, $\delta_{mn}=\begin{cases}0 & if \ m\neq n \\ 1 & if \ m=n\end{cases}$. 10

8(a) Prove the recurrence formulas for Bessel function $J_n(x)$: 14

(i) $\dfrac{d}{dx}\left[x^n J_n(x)\right]=x^n J_{n-1}(x)$ (ii) $\dfrac{d}{dx}\left[x^{-n}J_n(x)\right]=-x^{-n}J_{n+1}(x)$.

8(b) Prove that $\cos(x\sin\varphi)=J_0(x)+2\left[\cos 2\varphi J_2(x)+\cos 4\varphi J_4(x)+\cdots\cdots\right]$. 11

8(c) Find the value of $J_{\frac{3}{2}}(x)$. 10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year Special Backlog Examination, 2018

ME 2209

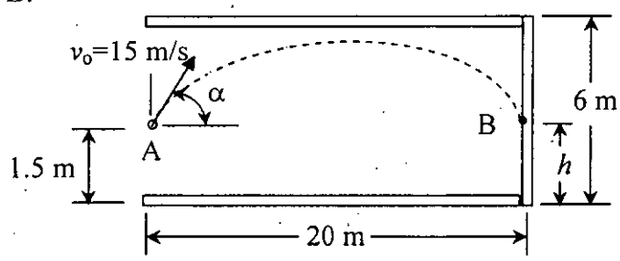
(Engineering Mechanics II)

Time: 3 Hours | Total Marks: 210

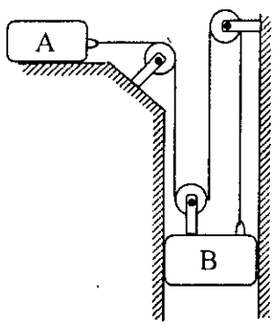
N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

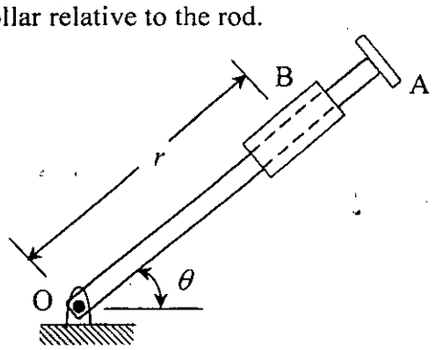
1(a) A player throws a ball with an initial velocity of 15 m/sec from a point A located 1.5 m above the floor. Knowing that h = 3 m, determine the angle α for which the ball will strike the wall at point B. 17



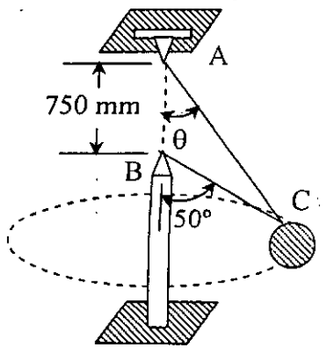
1(b) Block B starts from rest and moves downward with a constant acceleration. Knowing that after slider block A has moved 400 mm its velocity is 4 m/sec. Determine (i) the accelerations of A and B, (ii) the velocity and the change in position of B after 2 sec. 18



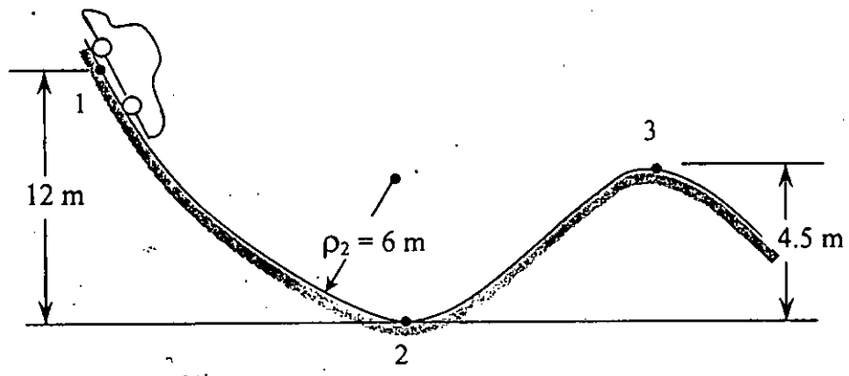
2(a) The rotation of rod OA about O is defined by the relation $\theta = t^3 - 5t$, where θ is expressed in radians and t in seconds. Collar B slides along the rod is such a way that its distance from O is $r = 20\ t^3 - 55\ t^2$, where r is expressed in meters and t in seconds. When t = 1.5 sec; determine– (i) the velocity of the collar, (ii) the total acceleration of the collar, and (iii) the acceleration of the collar relative to the rod. 18



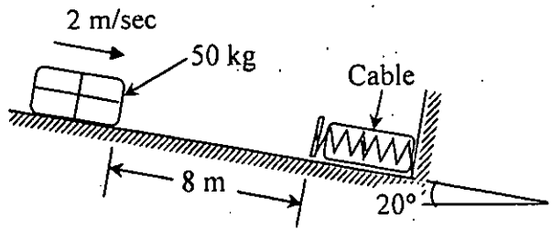
2(b) A single wire ACB passes through a ring at C that is attached to a 6 kg sphere which revolves at a constant speed v in the horizontal circle as shown, where the tension in both portions of wire is 40 N. Determine (i) the angle θ and (ii) the speed v. 17



3(a) A 950 kg car starts from rest at point 1 and moves without friction down the track shown. Determine (i) the force exerted by the track on the car at point 2, where the radius of curvature of the track is 6 m, and (ii) the minimum safe value of the radius of curvature at point 3. 17

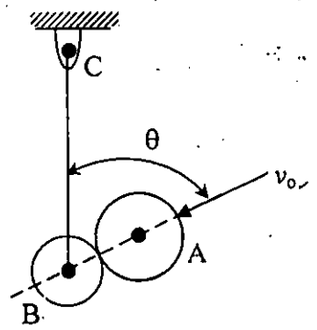


3(b) A spring is used to stop a 50 kg package which is moving down a 20° incline. The spring has a constant K = 30 kN/m and is held by cables so that it is initially compressed 50 mm. Knowing that the velocity of the package is 2 m/sec when it is 8 m from the spring and neglecting friction, determine the maximum additional deformation of the spring in bringing the package to rest. 18



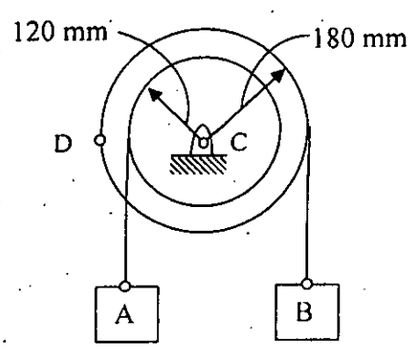
4(a) What is the difference between impact and impulse? For direct central impact show that in the case of perfectly elastic impact the energy of the system is conserved. 17

4(b) Sphere A of mass m hits squarely with the velocity v_0 sphere B of identical mass which is hanging from an inextensible cord BC. Knowing that θ = 30° and that the coefficient of restitution between the two sphere is e = 0.80, determine the velocity of each sphere immediately after impact. 18

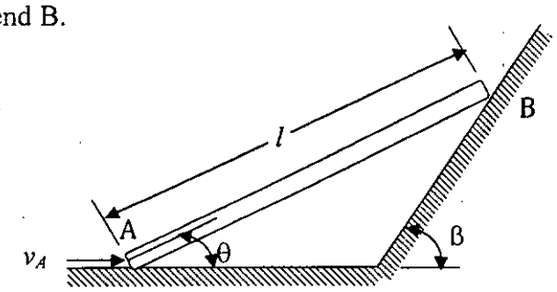


SECTION-B

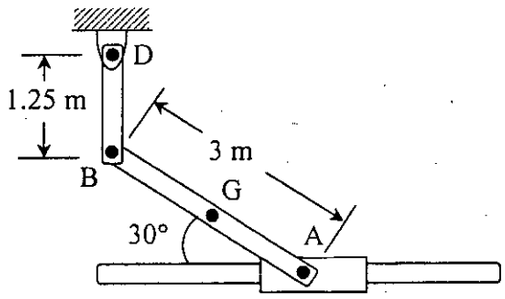
5(a) A pulley and two loads are connected by inextensible cords as shown. Load A has a constant acceleration of 300 mm/sec^2 and an initial velocity of 240 mm/sec, both directed upward. Determine (i) the number of revolutions execute by the pulley in 3sec, (ii) the velocity and position of load B after 3sec, and (iii) the acceleration of point D on the rim of the pulley at t = 0. 18



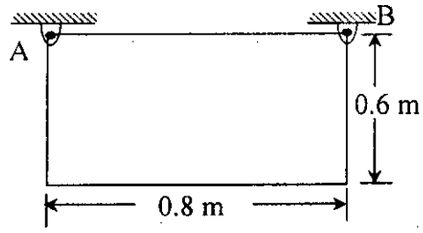
5(b) Rod AB can slide freely along the floor and the inclined plane. Denoting by v_A the velocity of point A, derive an expression for (i) the angular velocity of the rod, and (ii) the velocity of end B. 17



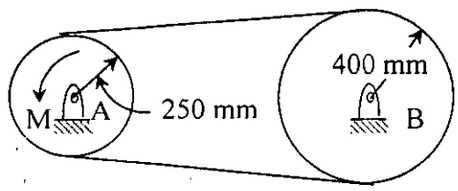
6(a) End A of rod AB moves to the right with a constant velocity of 2.5 m/sec. For the position shown, determine (i) the angular acceleration of rod AB, and (ii) the acceleration of the midpoint G of rod AB. 18



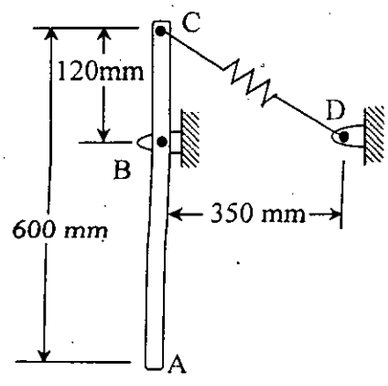
6(b) A rectangular plate of 35 kg mass is suspended from two pins A and B. If pin B is suddenly removed, determine– (i) the angular acceleration of the plate, and (ii) the component of reaction at pin A, immediately after pin has been removed. 17



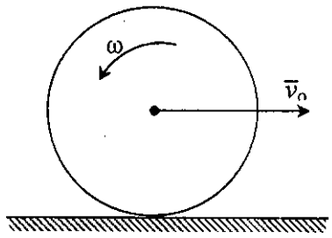
7(a) Two disk A and B of mass m_A = 2.8 kg and m_B = 5 kg are connected by a belt as shown. Assuming no sliping between the belt and the disks, determine the angular acceleration of each disc if a 4 Nm couple M is applied to disk A. 17



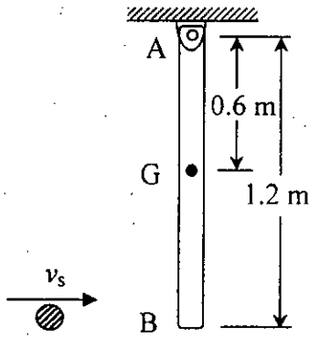
7(b) A slender 5 kg rod can rotate in a vertical plane about a pivot at B. A spring of constant K = 450 N/m and of unstretched length 150 mm is attached to the rod as shown. Knowing that the rod is released from rest in the position shown, determine its angular velocity after it has rotated through 90°. 18



8(a) A sphere of radius r and mass m is projected along a rough horizontal surface with the initial velocity shown. If the final velocity of the sphere is to be zero, express (i) the required magnitude of ω_0 in terms of v_0 and r, (ii) the time required for the sphere to come to rest in terms of v_0 and the coefficient of kinetic friction μ_k. 17



8(b) A 2 kg sphere, moving horizontally to the right with an initial velocity of 5 m/sec, strikes the lower end of an 8 kg rigid rod AB. The rod is suspended from a hinge at A and is initially at rest. Knowing that the coefficient of restitution between the rod and the sphere is 0.80, determine the angular velocity of the rod and the velocity of the sphere immediately after the impact. 18



KHULNAUNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th YearSpecial Backlog Examination, 2018

ME 2221

(Computer Programming)

Time: 3 Hours. Full 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 any missing.

SECTION – A

1(a) What is meant by Computer Programming? Illustrate the structure of a *C* program and explain the different sections of the program. 15

1(b) Define machine and high-level language. How compilation differ from interpretation. 08

1(c) Explain the following terms with example: 12

(i) Identifiers, (ii) Keywords, (iii) Variable, and (iv) Statement.

2(a) What are the relational and logical operators? Explain with example. 10

2(b) Explain the purpose of the following statements with example. 15

(i) For statement, (ii) Do while statement and (iii) While statement.
Explain the difference between them.

2 (c) Write a *C* program to find the sum of 100 numbers. 10

3(a) What is the purpose of Switch statement? How does it differ from if statement? Explain with example. 15

3(b) Write a *C* program to calculate the sum of the following series given x as input. 20

$$1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\cdots\cdots\cdots\cdots+\frac{x^n}{n!}.$$

4(a) In what way an array differs from an ordinary variable? Briefly explain the syntax of multidimensional array. 10

4(b) Write a *C* program to find the transpose of a matrix. 13

4(c) Write a *C* program to convert the seconds to days, minutes and seconds. For example, if 24122000 seconds is given as input, the required output will be 279 days, 4 hours, 33 minutes and 20 seconds. 12

SECTION – B

5(a) Discuss the advantages of user defined functions in *C* language. What is meant by call by value and call by reference in *C* programming? 10

5(b) What is meant by string? Write 5 string functions with their respective purposes. 10

5(c) Write a *C* program to count total number of vowels in a given text. 15

6(a)	Using recursion, write a program in *C* language to find the factorial of a number.	10
6(b)	Write a program to read, write and multiply two matrices A and B using function.	25
7(a)	What is linked list? What are its advantages and disadvantages over an array? Explain.	10
7(b)	Write a program to create a linked list and print it.	25
8(a)	What are the advantages of using data file in C programming.	10
8(b)	Write a program to read name, roll number and CGPA of *n* number of students from a file and store them in another file.	25

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year Special Backlog Examination, 2018
ME 3105/ ME3205(Old)
(Heat Transfer I)

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 any missing.

SECTION-A

1(a) Derive the three dimensional general heat conduction equation in rectangular coordinates. 17

1(b) A concrete slab has cross-sectional area A and thickness L. Air at a temperature T_1 with convective heat transfer coefficient h_1 flows over the surface at $x = 0$ and hot water at temperature T_2 having convective heat transfer coefficient of h_2 flows over the surface at $x = L$ of the plate. Calculate the heat transfer rate for 100 square meter of slab area when $T_1 = 25°C$, $T_2 = 150°C$, $h_1 = 20$ W/m^2·K, $h_2 = 120$ W/m^2·K, k = 1.37 W/m·K and L = 12 m. 18

2(a) What is meant by thermal contact resistance? 05

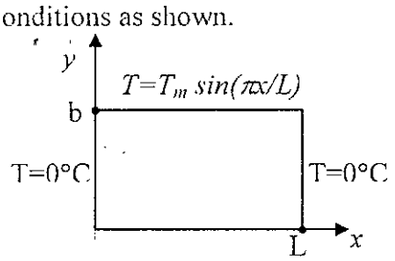
2(b) Consider a long hollow cylinder of inside radius $r = a$ and outside radius $r = b$. The outer surface is heated uniformly at a constant rate of q_0 W/m^2 while the inner surface is maintained at zero temperature. Develop an expression for the steady – state temperature distribution T(r) in the cylinder. 15

2(c) Derive an expression for the critical radius appropriate for the insulation of a sphere. 15

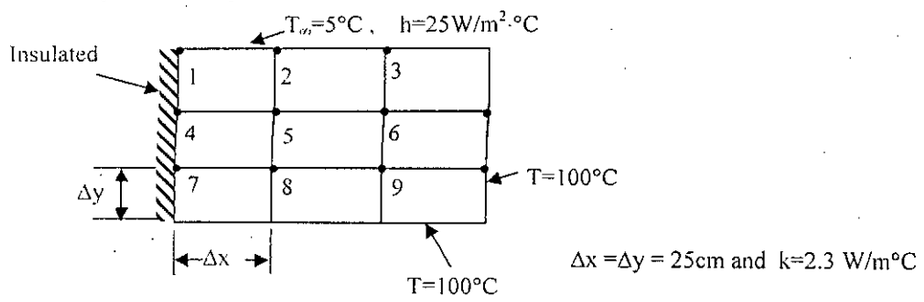
3(a) What is fin? Derive an expression for heat transfer through a sufficiently long fin. 20

3(b) A very long, 1 cm diameter copper rod (k = 377 W/m·K) is exposed to an environment at 22°C. The base temperature of the rod is maintained at 150°C. The heat transfer coefficient between the rod and the surrounding air is 11 W/m^2·K. Determine the heat transfer rate from the rod to the surrounding air. 15

4(a) Derive an expression of temperature distribution T(x,y) for a rectangular plate for the boundary conditions as shown. 16



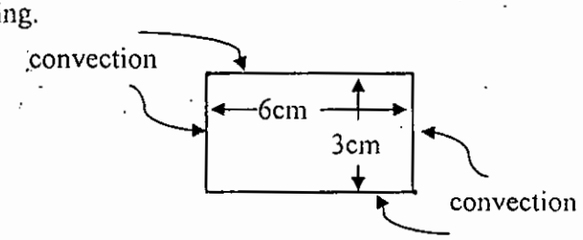
4(b) Calculate the steady state temperature for nodes 5, 6, 8 and 9. 19



SECTION-B

5(a) Explain the Lumped system analysis of transient heat transfer. 15

5(b) A rectangular aluminum bar 6 cm by 3 cm (k = 200 W/cm·°C, C_p=890 J/kg·°C, ρ=2700kg/m^3 and α=8.4×10^{-5} m^2/s) is initially at a uniform temperature T_i = 175°C. Suddenly the surfaces are subjected to convective cooling with a heat transfer coefficient h = 250 W/m^2·°C in an ambient at T_∞ = 25°C as shown in figure. Determine the center temperature T_o of the bar t = 1 minute after the start of the cooling. 20



6(a) Define the terms: 12
(i) Black body (ii) Radiosity, (iii) Reradiation, and (iv) Emissive power.

6(b) What is Stefan–Boltzmann law of radiation? Explain the concept of black body in relation to radiation. 09

6(c) Prove that the spectral black body emissive power is π-times the spectral black body radiation intensity. 14

7(a) Define and explain Wien's displacement law of radiation. 10

7(b) State and Explain Kirchhoff's law of radiation. Show that this law is valid for monochromatic radiation. 10

7(c) What is view factor? Develop the reciprocity relation of view factors between two surfaces. 15

8(a) What is meant by green house effect? What hazards are created due to green house gas? 08

8(b) What is radiation shield? Why it is used? 08

8(c) What is reradiating surface? What is its role in thermal radiation? Derive the expression of net heat flow in a three-zone enclosure of which one is reradiating surface by network method. 19

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year Special Backlog Examination, 2018

ME 3121
(Numerical Computation for Mechanical Engineers)

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 any missing.

SECTION-A

1(a) What is interpolation? Deduce Newton's Forward interpolation formula in general form. 19

1(b) Find $f(1.15)$ using Newton's Backward formula from the following table. 16

x	0.1	0.3	0.5	0.7	0.9	1.1	1.3
$f(x)$	0.003	0.067	0.148	0.248	0.370	0.518	0.697

2(a) Show the relation between Simple and Divided differences. 08

2(b) Deduce trapezoidal rule for numerical integration. 12

2(b) Evaluate $\int_0^1 \frac{1}{1+x}\, dx$ with h = 1/6 by using Simpson's 1/3 rule. 15

3(a) Derive the formula for Newton–Raphson method and state the geometric significance of the formula. 18

3(b) Given that the equation $f(x) = x^3 - 2x - 5 = 0$ has root between 2 and 3. Use the method of regular – falsi to determine it correct up to two decimal places. 17

4(a) Describe the Jacobi method of solution of system of linear algebraic equations. What is its limitation? 15

4(b) Solve the following system of equations by Gauss – elimination method. 20

$$3x + y + 2z = 3$$
$$2x - 3y - z = -3$$
$$x + 2y + z = 4$$

SECTION-B

5(a) Describe the Euler's method for the solution of first– degree ordinary differential equation. What modification is required in this method and why? 18

5(b) Use Range–Kutta method to solve $10\frac{dy}{dx} = x^2 + y^2$, $y(0) = 1$ for the interval $0 \le x \le 0.4$ with $h = 0.1$. 17

6(a) Given that $\frac{dy}{dx} - 1 = xy$, and $y(0) = 1$, obtain the Tailor's series for y(x) and compute y(0.1) correct up to four decimal places. 17

6(b) Fit a function of the form $y = ax^b$ to the following data: 18

x	2	4	7	10	20	40	60	80
y	43	25	18	13	8	5	3	2

7(a) Discretize the followings: 09

(i) $\frac{\partial T}{\partial x}$ (ii) $\frac{\partial^2 T}{\partial x^2}$ and (iii) $\frac{\partial^2 T}{\partial x \partial y}$

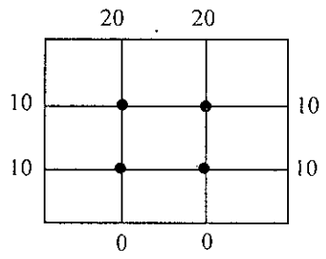
7(b) Derive standard five point rule in solving Laplace equation. 09

7(c) Find the Eigen values and Eigen vectors of the following matrix. 17

$$A = \begin{bmatrix} 5 & 0 & 1 \\ 0 & -2 & 0 \\ 1 & 0 & 5 \end{bmatrix}$$

8(a) Derive Crank–Nicolson method for solving parabolic type partial differential equation. 17

8(b) Solve the equation $u_{xx} + u_{yy} = 0$ in the domain of figure below by Jacobi method for the given boundary conditions to find out the values at four nodal positions (up to five iterations). 18



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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year Special Backlog Examination, 2018

ME 4017

(Refrigeration and Air-conditioning)

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 any missing.

SECTION-A

1(a) What is refrigeration? Explain the vapour compression refrigeration system with neat sketch. 17

1(b) A refrigeration system using R-22 is to have refrigerating capacity of 80 kW. The system follows vapour compression cycle with 5° subcooling and 10 superheating in which the evaporating and condensing temperature are -8°C and 42°C respectively. Determine – (i) the volume flow rate of refrigerant, (ii) COP and (iii) the power required to drive the compressor. 18

2(a) What multi-evaporators and multi-compressors systems are used in refrigeration and why? 12

2(b) Why superheating and subcooling are done in a vapour compression refrigeration system? 06

2(c) What types of condenser are used in refrigeration purpose? Describe the condenser used for a big plant with schematic diagram. 10

2(d) Describe the working principle of a rotary compressor used for refrigeration. 07

3(a) Why an aircraft is needed to cool? What are systems used for cooling aircraft? Describe the Bootstrap system with schematic diagram. 13

3(b) Describe the vortex tube refrigeration system with neat sketch. Where it is used? 07

3(c) Distinguish between primary and secondary refrigerants? Write down the name of three secondary refrigerants. 09

3(d) What are the qualities a good primary refrigerant should have? 06

4(a) What is dry ice? What are the advantages of dry ice? 06

4(b) Describe the Clande system for liquefaction of air with schematic diagram. 10

4(c) What is cryogenics? 03

4(d) A dry ice manufacturing plant produces 500 kg dry ice per hour following a standard system. The upper side and lower side pressures are 10 bar and 2 bar respectively. Calculate the compressor power required for the plant. Assume the temperature of the ambient as 32°C. 16

SECTION-B

5(a) What is Psychrometry? Describe the following process in a psychrometric chart: 09
(i) Sensible heating, (ii) Cooling and dehumidification
(iii) Heating and humidification.

5(b) What is human comfort? What are the factors affecting human comfort? 09

5(c) 20 cmm outside air at 35°C DBT and 24°C WBT is mixed with 80 cmm of return air from conditioned room at 25°C DBT and 50% RH, find the following properties of mixture 17
(i) T_{DB}, (ii) T_{WB}, (iii) T dew point, (iv) h, and (v) w.

6(a) Describe summer air conditioning system with schematic diagram. 07

6(b) What is air washer? What are the functions of it? 08

6(c) What is dehumidification? How many ways the air is dehumidified in air conditioning? 07

6(d) An air handling unit of an air conditioning plant supplies a total of 4000 cmm of dry air which comprises by weight 25% fresh air at 36°C DBT and 24°C WBT and 75% recirculated air at 23°C DBT and 50% RH. The air leaves the cooling coil at 12°C saturated state. Determine the cooling load and room heat gain. 13

7(a) What is meant by infiltration? Describe its effects on the design of an air conditioner. 09

7(b) What is ventilation? Describe the extraction system of ventilation. 10

7(c) 40 cmm of a mixture of outdoor air and recirculated air enters a cooling coil at 34°C DBT and 60% RH. The effective surface temperature of the coil is 6°C. The coil surface area is such that it would give 15 kW cooling effect with the given entering state. Determine the dry bulb and wet bulb temperature of the air leaving the coil and the bypass factor of the coil. 16

8(a) Describe the functions of an air handling system with schematic diagram. 06

8(b) Write down the relative advantages of rectangular duct over a circular duct. Deduce the circular equivalent of a rectangular duct. 08

8(c) What factors are essential to be considered in designing of a duct system? 06

8(d) What are the losses occurred in the duct of air conditioning system? Derive the expression of frictional pressure drop. 15

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year Special Backlog Examination, 2018

ME 4019
(Aerodynamics)

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 any missing.

SECTION-A

1(a) What is circulation? In a velocity field, show that the curl of the velocity is equal to the vorticity. 10

1(b) Derive an expression of lift per unit span for a circular cylinder in terms of circulation. 13

1(c) What is an airfoil? Explain the terminologies in airfoil description with neat sketch. Describe NACA0012 and NACA2412 airfoils. 12

2(a) What are vortex filament and vortex sheet? Explain the physical significance of replacing airfoil surface with vortex sheet in inviscid flow modeling. 10

2(b) Discuss the Kutta condition. Show that circulation at trailing edge of an airfoil is zero, $\Gamma(TE) = 0$. 12

2(c) Show that for a thin symmetric airfoil, the aerodynamic center is located at the quarter chord, C/4 location, where C is the chord length. 13

3(a) Derive the fundamental equation of classical thin airfoil theory. 17

3(b) Show that the lift coefficient is linearly proportional to angle of attack and lift slop is 2π. Use the fundamental equation of thin airfoil theory. 18

4(a) Derive the fundamental equation of Prandtl's lifting – line theory for finite wing. 18

4(b) Consider a rectangular wing with an aspect ratio of 6, an induced drag factor $\delta = 0.055$ and a zero-lift angle of attack of -2°. At an angle of attack of 4°, the induced drug coefficient for this wing is 0.01. Calculate the induced drag coefficient for a similar wing at the same angle of attack, but with an aspect ratio of 10. Assume $\delta = \tau = 0.105$. 17

SECTION-B

5(a) Explain with neat sketch the flowing vortex system: 16
(i) Trailing vortex system, and
(ii) Horseshoe vortex system.

5(b) A finite wing with an aspect ratio of 8 and taper ratio of 0.8 flying at 5° angle of attack. Assume the airfoil section is thin and symmetric, calculate the lift and induced drag coefficient if $\delta = \tau = 0.055$. 10

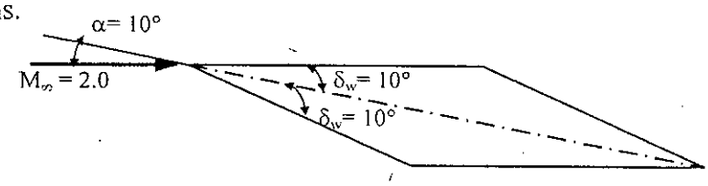
5(c) What is meant by compressibility correction and when this must be accounted for subsonic flow? Differentiate compressible flow from incompressible flow with neat sketch. 09

6(a) Prove that for small perturbation the pressure coefficient $C_p = -\frac{2\hat{u}}{V_\infty}$. where $\hat{u}$ is the perturbation velocity and V_∞ is the free stream velocity. 18

6(b) Show that the linearized pressure coefficient depends only on the x-component of perturbation velocity. 17

7(a) Show that the lift coefficient for a supersonic flow over a flat plate depends on angle of attack alone but independent of camber and thickness. 13

7(b) Use linear theory to calculate the lift and wave drag coefficients for a double-wedged airfoil section with given geometry, incidence and free stream flow conditions. 15



7(c) Explain the differences between the physics of supersonic and subsonic flows. 07

8(a) What is viscous interaction phenomena? How it affects the inviscid flow? 08

8(b) At hypersonic speeds, how do the lift coefficient C_L and drag coefficient C_D for a wing vary with angle of attack α? 10

8(c) Derive the modified Newtonian law for hypersonic flow. How is it differ from Newtonian Sine – squared law? 17

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KHULNAUNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4thYear Backlog Examination, 2018
ME 4021
(Flight Dynamics)

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 any missing.

SECTION – A

1(a) What are meant by aeronautics, aerodynamics and flight dynamics? Explain the relationship between them. 10

1(b) Explain how the reduction of drag has a domino effect on other important aspects of flight? 10

1(c) Name the five basic structural components of airplane. Explain the purposes of these components with clear sketches. 15

2(a) What is airfoil stall? Draw a typical lift co-efficient - angle of attack plot for a combered airfoil. Explain why and how stall occurs with appropriate diagram. 17

2(b) Derive the expression of lift coefficient in terms of pressure coefficient at upper and lower surfaces of the airfoil? 18

3(a) Prove that the minimum thrust required (TR), aerodynamically corresponds to equal to zero lift and drag due to lift ($C_{D,O}$= $C_{D,i}$). 15

3(b) Estimate the lift off distance at sea level for the airplane having the following characteristics: 20

Wing span = 16.25m, wing area = 29.5m^2, Oswald efficiency factor = 0.81, weight = 82965N, $C_{D,O}$= 0.02, $C_{L,max}$= 1.0, Q = 0.76 and the airplane is powered by two turbofan engines of 15280N thrust each at sea-level (ρ_∞ = 1.225 kg/m^3).

4(a) Define load factor and wing loading. Explain the practical constraints that limit maximum load factor using V-n diagram. 15

4(b) What is range and endurance? Derive the Breguet range and endurance formulae for propeller driven airplane. 20

SECTION - B

5(a) Derive an expression of landing ground roll distance for an airplane. Discuss the ways by which the landing ground roll distance can be minimized. 13

5(b) What is meant by stability and control of an airplane? Discuss the different types of stability of an airplane required. 10

5(c) Define aerodynamic center of the wing. Explain why aerodynamic center is a useful concept for the stability and control? Write the criteria for longitudinal static stability of an aircraft. 12

6(a) Define rate of climb. Deduce the expression of rate of climb in terms of excess power. 10

6(b) Discuss the criteria for longitudinal static stability of an aircraft. 07

6(c) Consider an airplane has the following characteristics: 18

Wing area = 50m^2, aspect ratio = 7, Oswald efficiency factor = 0.85, weight = 12000N, zero lift drag coefficient = 0.03, and the airplane is equipped with two engines with 40,000N of static thrust each at sea-level.

(i) Calculate the power required at sea level and,

(ii) Calculate the maximum velocity at sea-level.

7(a) Describe the mechanism of thrust production in two alternate explanations and use the explanations to derive the fundamental thrust equation for jet engines. 18

7(b) Why afterburner is used in a turbojet engine? Explain the working principle of a ramjet engine. 17

8(a) Describe the working principle of turbojet engine. Why afterburner is used in a turbojet engine? 12

8(b) What is meant by detonation? Classify the detonation engines. 08

8(c) A-rocket engine burning hydrogen and oxygen: the combustion chamber pressure and temperature are 25 atm and 3517K, respectively. The nozzle throat areais 0.1 m^2. The area of the exit is designed, so that the exit pressure exactly equals ambient pressure at a standard altitude of 30 Km. For the gas mixture, γ=1.22 and molecular weight $\bar{M}$=16 and $\bar{R} = 8314\, j/Kg\, mol.K$. Calculate; 15

(i) Specific impulse
(ii) Area of the exit

Assume $\rho = 1.786\times10^{-2}$ kg/m^{3}at 30 km altitude.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year Special Backlog Examination, 2018
ME 4113/ ME 4213(Old)
(Fluid Machinery)

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 any missing.

SECTION-A

1(a) Draw the indicator diagram of a reciprocating pump in a suction and delivery sides with the effect of accelerations and frictional head losses. Hence deduce the expression of total head on the suction side for angular displacement of crank angle 61°. 18

1(b) A single acting reciprocating pump has a piston diameter of 0.15 m and a crank radius of 0.30 m, the delivery is 0.10 m in diameter and 30 m long. The water is lifted 20 m above the center of the pump. Find the maximum speed at which the pump can be run so that no cavitation takes place during the delivery stroke and the power requirement for the pump. Assume H_{atm} = 10.3 m of water and separation occurs at 2.6 m of water absolute. 17

2(a) Describe the principle of centrifugal pump for lifting water. 10

2(b) What is priming? Why it requires in running a centrifugal pump? 08

2(c) A centrifugal pump has an impeller 0.5 m outer dia and when running at 550 rpm discharges 700 liters/minute against a head of 10 m. The water enters the impeller without whirl and shock. The inner dia is 0.25 m, and the vanes are set back at outlet at an angle of 40° and the area of flow which is constant from inlet to outlet of the impeller is 0.062 m^2. Calculate (i) the manometric efficiency of the pump, (ii) the vane angle at inlet, and (iii) the least speed at which the pump commences to work. 17

3(a) What are the purposes of draft tube to use in a turbine? Derive the expression of pressure regained by fitting a draft tube. 18

3(b) A ¼ scale turbine model is tested under a head of 12 m. the prototype turbine is required to under a head of 30 at a speed of 425 rpm. At what speed the model be run and it develops 100 kW and uses 1.14 m^3/s of water at this speed, what power will be obtained from the prototype turbine, assuming that its efficiency is 3% better than that of the model? Also indicate the type of runner used in this turbine. 17

4(a) Prove that in Pelton wheel, the maximum hydraulic efficiency depends on the outlet tip angle of the buckets. 17

4(b) Design a Pelton wheel to produce 2016 kW power at a head of 300 m with speed 550 rpm. Ratio of jet diameter to wheel diameter is 1/10. Overall efficiency is 82%. Calculate: (i) the number of jets, (ii) the diameter of the jet, (iii) the diameter of the wheel, and (iv) the quantity of water required. 18

SECTION-B

5(a)	What is open channel flow? Derive Chezy formula for open channel flow.	12
5(b)	Find the most economical section of triangular open channel.	10
5(c)	A trapezoidal channel with side slopes of 2 horizontal to 1 vertical has to carry a discharge of 20 m^3/s. It the bottom width is 4 m, calculate the bottom slope required to maintain a uniform flow at a depth of 1.5 m. Use Manning's n= 0.015.	13
6(a)	Derive the expression of energy dissipation due to hydraulic jump in terms of Froude number.	14
6(b)	What are the applications of hydraulic jump?	06
6(c)	A trapedoidal channel having bottom width 7 m and side slope 1: 1.2 carries a discharge of 90 m3/s. Determine the depth conjugate to initial depth of 0.8 m before the jump. Also calculate the lost of energy in the jump.	15
7(a)	Show that for irrotational flow, the velocity is zero.	08
7(b)	Derive the expression of stream function, ψ for source and sink flow.	14
7(b)	Deduce the expression of ψ for a combined flow of uniform flow with a source flow hence show that how a half body is formed in this case.	13
8(a)	What are the conditions that required to form a doublet? How flow net is formed?	17
8(b)	A line source discharging a flow at 0.7 m^3/s per unit length is located at (-2, 0.5) and a sink of discharge 1.2 m^3/s is located at (2, 0). For a dynamic pressure of 20 N/m^2 at the origin. Calculate the dynamic pressure velocity at (1.1)	18

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