KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 3rd year 1st Term Examination, 2018

ME 3109

(Engineering Mechanics III)

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) Deduce the expression of angular velocity and angular acceleration of the piston by analytical method. 17

1(b) A machine shaft, running at a mean speed of 200 rpm, requires a torque which varies uniformly from 1200 Nm to 3600 Nm during the first half revolution, remains constant for the next one revolution, decreases uniformly to 1200 Nm during the next one revolution and then remains constant for the two revolutions, thus completing a cycle of operations. It is driven by a constant speed motor and a flywheel of radius of gyration of 0.60 m is fitted to the shaft. If the fluctuation of speed is ±2% of the mean speed, find - 18
(i) the power of the motor,
(ii) the mass of the flywheel required.

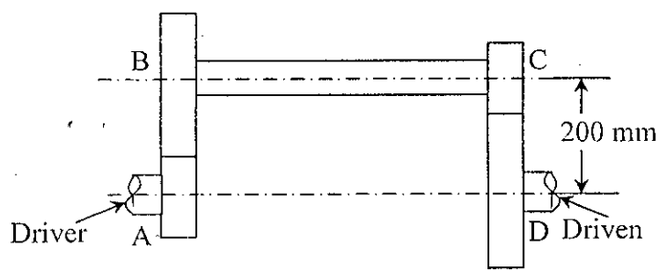
2(a) Deduce an expression for the height of a Watt governor. If a central weight is added to a Watt governor, deduce the expression for the new height and compare the two heights. 20

2(b) A porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the range of speed, sleeve lift, governor effort and power of the governor neglecting the friction at the sleeve 15

3(a) What are the advantages and disadvantages of gear drive? State and prove the law of gearing. 12

3(b) Discuss different types of gear train. 06

3(c) The speed ratio of the reverted gear train, as shown in figure is to be 12. The module pitch of gears A and B is 3.125 mm and that of gears C and D is 2.5 mm. Calculate the suitable numbers of teeth for the gears. No gear is to have less than 24 teeth. 17



4(a) Why primary forces are partially balanced in a reciprocating engine? Explain. 07

4(b) What are meant by direct and reverse cranks method of balancing? Explain. 08

4(c) A two cylinder uncoupled locomotive has inside cylinders 0.6m apart. The radius of each crank is 300 mm and are at right angles. The revolving mass per cylinder is 250 kg and reciprocating mass per cylinder is 300 kg. The whole of revolving and two-third of the reciprocating masses are to be balanced and the balancing masses are placed in the planes of rotation of the driving wheels, at a radius of 0.8 m. The driving wheels are 2m in diameter and 1.5m apart. If the speed of the engine is 80 km/hr; find the hammer blow, maximum variation of tractive effort and maximum swaying couple. 20

SECTION – B

5(a) Discuss different types of followers. 10

5(b) Draw the profile of a cam operating a knife-edged follower from the following data: 25

(i) The follower to move outwards through 4 cm during 60° of cam rotation;
(ii) Follower to dwell for the next 45°;
(iii) Follower to return to its original position during next 90°;
(iv) Follower to dwell for the rest of the cam rotation.

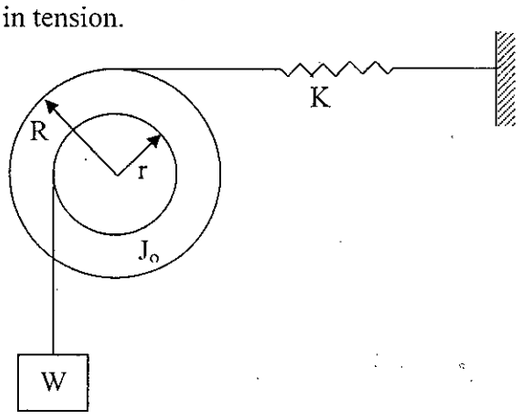
The displacement of the follower is to take place with simple harmonic motion during both the outward and return strokes. The least radius of the cam is 5 cm. If the cam rotates at 300 rpm, determine the maximum velocity and acceleration of the follower during the outward stroke and return stroke.

6(a) Show that the natural frequency of free longitudinal vibration is $f_n = \frac{1}{2\pi}\sqrt{\frac{s}{m+m_c/3}}$, 10

where, s is the stiffness of the constraint, m is mass of the disk and m_c is the total mass of the constraint.

6(b) Derive the expression of natural frequency of free transverse vibration for a shaft subjected to a number of point loads by Dunkerley's method. 10

6(c) Determine the expression for the natural frequency of the system as shown in figure. The tub disks are keyed to a common shaft and have a combined mass moment of inertia about their centre of oscillation O and J_o. It is assumed that the cord attached to W does not stretch and is always in tension. 15



7(a) Explain the terms 'under damping', 'critical damping' and 'over damping'. 06

7(b) What is meant by logarithmic decrement? Deduce the expression for logarithmic decrement. 12

7(c) A mass of 5 kg is supported by a spring of stiffness 5 kN/m. In addition, the motion of mass is controlled by a damper whose resistance is proportional to velocity. The amplitude of vibration reduces to $^1/_{15}$th of the initial amplitude in four complete cycles. Determine the damping force per unit velocity and the ratio of the frequencies of the damped and undamped vibrations. 17

8(a) Deduce the expression for the natural frequency of free torsional vibrations of a geared system. 17

8(b) A 4-cylinder engine and flywheel coupled to a propeller are approximated to a 3-rotor system in which the engine is equivalent to a rotor of moment of inertia 800 kg-m^2, the flywheel to a second rotor of 320 kg-m^2 and the propeller to a third rotor of 20 kg-m^2. The first and the second rotors being connected by 50 mm diameter and 2m long shaft and the second and third rotors being connected by a 25 mm diameter and 2m long shaft. Neglecting the inertia of the shaft and taking its modulus of rigidity as 80 GN/m^2, determine: natural frequencies of torsional oscillations and the positions of the nodes. 18

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 3rd year 1st Term Examination, 2018
ME 3119
(Statistics and Quality Control)

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) Necessary Charts may be supplied on request.
iv) Assume reasonable data if any missing.

SECTION - A

1(a) Define statistics. Construct an Ogive from assumed cumulative frequency table. 10

1(b) What is meant by frequency polygon? Enlist and draw various types of frequency curve. 12

1(c) Determine 6th decile and 3rd quartile of the table. 13

Hourly wages in Taka	No. of workers, f	Cumulative frequency
12.5 – 17.5	32	32
17.5 – 22.5	52	84
22.5 – 27.5	79	163
27.5 – 32.5	114	277
32.5 – 37.5	93	370
37.5 – 42.5	64	434
42.5 – 47.5	26	460
47.5 – 52.5	11	471
52.5 – 57.5	7	478
Total	478	

2(a) Define the terms: (i) Independent event, (ii) Mutually exclusive event, (iii) Dependent event, (iv) Conditional probability. 12

2(b) In a certain assembly plant three machines B_1, B_2 and B_3 make 30%, 45% and 25% respectively are defective. Now, suppose that a finished product is randomly selected. What is the probability that it is defective? 10

2(c) Management suspects that some of the machines are in violation of accepted standards of the product. 20 machines are under suspicion but all cannot be inspected. Suppose that 3 of the machines are in violation. 13

(i) What is the probability that inspection of 5 machines finds no violation?
(ii) What is the probability that plan above will find 2 violations?

3(a) Explain Poisson distribution with properties and example. 10

3(b) In a certain industrial facility accidents occur in frequently. It is known that the probability of an accident on any given day is 0.005 and accidents are independent of each other. 12

(i) What is the probability that in any given period of 400 days there will be an accident on each day?
(ii) What is the probability that there are at most 3 days with an accident?

3(c) A certain washing machine is characterized by the following density function: 13

$$f(x) = \begin{cases} \frac{1}{4} e^{-y/4}, & y \geq 0 \\ 0, & \text{elsewhere} \end{cases}$$

This is an exponential with $\mu = 4$ years. The machine is considered a bargain if it is unlikely to require a major repair before the 6th year.

(i) What is the probability P (y > 6)?
(ii) What is the probability that major repair occurs in the first year?

4(a) What is statistical decision and statistical hypothesis? Show critical region and acceptance region indicating critical value on a normal curve. 10

4(b) What is chi square goodness of fit test? What are the disadvantages of it? 10

4(c) A normal distribution was fit to a flow data in litres/second - 15

Flow (L/s)	7.65	7.95	8.25	8.55	8.85	9.15
Frequency	5	21	35	15	3	1

Test the hypothesis, H_0: Flow has a normal distribution;
H_1: Flow does not have a normal distribution.

SECTION – B

5(a) Define quality. What are the dimensions of quality? Explain with examples. 10

5(b) Control charts for $\bar{X}$ and R is maintained on the outside diameter of a helical spring. The sub-group size is 5. The value of $\bar{X}$ and R are computed from each sub-group. After the inspection of 25 sub-groups, it was observed that $\sum \bar{X} = 51.50$ and $\sum R = 0.375$. The specification for the product is 2.050 ± 0.020. If the dimension falls above the upper specification limit, rework is required; if it falls below the lower specification limit, the product is rejected. If the process is under statistical control and normally distributed, determine the percentages of rework and scrap. Can you make any suggestion to improve the situation? How? Show the improvement numerically. 25

6(a) Define statistical process control. Briefly describe magnificent seven. 12

6(b) The number of non-conforming items in sample size of 150 are shown below. 23

Sample No.	No. of nonconforming items	Sample No.	No. of nonconforming items
1	5	11	7
2	1	12	1
3	3	13	4
4	2	14	2
5	2	15	14
6	4	16	1
7	0	17	2
8	2	18	0
9	8	19	4
10	6	20	2

Construct a fraction non-conforming control chart for these data. Does the process appear to be in control? If not, assume that assignable causes can be found for all points outside the control limits, and recalculate the revised control limits.

7(a) Define acceptance sampling. Describe the effects of sample size and acceptance number in OC curve. 12

7(b) For a single sampling plan by attributes with n = 30, c = 3. Calculate the acceptance probabilities for percent defective; P =5%, P = 9%, P = 12% and P = 15% and draw the OC curve. 23

8(a) Explain the double sampling plan with flow chart. 10

8(b) Describe MIL STD 105E. 08

8(c) A double sampling plan with $n_1 = 50$, $c_1 = 2$, $n_2 = 100$, $c_2 = 4$ and N = 1000. Compute the following if the lot contains 4% defective items. 17

(i) Probability of acceptance after the first sampling.
(ii) Probability of going for second sampling.
(iii) Total probability of acceptance.

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 3rd year 1st Term 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? Develop the relation between simple and divided difference. 08

1(b) Deduce Newton's general interpolation formula. 12

1(c) Use Simpson's $^1/_3$ rule with $h = 0.5$ to integrate $f(x) = 0.2 + 25x + 3x^2 + 2x^4$ from $a = 0$ to $b = 2.0$. 15

2(a) Deduče Gauss's Forward formula using central difference. 17

2(b) From the following table of x and y, find y when $x = 1.45$ using Stirling's formula. 18

x	1.0	1.2	1.4	1.6	1.8	2.0
y	0.0	-0.112	-0.016	0.336	0.992	2.0

3(a) Derive the formula for Newton-Raphson method and state the geometric significance of the formula. When this formula should not wise to use? 20

3(b) Given that the equation $f(x) = x^3 - x - 4$ has roof lies between 0 and 2. Find the real root correct to three decimal places by the method of Regula-falsi. 15

4(a) Explain the following terms: 10
(i) Round-off error (ii) Truncation error
(iii) Pivoting (iv) Condition for the converges of iteration process.

4(b) What are the methods for solving system of linear equations? Distinguish between Jacobi and Gauss-Seidel method. 08

4(c) Solve the following equations by Gauss Elimination method. 17

$$x_1 - 3x_2 + 12x_3 = 31$$
$$4x_1 + x_2 - x_3 = 3$$
$$2x_1 + 7x_2 + x_2 = 19$$

SECTION – B

5(a) Define Eigen value and Eigen-vector. What are the importance of Eigen value and Eigen vector? 08

5(b) Determine the largest Eigen value and corresponding Eigen vector of the following matrix. 12

$$\begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

5(c) Fit a function of the form $y = ax^b$ to the following data. 15

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

6(a) Distinguish between initial value problem and boundary value problem. Derive Euler's formula for the solution of ordinary differential equation and also show how the limitation of this formula is overcome? 17

6(b) Use the Forth order Runge-Kutta method to find the value of y when $x = 1$ from the following equation taking h = 0.5. 18

$$\frac{dy}{dx} = \frac{y-x}{y+x}, \text{ with } y(0) = 1.$$

7(a) What are the steps in finite difference method of solution of partial differential equation? 04

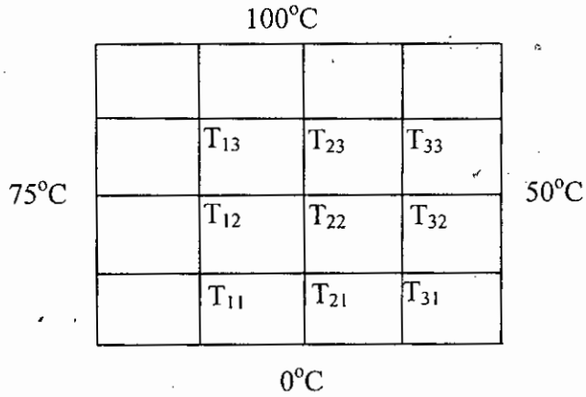
7(b) Distinguish between explicit and implicit schemes. 04

7(c) Derive the expression for Crank-Nicolson implicit scheme which is unconditionally stable. 12

7(d) A 100 mm long conducting rod of rectangular cross section and thermal conductivity k = 20 W/m.K. The temperature of one end is 150°C and the other end is 50°C. All other surfaces are insulated. Assuming steady state heat conduction and using finite difference method with a grid spacing of 20 mm, determine the temperature distribution in the rod. 15

8(a) From the Taylor series for $y(x)$, find y(0.1) correct to four decimal places if $y(x)$ satisfies $y'' - xy' - y = 0$ with the conditions $y(0) = 1$ and $y'(0) = 0$. 17

8(b) Solve the equation $u_{xx} + u_{yy} = 0$ in the domain of figure below using the Gauss-Seidel method with the relaxation parameter $\lambda = 1.5$ for the given boundary condition up to three iterations. 18



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