COURSE CODE:	*MCE 303*
COURSE TITLE:	*Mechanics of Machines I*
NUMBER OF UNITS:	*3 Units*
COURSE DURATION:	*Three hours per week*

COURSE DETAILS:

Course Coordinator:	**Engr. Adekunle, N .Olatunde** B.Sc, M.Sc.
Email:	noadekonle@yahoo.com
Office Location:	**Room 4 PG School**
Other Lecturers:	**None**

COURSE CONTENT:

Elementary study of machine kinematics and dynamics. Velocity and acceleration, diagrams of link mechanisms. Flywheel. Balancing of reciprocating and rotating masses. Gear and gear trains. Governors. Cams and followers. Gyroscopes.

COURSE REQUIREMENTS:

This is a compulsory course for all students in engineering. In view of this, students in the college of engineering are strongly advised to attend classes regularly and have a minimum of 75% attendance to be eligible to write the final examination.

READING LIST:

Design Data Handbook for Mechanical Engineering by D.P. Mandal
Mechanics of Machine (Advanced) by John Hannan and R.C. Stephens.
Mechanics of Machine (ElementaryTheory) by John Hannan and R.C. Stephens.
Theory of Machine R.S KHUMI

LECTURE NOTES

Lecture One

Method of Obtaining the Velocity of Link Mechanism.eg Hack Saw Frame using:

1 Instantaneous Centre Method with illustration

a. Relative Linear Velocities of Points in a Link.

b. Method of Transmitting Motion : Direct contact ,Intermediate Link , and Flexible connector.

Other Methods.

Related Terms

Line of Transmission

Transmission Angle

Deviation Angle

Some specific examples eg. Slider Crank Mechanism, 3 – Bar Mechanism and 4- Bar Mechanism

Determination of Velocity in Mechanism using Polygon Method

Determination of Relative Velocity of Points in a particular Kinematics Link

Determination of Relative Angular Velocities of 2 or more kinematics Links using 2-Bar,3-Bar

Lecture Two

Acceleration Diagram for Links

It plays a vital role in the development of machines and mechanism. The normal acceleration is proportional to the square of the speed, this will affect the centrifugal force ,hence, the acceleration analysis in an important step.

Acceleration diagram for the link

The acceleration centre method

Case 1.Slider crank mechanism

Case 2.Four bar Mechanism

Draw the Mechanism to scale

Draw the velocity vector for the mechanism

Draw the acceleration diagram for the mechanism

Consider link AB as shown in figure below

Draw the link AB according to the specifications and directions indicated.

Assume the angular velocity of link AB to be Ω and the corresponding angular acceleration to be α.

Represent the acceleration of points A and B to be F_a and F_b respectively.

Locate point 0 away from the figure at any convenient position in the plane.

Draw oa and ob in the given direction with respect to the figure in magnitude and direction.

The acceleration of A relative to B can be obtained by joining ba.

Note, f_{ab} has two components $0a_1$ centripetal acceleration –having magnitude Ω^2 AB or $V^{ab}{}_2$/AB its direction is along AB and must be drawn parallel to AB from point b,

(2) Tangential acceleration –has a magnitude of αAB, this is drawn perpendicular to AB.

To locate point a draw a parallel line from b and another perpendicular line to AB to intersect the former line.

Typical example to illustrate to student

Crank and connecting rod mechanism;

Graphical construction for acceleration diagram using –Kleins approach e.g. slider-crank mechanism.

Draw the schematic diagram and identify the elements.

Draw a circle through connection rod, length of connecting rod serves as diameter of the circle.

Draw a perpendicular through 0. Then, produce connecting with crank radius to meet perpendicular line at a point to serve as the centre of the circle.

Draw another circle through centre M locate the points of intersections of two circles.

Draw the common chord through these points.

Lecture Three

Flywheel

TERMS USED IN DESCRIBING FLYWHEEL

Coefficient of Fluctuation of speed, Coefficient of steadiness,

Flunctuation of Energy.

Determination of Maximum Fluctuation of Energy

Introduction to Turning Moment Diagram for Two Stroke Engine, Four Stroke Engine

Deduction of Maximum Energy and Minimum

Energy from Turning Moment Diagram.

Determination of K.E. Energy given up by the flywheel.

Determination of weight of flywheel.

Determination of Tensile stress in the rim of Flywheel due centrifugal Force.

Bending Stress, Tensile Stress.

How to design a Flywheel

Design for RIM, Design for Arm (Hub).

Analysis of stresses in the RIM

Analysis of stresses in the Arm.

Determination of flywheel Data e.g.

Hub length,

thickness, Width,

Depth of the Flywheel.

Lecture Four

Balancing of Rotating and Reciprocating Masses

Causes of imbalance in rotating masses.

Definition for centrifugal force – force acting on a body moving round a circular path. Influence of centrifugal force on bearing support for the shaft carrying masses. Balancing of a single rotating mass

Balance can be achieved in the same plane by another mass.

Consequences / Result of couple

Balancing can also be achieved in another plane by introducing a balancing mass and its consequences.

Balancing can also be achieved by using two masses placed at different plane to reduce the effect of couple. Choosing smaller balance mass and longer radius, larger mass, smaller radius.

Simple example on how to balance the disturbing mass.

Balancing of Several Masses

How to balance several masses revolving in the same plane m_1, m_2, m_3, m_4.

Methods of Balancing several masses in the same plane can be achieved in two different ways: Graphical / Polygon Methods.

For Polygon method, draw the vector force for each mass. Analytical method – obtain centrifugal force produced by each mass and resolve it into two – principal axes to obtain – Horizontal component and vertical component – obtain the resultant and its direction .

Balancing of Several Masses at Different Planes

Balancing of several masses in differential plane can be achieved by using reference plane – obtain the centrifugal force of each mass, the moment of force for each mass, the algebraic sum of the moments.

Obtain the force polygon, moment force polygon by using suitable scale. Tabulate your result.

Examples

Example 1 – A shaft carrying disc supported by bearings. How to find reactions at bearings and its effect.

Example 2.A shaft carrying three masses in the same plane, at different plane.

The effect of the inertia force of the Reciprocation mass on the Engine frame Primary Balance, Secondary Balance of internal combination engine

Lecture Five

Gear and Gear Trains

Combination of two or gears to transmits power or motion.

Brief discussion of types of Gear.

Factors affecting the gear train, velocity ratio, relative position of the shafts.

Types of Gear Trains: simple Gear train, Compound Gear Train, Reverted Gear Trains and Epicylic gear train.

Condition for using gear train- distance between the two shafts is small

- Examples of simple Gear train (each gears is on separate shaft.
- Case 1. 2 gears mating, 3- gears mating, 4 –Gears mating.

Importance of idle Gear.

when the distance between the shafts is large motion can be transmitted in two ways (1) Using large size gear,(2) one or more intermediate gears called idler.

Difference between Driver and follower

Determination of speed ratio, Train value

Speed Ratio defined as the ratio of speed of driver to the driven gear (follower),

Speed Ratio defined as the ratio of number of teeth of driven gear to number of teeth of driving gear .

Compound Gear Train

More than one gear on a single shaft e.g. -4 gears arrangement on three shafts – 6 gears arrangement on four different shafts. Formulae for finding speed ratio for compound Gear Train – deduction from the diagram Speed Ratio – ratio of the speed of 1st driver to speed of the last driven or follower

Product of no of teeth on the driven to product of no teeth on the driver.

Reverted Gear Train

When the axes of the first gear (1st driver) and the last gear(i.e. last driven or follower) are co-axial, then the gear train is known as reverted gear train.

Gear 1 drives gear2 in opposite direction.

Gear2 and 3 are mounted on the same shaft.

Gear 3 drives gear 4in the same direction as gear 1

Lecture Six

Governors

The function of an engine governor is to control the mean speed of an engine within prescribe limits for varying load conditions. It help to manipulates the throttle valve, the fuel pump. It adjusts supply energy of the prime mover

Classification of Governors:

a. Centrifugal Governor

b.Inertia Governors:

Special consideration

Portal Governor,

Proel Governor,

Hartnel Governor.

Description of Centrifugal Governor

Operation principle of Centrifugal Governor

Operation principle of Centrifugal Governor.

Description of Inertia Governor.

Operation principle of Inertia Governor.

Basic Terms used to describe Governor

These include: Sleeve Rise height, maximum speed, Minimum speed, Mean speed, Effort and Power, sensitivity of Governor, Controlling Force, and Stability.

Description of Porter Governor.

Determination of Maximum and Minimum Speed at varying radius.

Range of Speed.

Relationship between speed and Sleeve Heght.

Typical example on Porter Governor.

Proel Governor

Description of Proel Governor.

Operation Principle of Proel Governor

Determination of Maximum and Minimum Speed at varying radius. Range of Speed. Relationship between speed and Sleeve Height.

Typical example on Proel Governor.

Hartnel Governor

Description of Hartnel Governor.

Operation Principle of Hartnel Governor

Determination of Maximum and Minimum Speed at varying radius. Range of Speed. Relationship between speed and Sleeve Height.

Typical example on Hartnel Governor.