

School of Mechanical Engineering

Course Code : BTME2001

Course Name: Engineering Mechanics

The logo of Galgotias University, featuring a stylized 'G' composed of three overlapping curved segments in yellow, blue, and red.

UNIT-5

IMPLUSE MOMENTUM METOD For Connected Bodies

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Program Name: B.Tech (ME)

RECAP – I M Method

- \int is called Impulse.
- The unit of impulse is N-s.
- Mass* Velocity is called momentum of the body in N-s.
- u is initial velocity of the body.
- v is the final velocity of body after time 't'
- $\dots = \dots - \dots$
- The impulse momentum equation holds good if the direction of u , v and R are same
- The components of a resultant linear impulse along any direction is equal to change in the component of momentum in that direction.

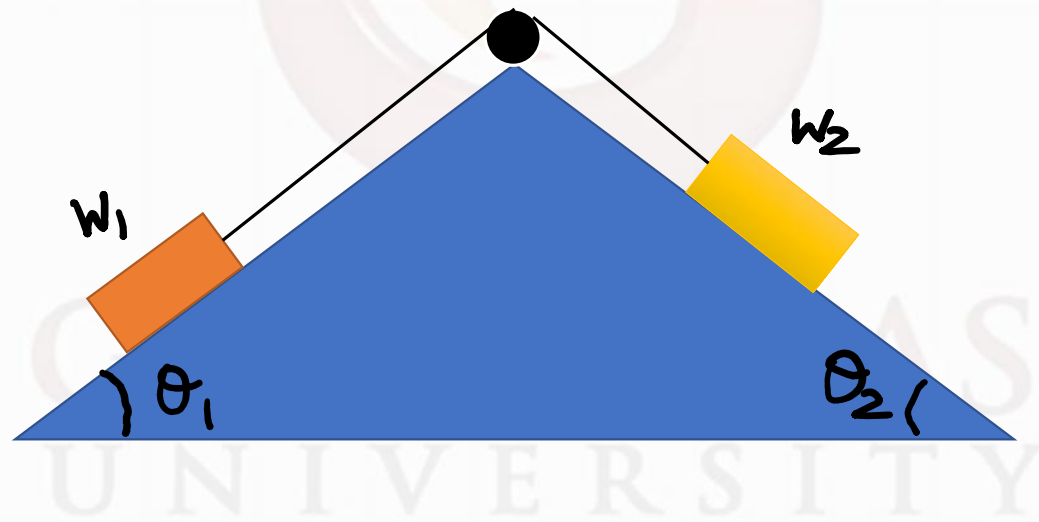
Lecture Objectives

- Apply IM equation to connected bodies.
- Apply IM equation to analyze force of jet on a vane.
- Derive law of conservation of momentum from IM equation.
- Understand the concept of pile hammer.

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Connected Bodies

- This is an example of two connected bodies each having weight of W_1 and W_2 N.
- Generally pulley is considered as smooth.
- The coefficient of friction at plane surfaces is also known.



Connected Bodies – First solution Approach

- The problems involving connected bodies may be solved by any one of the following two methods:
- First Method:
 - A. Free body diagrams of each body is drawn separately.
 - B. Impulse momentum equation for each body in the direction of its motion is written
 - C. Then the equations are solved to get the required values.

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Connected Bodies – Second solution Approach

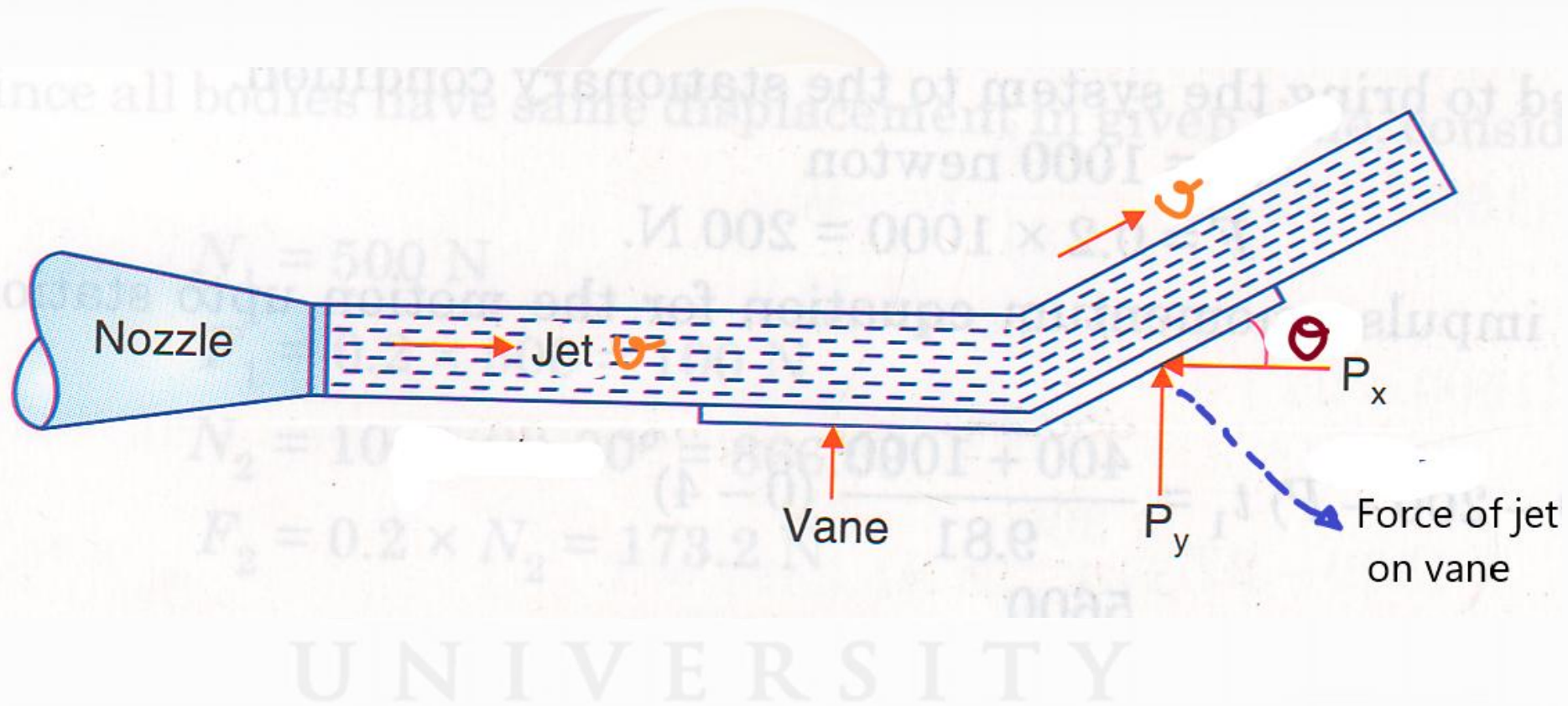
- Second Method:
 - A. If the connected bodies have same displacement in the same time, the impulse Of internal tension in connecting chords will get cancelled.
 - B. Hence free body diagram of combined bodies may be considered
 - C. Then impulse moment equation applied in the direction of motion of combined bodies.
 - D. This method is applicable only if displacement of each body is same in given time.

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Force of Jet on Vane

- In hydro power stations- The IM principle is used.
- Water jet is made to impinge on turbine blades.
- The blades are perfectly smooth made by investment casting.
- The water jets glides over the curved blade surface and gets deflected by a certain angle.
- As the velocity vector changes its direction, the force is exerted on the turbine vane which causes rotation of turbine.
- The mechanical energy is converted to electrical energy by generator.
- The force exerted by the water jet can be determined by applying Impulse momentum equation.

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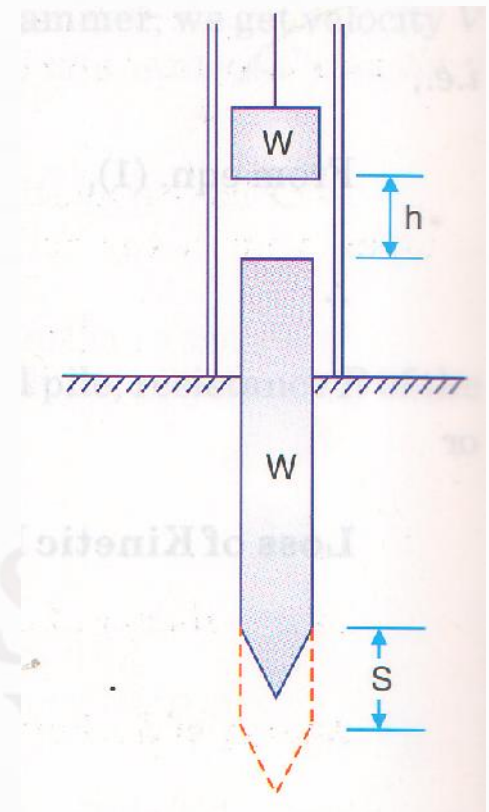


Conservation of Momentum

- $\sum \vec{p} = \text{constant}$
- If $R = 0$, then IM equation will be transformed into $\sum \vec{p} = \text{constant}$
- The principle of conservation of momentum is stated as, “the momentum is conserved in a system in which the resultant force is zero.”
- Alternately, “In a system in which the resultant force is zero, initial momentum will remain equal to final momentum.
- It must be noted that conservation of momentum applies to entire system and not to the individual elements of the system.

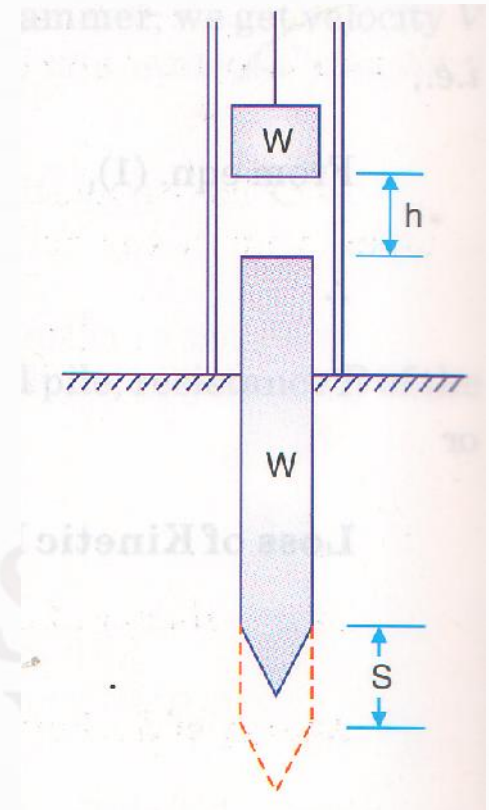
Pile Hammer

- Generally safe bearing capacity of the soil is too less, A set of reinforced concrete or steel poles are driven into the soil. Such poles are known as piles.
- Over a group of piles, concrete cap is cast and on it structure is built.
- The Piles are driven by Pile hammer. It consists of a movable weight called the hammer.
- The hammer raised to a convenient height h and freely dropped.
- It is guided to fall over the pile.
- After the hammer strikes the Pile the hammer and the Pile move downward together.



Pile Hammer

- The kinetic energy of the Pile and the hammer is utilized in doing the work against resistance of the ground and Pile gets driven by a distance 's'.
- By repeated hammering, the Pile driven to required depth.
- If the distance moved per blow is known, earth resistance can be calculated.



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Summary

- $\dot{m} v = \dot{m} v_1 - \dot{m} v_2$
- I M equation can be applied to solve a variety of problems like connected bodies, force of jet on vane and pile hammer.

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Question

- Establish the governing equations for a pile hammer. Given that:

w = weight of hammer

W = weight of pile

h = drop height of hammer

s = distance travelled by pile

R = resistance of earth

A. Prove $\frac{1}{2} w v^2 = w s + \frac{W s^2}{h}$

B. Prove Loss of KE = $\frac{W s^2}{h}$

C. Time during which pile is in motion = $\frac{2s}{v} + \sqrt{\frac{2s}{g}}$

Text Book

Text Book:

- Engineering Mechanics by S. S. Bhavikatti and K G Rajashekharappa, Seventh Multi Color edition, 2019. New Age International Publisher, Delhi, ISBN: 978-93-87788-49-7

Reference Books:

- J. V. Rao, D. H. Young, S. Timoshenko, Sukumar Pati (2013), Engineering Mechanics, Tata McGraw Hill Education. ISBN: 978-1-259-06266-7.
- P. Ferdinand, E. Beer and J. Russell (2010), Vector Mechanics for Engineers, 9th Edition, McGraw-Hill International Edition. ISBN: 978-0-079-12637-5
- Irving H. Shames (2012), Engineering Mechanics – Statics and Dynamics, 4th Edition, Prentice-Hall of India Private limited. ISBN: 978-8-131-72883-3

Thanks!