

**Ministry of higher Education and Scientific Research
Middle Technical University
Technical Institute / Kut**

**Training package
of**

ENGINEERING MECHANICS

For
First class Students
Building and Constructions Department

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ENGINEERING MECHANICS

❖ Course Goals: Intends to provide understanding analysis of static bodies

when the forces and couples applied. Also, study the strength of material

which used select proper material for designing. To be able to solve these

problems which faced in the work field.

❖ Course Description: The course provide students with basic information on

static bodies, and strength of material . These include the analysis of forces,

couples, moment, equilibrium, Friction, centroid, moment of inertia, stress-

strain curve, stresses types, shear effects, shear force and bending moment

diagram, and so on.

Important Notes

- Attendance Policy: It applies policy of Higher Education Ministry of Iraq on this course.
- The classroom doors will be closed 10 minutes after the class start time.
- Be free for any inquire by oral or emailed me any time and will reply you as possible.
- Investing students times not allowed.
- Your time golden: In your professional life dedication and keeping deadlines are your keys for success.

Course Assessments Method

- 1.Assignments and attendance 5 %
- 2.Quizzes approx. 1 per Chapter 5 %
- 3.Mid Exam1. on January 20 %
- 4.Mid Exam2. on April 20 %
- 5.Final Exam on June 50 %

References

1. Singer “strength of materials” 3rd edition,1980 and 4th edition
2. R.C.Hibbeler “ Mechanics of Materials” 8th edition,2008
3. R.J.Hearn “Mechanics of Materials “ 3rd edition,1997
4. Higdon Archie and William B. Engineering Mechanics 3rd edition , United States , prentice -Hall
5. Technical Institute website

Course Weekly Outline :

Week	Topics
1	Definition of mechanics ,force and trigonometric ratios
2	Analysis of forces
3	Triangle force and parallelogram laws
4	Moment of forces
5	Couples
6	Resultant of concurrent forces
7	Resultant of non-concurrent forces
8	Distributed loads
9	Equilibrium in concurrent forces
10	Equilibrium in non-concurrent forces
11	Types of beams and supports
12	Analysis of trusses by method of joints
13	Analysis of trusses by method of sections
14	Friction ,friction theory
15	Laws of friction ,types of friction ,applications
16	Centroids of simple shapes
17	Centroids of complex shapes

18 Moment of inertia for the simple shapes

Week	Topics
19	Moment of inertia for the complex shapes
20	Applications
21	Strength of materials ,definition of stress ,types of stresses factor of safety
22	Strain ,hook ' s law
23	Lateral strain ,poison ' s ratio ,applications
24	Shear force and bending moment diagrams
25	Applications
26	Bending stress for beams
27	Shear stress for beams , Applications
28	Beams which making from two materials
29	Reinforced concrete beams
30	Applications

Lecture No.1

Goals:-

By the end of the class, students will be able to know:

- 1- Classification of forces.
- 2- Trigonometric ratios of angles.

Definitions

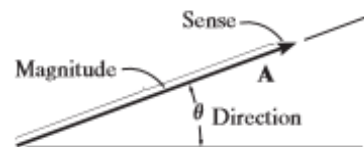
Mechanics: is a branch of physical sciences which describes the motion of bodies with rest being considered a special case of motion.

Mechanics of rigid bodies: is divided into two portions:

- 1-Statics:deals with bodies at rest.
- 2-Dynamics:deals with bodies in motion.

Physical Quantities: is classified to:

- 1-Scalar quantities :have only magnitude(mass ,volume)
- 2-Vector quantities :have both magnitude and direction(couple ,force)



FORCE : Any action which change or try to change the shape ,volume or the motion of a body.

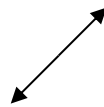
Resultant forces: Is a summation of horizontal and vertical forces components

Basic Quantities.

- ❖ Length(L): is used to locate the position of a point in space and thereby describe the size of a physical system.(m, cm, mm. or ft)
- ❖ Mass(m): is a measure of a quantity of matter that is used to compare the action of one body with that of another(kg, g).
- ❖ Force(F): force is considered as a “push” or “pull” exerted by one body on another(N, lb).

Classification of forces :

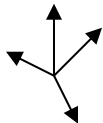
1-Collinear forces.



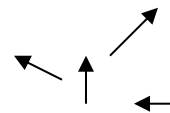
2-Parallel forces.



3-Concurrent forces.



4-Non parallel, non-concurrent forces.



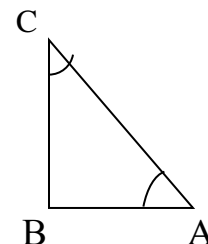
Right angle triangle:

$$\sin \alpha = BC / AC \rightarrow BC = AC \sin \alpha$$

$$\cos \alpha = AB / AC \rightarrow AB = AC \cos \alpha$$

$$\tan \alpha = BC / AB$$

$$\text{Result}(R) = (AC)^2 = (AB)^2 + (BC)^2$$



Notes

To calculate resultant of forces, follow these points:

- 1- Analysis incline forces to rectangular components X,Y.
- 2- Summation of the forces components on X-axis.
- 3- Summation of the forces components on Y-axis.
- 4- Calculate the resultant of the forces.

Questions:

- 1-Define the vector quantities.
- 2-Classify the physical quantities.
- 3- Define and classify forces types

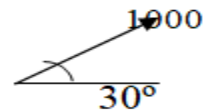
Lecture No.2

Goals:

By the end of this lecture, students will be able to:

- 1- Analyze identical forces.
- 2- Calculate forces components.
- 3- Find resultant of forces.

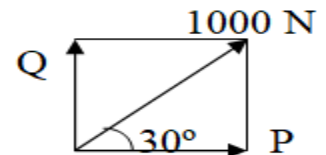
Example: Solve the (1000N) force shown in figure into two perpendicular components .



tion:

$$\sin 30 = Q / 1000 \rightarrow Q = 500 \text{ N}$$

$$\cos 30 = P / 1000 \rightarrow P = 866 \text{ N}$$

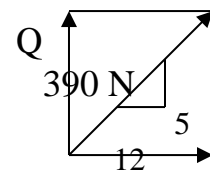
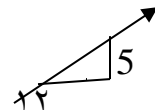


Example: Solve the (390 N) force shown in figure into two Perpendicular components .

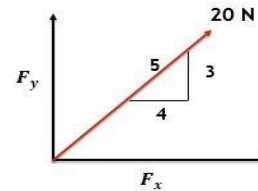
Solution:

$$5/13 = Q/390 \rightarrow Q = 150 \text{ N}$$

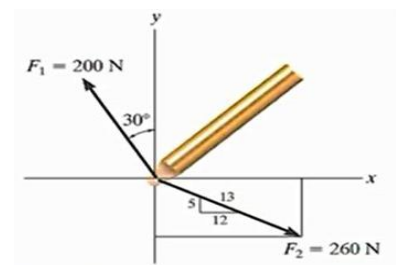
$$12/13 = P/390 \rightarrow P = 360 \text{ N}$$



Example: Determine the force components and result of the force has 20N, as shown in the figure?

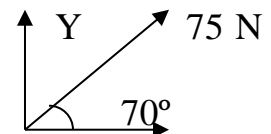


Example: Determine x and y components of forces which acting on the boom shown in the figure.

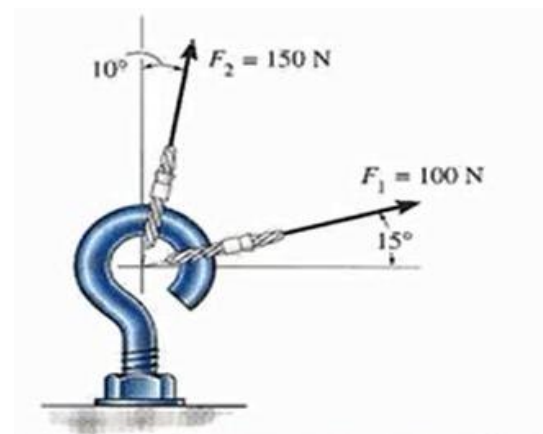


Home Work No. 1

1-Resolve the (75N) into two perpendicular components as shown in figure .



2- The screw eye in this figure is subjected to two forces, . Determine the magnitude and direction of the forces.



Lecture No.3

Goals:

By the end of this class, students will be able to:-

- 1.Determine the non-perpendicular components of forces.
- 2.Use Sin and Cos laws.

Parallelogram :

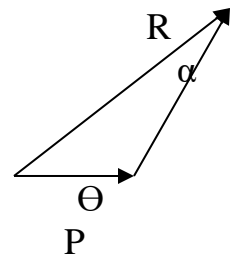
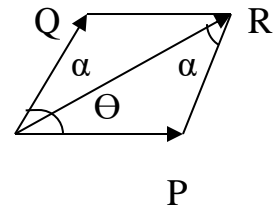
Cos. Law:

$$R^2 = P^2 + Q^2 - 2PQ \cos(180 - \Theta - \alpha)$$

Sin. Law:

$$R / \sin(180 - \Theta - \alpha) = Q / \sin \Theta = P / \sin \alpha$$

Q

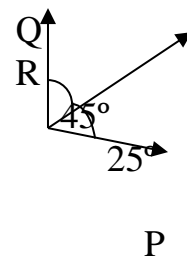


Example :Resolve the (300N) force into two components as shown in figure .

Solution :

$$180 - 45 - 25 = 110^\circ$$

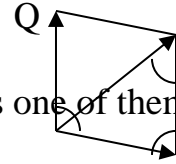
$$300 / \sin 110 = P / \sin 45 \rightarrow P = 225.7 \text{ N}$$



$$300 / \sin 110 = Q / \sin 25 \rightarrow Q = 134.69 \text{ N}$$

$$R = 300 \text{ N}$$

Example: Solve the (600N) force shown in figure into two components one of them perpendicular on the inclined surface and the other parallel to it .



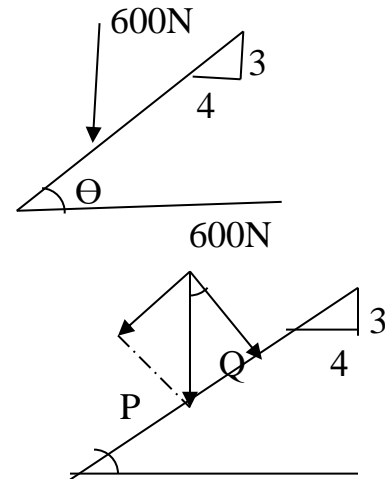
Solution:

$$\sin \theta = P / 600$$

$$3/5 = P / 600 \rightarrow P = 360 \text{ N}$$

$$\cos \theta = Q / 600$$

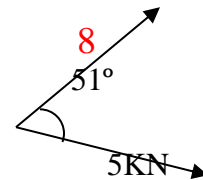
$$4/5 = Q / 600 \rightarrow Q = 480 \text{ N}$$



Example: Determine the magnitude of resultant for the two forces shown in figure .

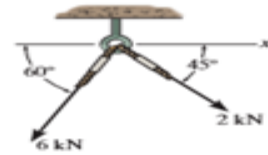
Solution:

$$\begin{aligned} R^2 &= P^2 + Q^2 - 2PQ \cos(180 - \theta - \alpha) \\ &= (8)^2 + (5)^2 - 2 \cdot 8 \cdot 5 \cdot \cos(129) \\ &= 139.34 \\ R &= 11.8 \text{ N} \end{aligned}$$

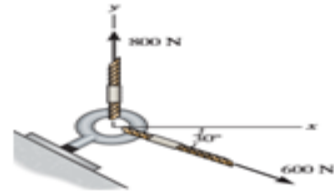


Home work

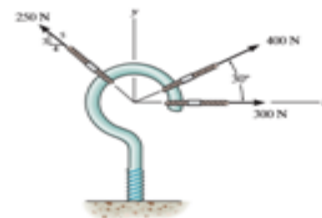
1- Determine the magnitude of the resultant force acting on the screw eye and its direction.



2- Determine the magnitude of the resultant force and its direction.



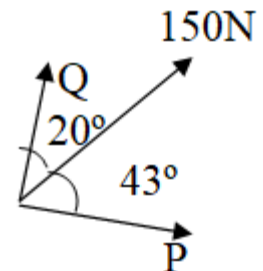
3- Determine the magnitude and direction of the resultant force.



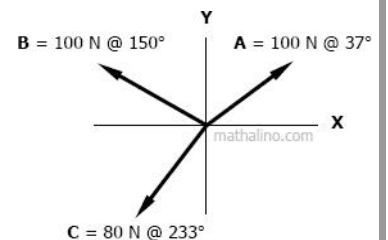
4- Resolve the (150N)force into two components as shown in figure .

Answer:

4- $P=57.57\text{N}$, $Q=114.81\text{N}$



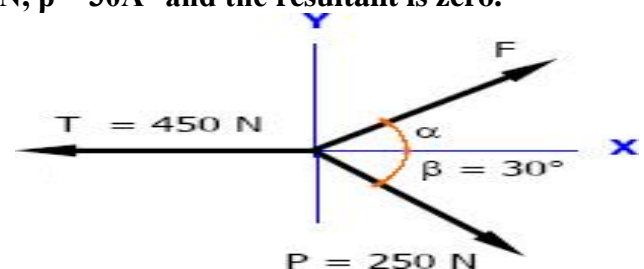
EX: Three vectors A, B, and C are shown in the figure below. Find (magnitude and direction) of the three vectors.



Ex: Forces F, P, and T are concurrent and acting in the direction as shown in fig.

1- Find the value of F and α if $T = 450\text{ N}$, $P = 250\text{ N}$, $\beta = 30^\circ$, and the resultant is 300 N acting up along the y-axis.

2- Find the value of F and α if $T = 450\text{ N}$, $P = 250\text{ N}$, $\beta = 30^\circ$ and the resultant is zero.



Lecture 4: Moment

Moment Of Forces: is a measure to its tendency to turn a force about a point or axis

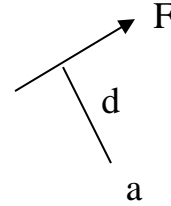
Mathematical expression of moment:

$$M_a = F \cdot d$$

Where:

F = Magnitude of force.

d = Perpendicular distance between the force and the point.



Assumptions: Direction of Moment:

Clock wise \Rightarrow -

Counter clockwise \Leftarrow +

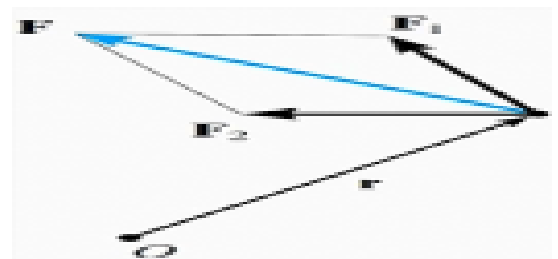
Units of Moment: N.cm , N.m , Kn.m , Ib.in .

Varignon's Theory:

Moment of a force about any point or axis is equal to sum for the moments of its components about the same point or axis as described.

$$[M_o = R * d = F_1 * d_1 + F_2 * d_2 + F_3 * d_3 + \dots]$$

$$\mathbf{M}_O = \mathbf{r} \times \mathbf{F} = \mathbf{r} \times (\mathbf{F}_1 + \mathbf{F}_2) = \mathbf{r} \times \mathbf{F}_1 + \mathbf{r} \times \mathbf{F}_2$$



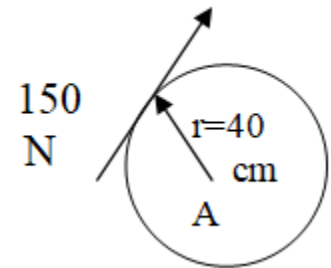
Example: Determine the moment of the (100N) force shown in figure about the axis through Point A .

Solution:

$$+ \curvearrowright M_a = F \cdot d$$

$$= - 100 \times 50 = -5000 \text{ N.cm}$$

$$= 5000 \text{ N.cm} \quad \Rightarrow$$



Example: Determine the moment of the (130N) force shown in figure about the axis through Point A .

