Ministry of high Education and Scientific Research
Southern Technical University
Technological institute of Basra
Department of mechanic Techniques

Learning package

Engineering Mechanics **1 (M112)**

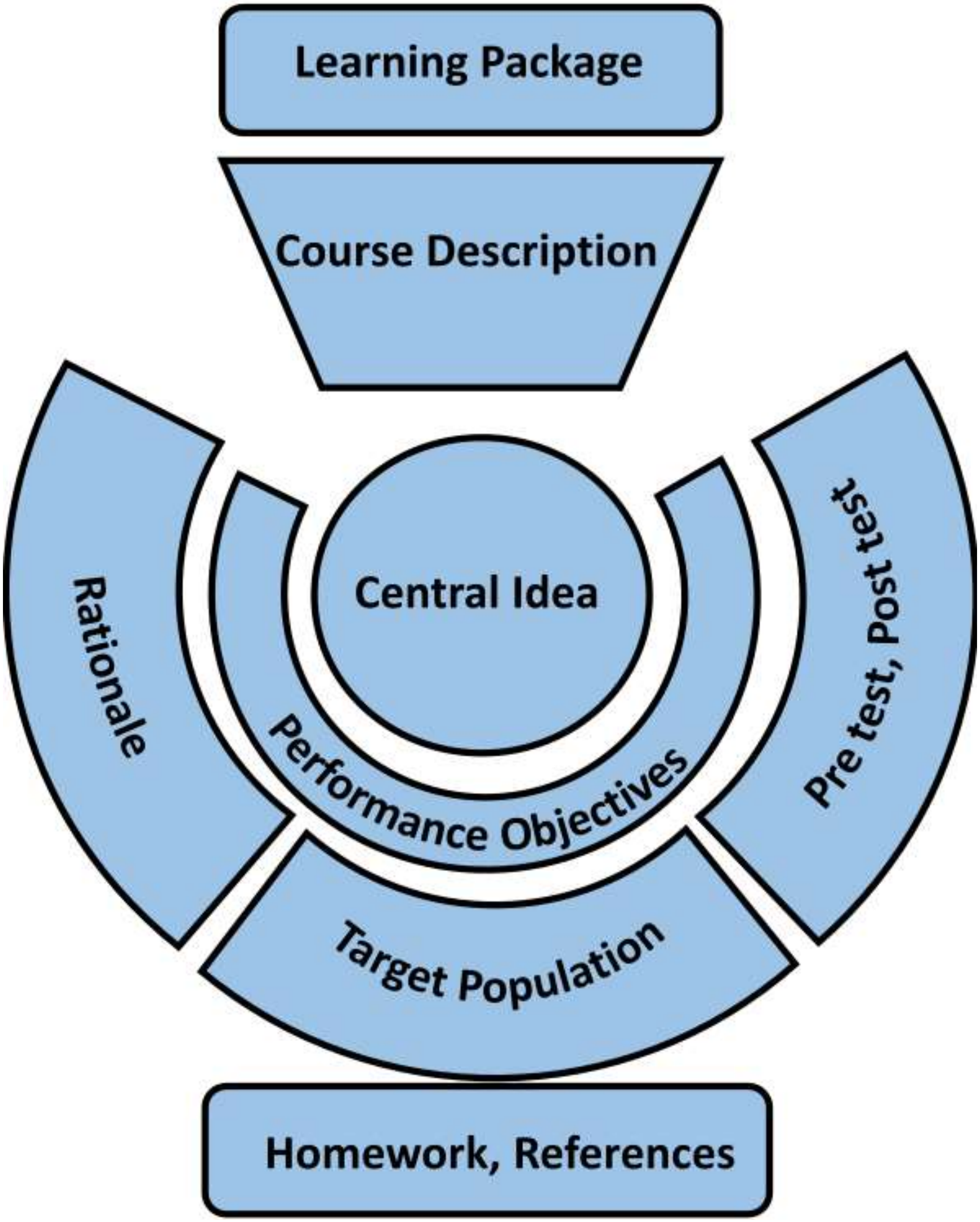
For

First year students

By

Khalda Mohammed
Assistant Teacher
Dep. Of Mechanic Techniques
Production branch

2025


Learning Package
Course Description
Central Idea
Rationale
Performance Objectives
Pre test, Post test
Target Population
Homework, References

Course Description

Course Name:	
Engineering Mechanics 1	
Course Code:	
M112	
Semester / Year:	
Semester	
Description Preparation Date:	
14/ 05/ 2025	
Available Attendance Forms:	
Attendance only	
Number of Credit Hours (Total) / Number of Units (Total)	
75 hours/5 hour weekly/4 unit	
Course administrator's name (mention all, if more than one name)	
Name: Khalda Mohammed Email: kh.hydar@stu.edu.iq	
Course Objectives	
1. The student learns the meaning of engineering mechanics, its divisions, and some concepts that help in understanding the science.. **2.** Applying important concepts such as force analysis to be able to access the rest of the topics, all in a state of rest, i.e. the body is stationa or about to move. **3.** Developing practical skills: Providing practical training through laboratory experiments, allowing students to acquire the skills necessary t link theories to practical reality.	• ..... • ..... • .....

4. Knowing the importance of what the student has learned theoreticall in practical and life situations. **5.** Enhancing Critical Thinking: Encouraging students to engage in critic and analytical thinking when solving problems related to mechanic.	
Teaching and Learning Strategies	
1. Cooperative Concept Planning Strategy. **2.** Brainstorming Teaching Strategy. **3.** Note–taking Sequence Strategy. **4.** Examples, exercises and problems used to achieve the objectives.	
Course Structure	

Weeks	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1 2 3 4 5 6 7 8 9 10 11 12 13 14	5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours	**1.** Basic concepts. Types forces and their relationship systems. **2**DevelopingCritical Thinking and Problem-Solving Ski through Analysis forces **3.**to Use Electronic Laboratory Tools, such as forces drum and shape center finder **4.** Finding the resultan of forces and moments 5. Understand and learn find the centers of shape and the work of inertiaز	1-1Static, fundamental concepts, forces scalars and vectors ,units ,force polygon, Cartesian components 2.Analysis of forces 3.Resultant of concurrent, coplanar force system(2-D) 4.Moments	1.Conduct laboratory experiments to construct and te force and resulta analysis. 2. This reinforce theoretical understanding a develops practic skills.. **3.**Reviewing concepts periodically and applying them to new problems t reinforce memory and understandin	Weekly, Monthly, Daily and Written Exams, and Final Term Exam.

			4.Couples, the transformation of the couple and the force 5.Equilibrium, free body diagram(F.B.D) condition(2-D) condition(2-D) 6.Friction ,type of friction ,dry friction 7.,centroid 8.moment of inertai	**4.**Using education software and Interactive application to bett understand concepts. **5.** Linking the understanding of engineering mechanics to othe sciences.	

Course Evaluation	
Distribution as follows: 20 points for Midterm Theoretical Exams for the first semester, 20 points for Midterm Practical Exams for the first semester, 10 points for Daily Exams and Continuous Assessment, and 50 points for the Final Exam.	
Learning and Teaching Resources	
Required textbooks (curricular books, if any)	Holdsworth, Brian, and Clive Woods. Digital logic design. Elsevier, 2002.
Main references (sources)	1 .Engineering Mechanics: Statics 14th ed. Hibbeler. 2. Engineering Mechanics, 5Th Edn: Timoshenko.
Recommended books and references (scientific journals, reports…)	

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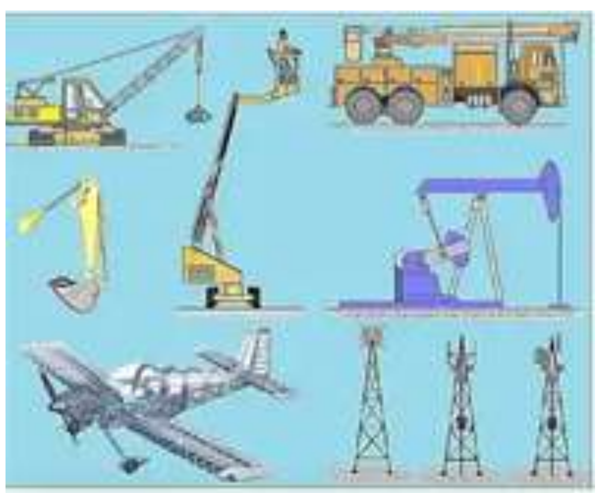
Learning package
In
Engineering Mechanics
For
Students of First Year



Khalda Mohammed
Assistant Teacher
Dep. Of Mechanic Techniques
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2025

Classroom code wprpjg3

1/ Overview

1 / A –Target population :-

For students of First year
Technological institute of Basra
Dep. Of Mechanic Techniques

1 / B –Rationale :-

Understanding the basic principles is crucial to gaining a comprehensive knowledge of engineering mechanics, which is why I have created this module to facilitate learning on the subject.

1 /C – Performance Objectives

After studying the first unit, the student will be able to:-

1. Know fundamental concepts
2. Know the types of forces and forces polygon
3. Know scalars and vectors quantities
4. Know the Cartesian Component

2/ Pretest :

1- Engineering Mechanic

3/ Content :-

1. Engineering Mechanic

2.Definition of Engineering Mechanic

Is the physical science deal with the effects of forces on the objects or particle.

3.The types of Engineering Mechanic

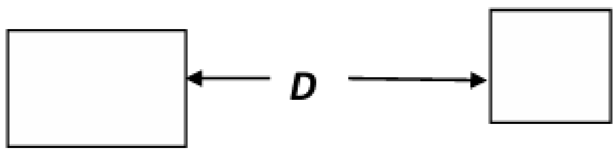
Engineering Mechanics

Static ← → Dynamic

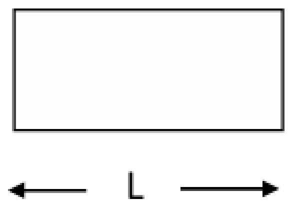
Static Mechanic: It is the study of the effect of forces on rigid bodies without moving them or being about to move.

4. Fundamental Concept

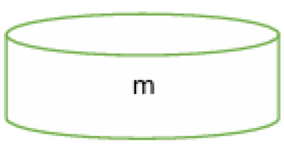
4.1/Distance (D): It is the verticality distance between two points without specifying the direction.



4.2 /Length (L): It is the distance between the beginning and end of the body, depending on the direction.



4.3/mass (m): A physical amount, defined as the amount of matter a body contains.



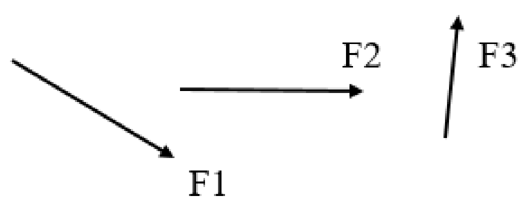
4.4/Rigid body: They are solid, inflexible bodies whose shape or size do not change when exposed to forces. Like iron and copper.

5-Forces

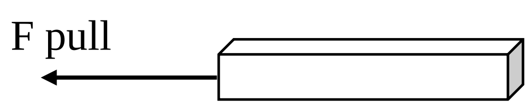
5.1-Force: It is the effect on the body of moving it or trying to move it, it may be internal or external and is divided into Push force or pull forces.

It is symbolized by an arrow that begins at the point of influence and points toward the potential for movement. Force has a point of influence, a numerical value, and a direction.

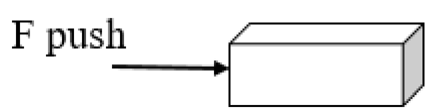
5.2- Effect of Forces



5.2.1-Pull force: It extends from the body to the outside and is represented by arrow as shown in figure.



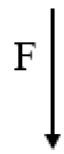
5.2.2-Push force: It is from the outside towards the body and is represented by arrow as shown in figure



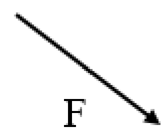
5.3 -Types of Forces

5.3.1-horizontal force.

5.3.2 -vertical force

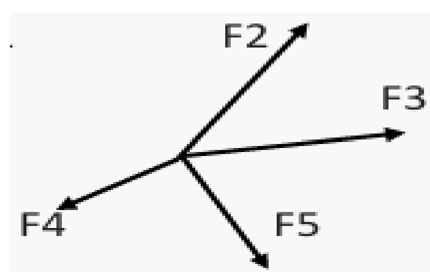


5.3.3 -slope force

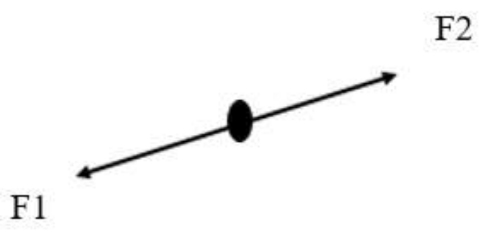


<u>6-Forces system –:-</u>

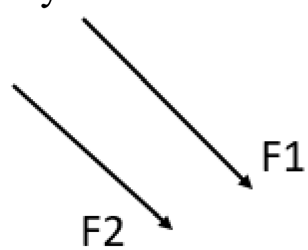
6.1-Concurrent coplanar: a group of forces that converge at a point and lie in on plane.



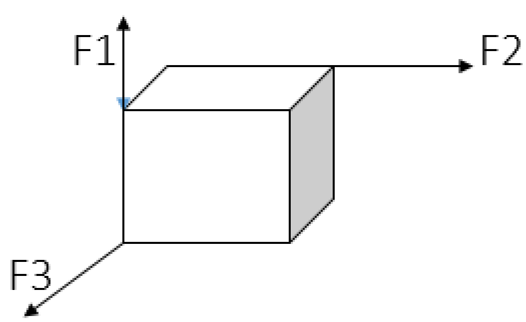
6.2-Collinear system: a group of forces that converge at a point and lie in on plane, and lie on one straight line.



6.3-Parallel coplanar: a group of parallel forces location in on plane that may by in one direction or in two directions**.**

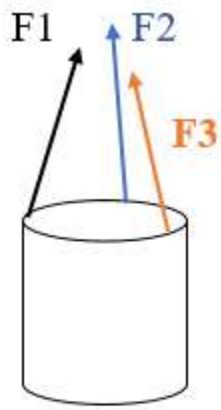


6.4 - Non concurrent non parallel coplanar system: It is a set of non- contiguous, non- parallel forces are located in one plane.

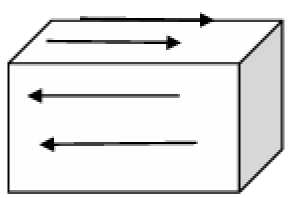


6.5- Concurrent non-coplanar forces system: It is a group of forces

which concurrent but are not located on one plane.



6.6-parallel non-coplanar forces system: It is a group of forces that parallel but are not located on one plane.



7- Scalars and Vectors quantity

7.1-Scalars Quantity: are quantities that are defined only by their magnitude and have no direction. Like length and mass.

7.2 Quantities: are quantities known by their magnitude and direction, such as displacement and weight.

8- Unit

Base Units

There are seven base units in the International System of Units:

8.1-The meter, which measures length and is symbolized by the letter "m." A meter of length is defined by the wavelength of radiation from a krypton atom.

8.2-The gram, which measures mass and is symbolized by "g."
8.3-The second, which measures time and is symbolized by "s." It is defined by the duration of radiation from a cesium atom.
8.4-The ampere, which measures electric current and is defined by the electrodynamic force between two conductors.
8.5-The kelvin, which measures temperature and is symbolized by "k."
8.6-The candela, which measures light intensity (not an abbreviation for "candela"), is the amount of radiation produced by a frozen platinum atom.
8.7-The mole, which is a unit of measurement commonly used in chemistry, is Avogadro's number (approximately 6.0221415×10^{23}) of molecules. If we are talking about helium, for example, it is the number of helium atoms because it does not form molecules.

9- Cartesian compounders

Cartesian compounders" is not a standard or widely recognized term in mathematics or computer science. However, the term "Cartesian" is closely associated with the Cartesian product, which is a fundamental concept in set theory and beyond, and "compounder" could refer to combining elements in various ways. It is likely a misunderstanding or a non-standard phrasing for the Cartesian product of sets or related concepts, such as Cartesian coordinates or Cartesian products in databases.

4/ Post test -

1- What is the difference between Scalars and Vectors?

2- 2- What is the difference between Pull and push forces?

6/References :-

Forces Analysis

1/ Overview

1 / A –Target population :-

For students of First year
Technological institute of Basra
Dep. Of Mechanic Techniques

1 / B –Rationale :-

Understanding the basis of the expected motion of a given body depends on the direction of the forces acting on it and on the system of forces acting on the body.

1 /C – Performance Objectives

After studying the second unit, the student will be able to:-

1. Know the importance of power analysis in solving problems.
2. Know how to analyze a force whose slope is known relative to the x-axis. If there is a horizontal-to-vertical slope ratio, find its chord and then find the trigonometric ratios.

2/Content:-

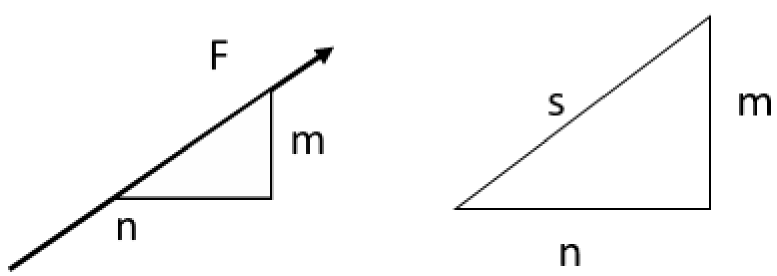
2. Forces Analysis

Decomposing oblique force into two perpendicular forces.

There are several cases in which inclination forces are given.

2.1 -when the slope force is given in the right –angled triangle whose hypotenuse is parallel to the force.

-



From Pythagorean rule

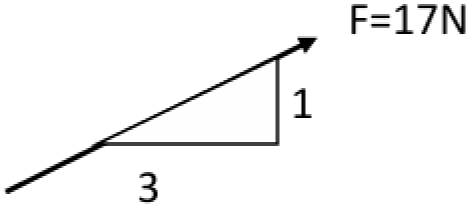
s=$\sqrt{n^2+m^2}$

sin α=m/s , cosα=$n\,/s$

F y=F sinα (vertical component)

F x=F cosα (horizontal component)

Example (1): find the components of forces shown in the figures below?

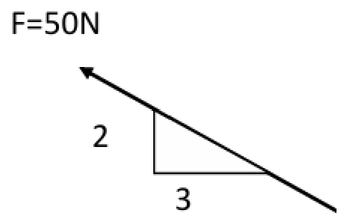


sol.: s=$\sqrt{1^2+3^2}$ =$\sqrt{1+9}$ = $\sqrt{10}$ = 3.2

sin α=$\frac{m}{s}=\frac{1}{3.2}$, Fy =17× $\frac{1}{3.2}$ =5.3N

con α=$\frac{n}{s}$ =$\frac{3}{3.2}$, Fx =17× $\frac{3}{3.2}$ =15.9N

Example (2): find the components of forces shown in the figures below?

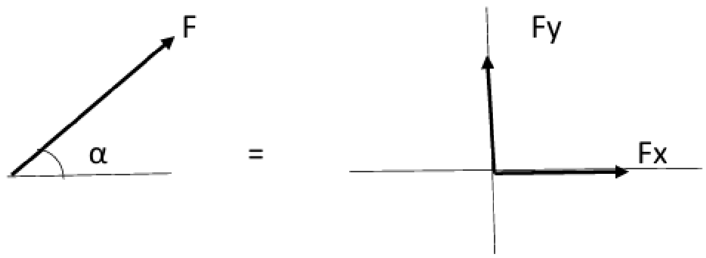


sol.: s=$\sqrt{2^2+3^2}$ = $\sqrt{4+9}$ = $\sqrt{13}$ = 3.4

sin α=$\frac{m}{s}=\frac{1}{3.4}$, Fy =17× $\frac{1}{3.4}$ =5 N=

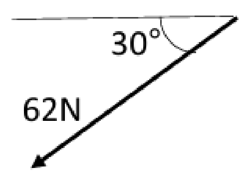
con α=$\frac{n}{s}=\frac{3}{3.4}$, Fx =17× $\frac{3}{3.4}$ = - 15N

2.2-when the slop is given a direction.

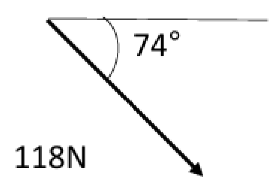


F y=F sinα (vertical component)
F x=F cosα (horizontal component)

Example (1): find the components of forces shown in the figures below ?



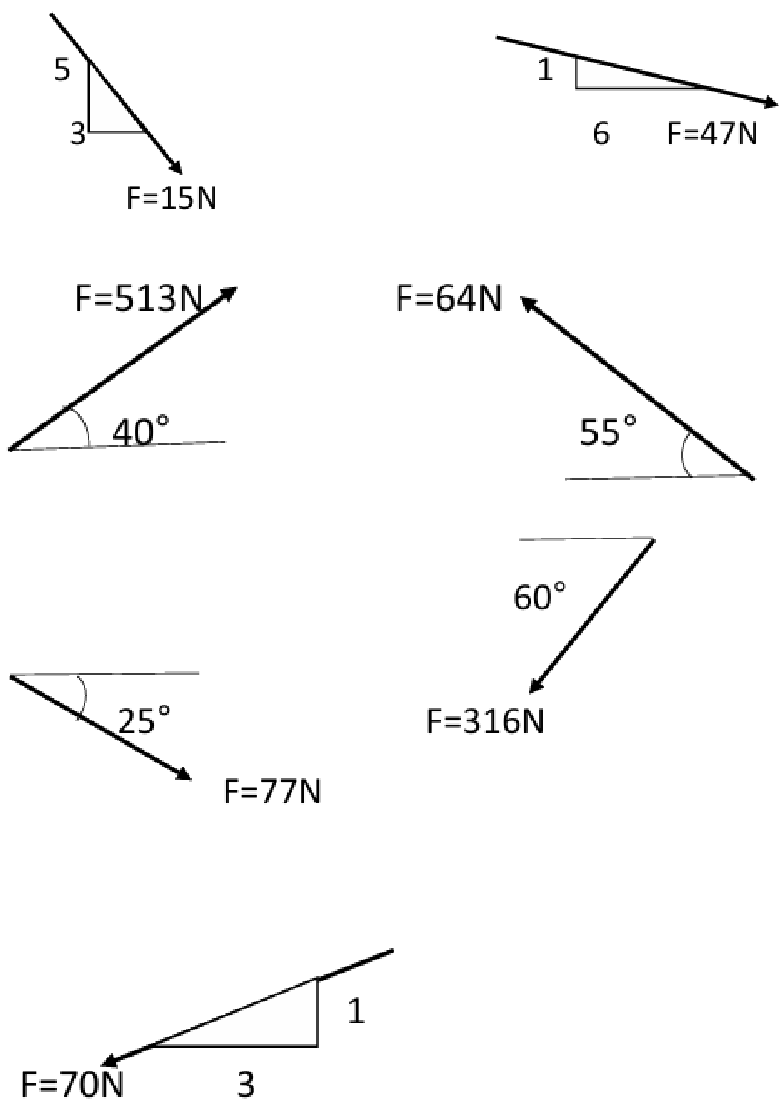
Sol:-
Fy =F sinα , Fy =62sin30° = -31N
Fy =F sinα , Fy =62sin30° = -31N



Sol.:
Fy=F sinα , Fy=118sin74° = -113.4N
Fx=F cosα , Fx= 118cos74° =32.5N

4/ Post test -

Home work



3-Resultant

1/ Overview

3 / A –Target population :-

For students of First year
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3 / B –Rationale :-

Understanding the meaning of the resultant forces acting on a particular body is the basis for finding them and their relationship to each other.

3 /C – Performance Objectives

After studying the second unit, the student will be able to:-

1. Know how to find the resultant of two forces acting on a straight line.

2. Know how to find the resultant of two forces that are perpendicular or between them at an angle between 0 and 90 degrees.

3. Know how to find the resultant of a group of forces converging at a point .

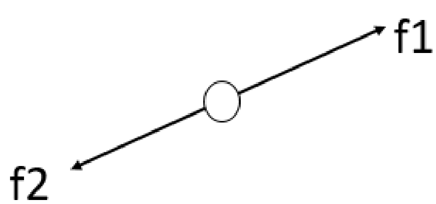
2/ Pretest :

2.1-How do I find the sine of an angle given the height and base of a triangle?
2.2-How do I find the horizontal component?

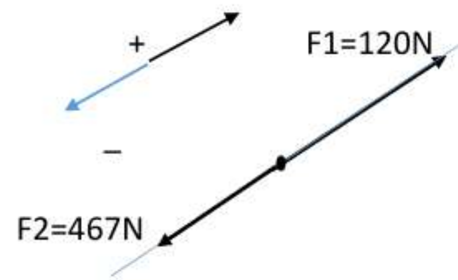
3/Content:-

3.1-resultant
It is a force equivalent to the effect of a combination of forces, location and direction.

3.1.1- When the forces lie on one straight line.
$R = \sum F$



Example 1: calculate the resultant to the forces shown in figure below?



Sol. R =∑F

R=F1-F2

R=120 -467 = -347N

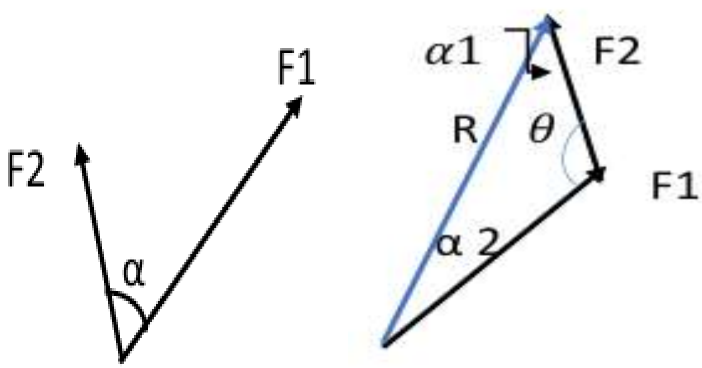
3.2.1- When two forces have an angle between them.

3.2.2. -How to solve by drawing?

a-the force (F1) is drawn in same original direction and with a drawing scale that represent the value of the force.

b- From the arrowhead of (F1), we draw (F2) in its direction and a drawing scale That represents it

$\Theta = 180° - \alpha$



c- How to solve by equation?

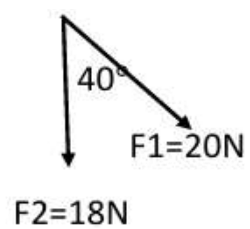
$R=\sqrt{F12+F22+2F1F2\cos\alpha}$

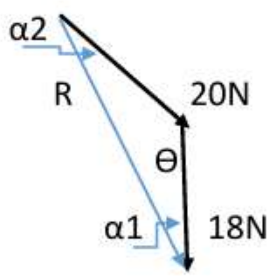
d-To find the direction (calculate angle between R and F1 ,F2 by sin law).

$$\frac{R}{sin\theta} = \frac{F1}{sin\alpha 1} = \frac{F2}{sin\alpha 2}$$

$$\alpha = \sin^{-1}\frac{F \sin \Theta}{R}$$

Ex 1: calculate the resultant to the two forces shown in figure below?





Sol.:- $\theta = 180° - 40° = 140°$

$R=\sqrt{F12+F22+2F1F2\cos\alpha}$

$R=\sqrt{202+182+2\times20\times18\cos40°}$

$\sqrt{400+324+551} = \sqrt{1275.5} = 35N$

$$\alpha = \sin^{-1}\frac{F1\ \sin\Theta}{R}$$

$$\alpha = \sin^{-1}\frac{20 \sin 140°}{35}$$

3.3.1 When two forces have a right angle between them.

3.3.2 -How to solve by drawing?

a-The first force is vertical and the second is horizontal. Draw two parallels to them to complete a rectangle.

b-The diameter of the rectangle from the point of application of the two forces represents the resultant.

c- How to solve by equation?

R=$\sqrt{F1 + F2}$

d-To find the direction (calculate angle between R and F1 ,F2 by tan law).

tanα =$F1F2$

α=$\tan^{-1}\frac{F1}{F2}$

By calculator = shaft tan $\frac{F1}{F2}$

Ex1: - Calculate the resultant of the forces shown in the figure below?

Slo.

R= $\sqrt{Fx^2 + Fy^2}$

R=$\sqrt{160^2 + 80^2}$

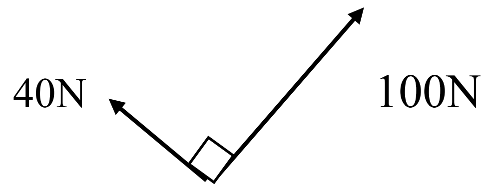
R=$\sqrt{25600 + 6400}$

R=$\sqrt{32000}$ =178N

$\tan\theta = \frac{Fy}{Fx} = \frac{80}{160} = 0.5$

$\theta = \tan^{-1}\frac{80}{160}$ = 26.6°

Ex2: - Calculate the resultant of the forces shown in the figure below?



Slo.

R= $\sqrt{Fx^2 + Fy^2}$

R=$\sqrt{40^2 + 100^2}$

R=$\sqrt{1600 + 10000}$

R=$\sqrt{11600}$ =108N

$\tan\theta = \frac{F1}{F2} = \frac{40}{100} =$

θ=$\tan^{-1}\frac{40}{100}$ = 21.8°

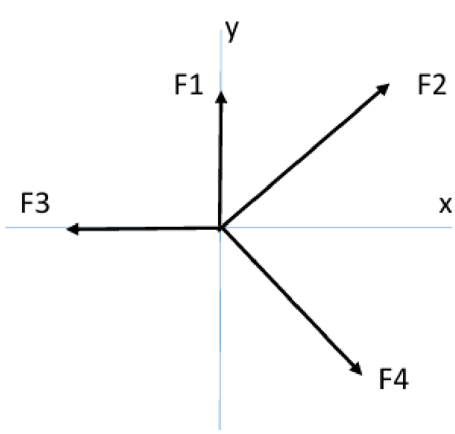
3.4.1 When two forces have a right angle between them.

3.4.2 -How to solve by drawing?

a-analysis the slop forces into two components (horizontal and vertical).

b- horizontal compounds and horizontal forces combine together (∑Fx).

c- vertical compounds and vertical forces combine together (∑Fy).



4- To find resultant use the equation

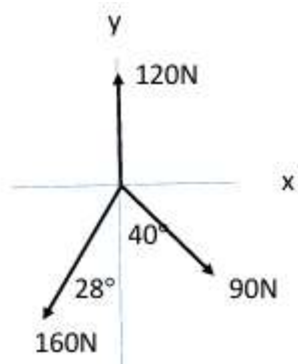
R=$\sqrt{\sum Fx^2 + \sum Fy^2}$

5- To find direction of resultant

Tan α=$\frac{\sum Fy^2}{\sum Fx^2}$

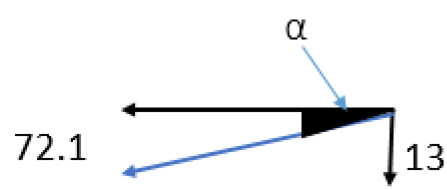
α= $\tan^{-1}\frac{\sum Fy^2}{\sum Fx^2}$

Ex.1 Calculate the resultant of the forces shown in the figure below?



Sol. :

$\sum Fx$= 90 cos 40°- 160cos 28°
=68.9 – 141.3= - 72.4 N



=120 – 90 sin 40°- 160 sin 28°
$\sum Fy$ =120 – 57.9 - 75.1 = -13N

R=$\sqrt{\sum Fx^2 + \sum Fy^2}$

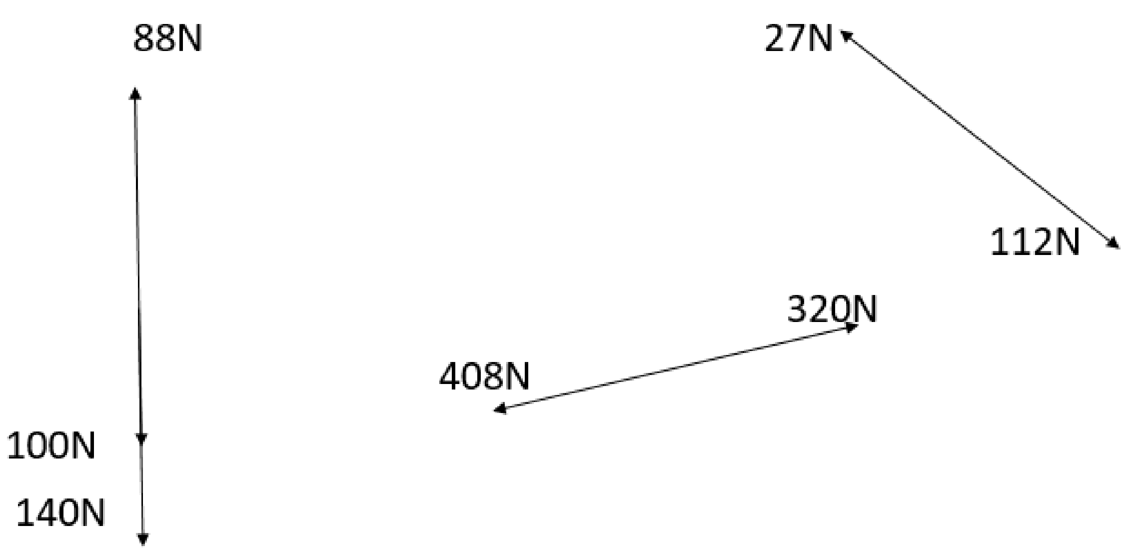
R=$\sqrt{(-72.4)^2 + (-13)^2}$ =$\sqrt{5241 + 169}$

$\alpha = \tan^{-1}\frac{\sum Fy}{\sum Fx} = \tan^{-1}\frac{-13}{-72.4}$

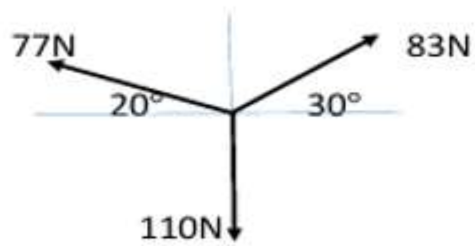
$\alpha = 10°$

4/ Post test -

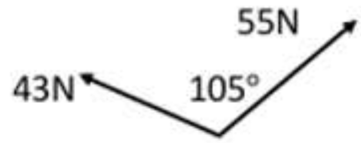
Q1-calculate the resultant to the forces shown in figures below?



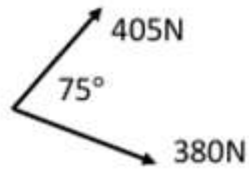
Q2- calculate the resultant to the forces shown in figures below?



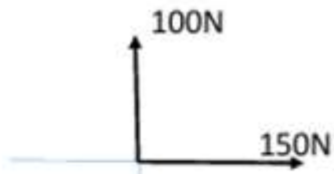
1- Calculate the resultant of the forces shown in the figure below?



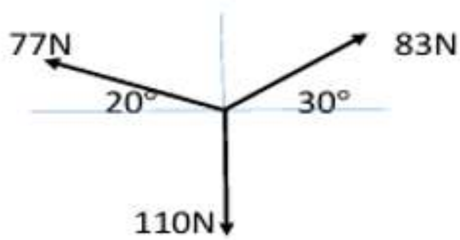
2-Calculate the resultant of the forces shown in the figure below?



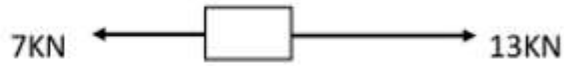
3- Calculate the resultant of the forces shown in the figure below?



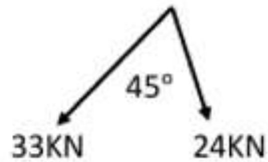
4-Calculate the resultant of the forces shown in the figure below?



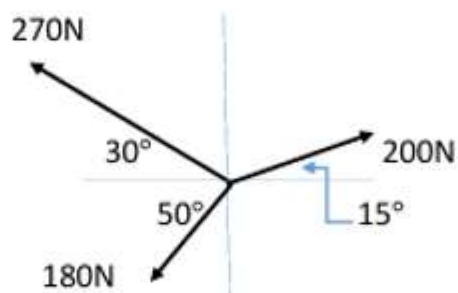
5- Calculate the resultant of the forces shown in the figure below?



6-- Calculate the resultant of the forces shown in the figure below?



7-- Calculate the resultant of the forces shown in the figure below?



4/ Post test :-

Draw the circuit diagrams to show how a NOR gate can be made into a NOT gate.

5/ HomeWorks: -

a) determine the output expression for the following circuit

b) determine the output logic level if A=1, B=1 and C=0, D=0

6 / Resferences

4-Moment Rotation (Torque) And couple

1/ Overview

3 / A –Target population :-

For students of First year
Technological institute of Basra
Dep. Of Mechanic Techniques

3 / B –Rationale :-

Understanding the meaning of the moment of forces and couple acting on a particular or body is the basis for finding them and their relationship to each other.

3 /C – Performance Objectives

After studying the second unit, the student will be able to:-

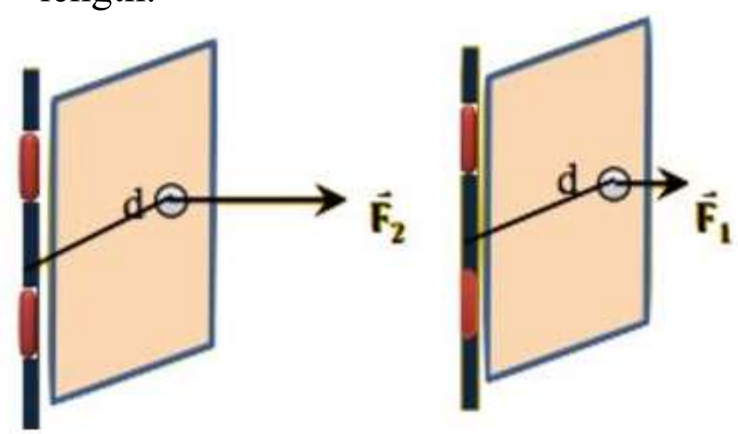
1. Knowing the centers of known shapes
2. Knowing the centers of complex shapes

2/ Pretest :

3/Content:-

The Moment

It is a vector value that measures the extent to which a force is able to rotate a body around an axis. The amount of torque is defined as the product of the force multiplied by the arm length.



M=F.d

F:force

d: rotation arm

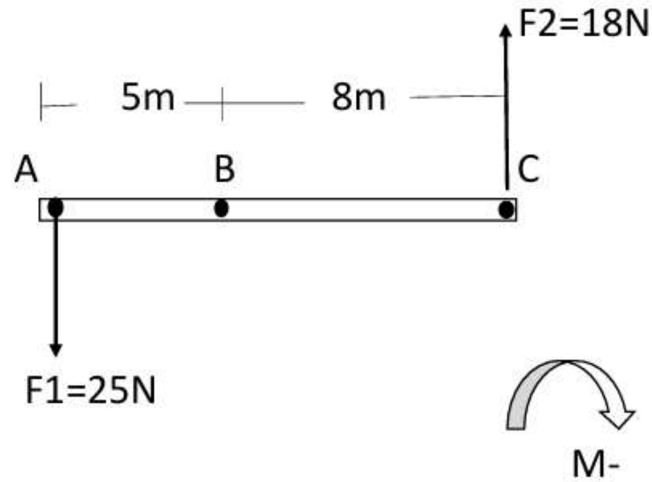
Moment can be increased

1- Increase strength

2- Increase arm length

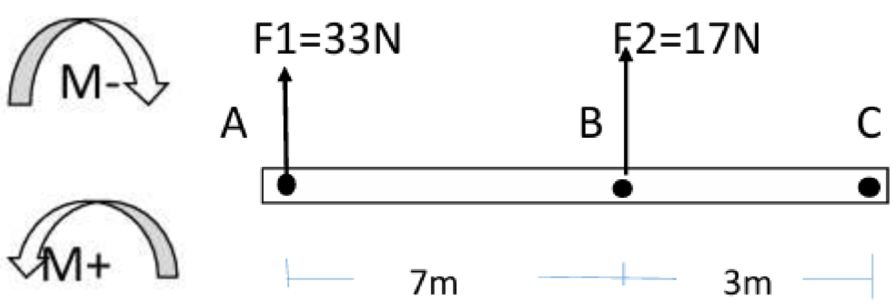
Note: There is no force torque if the force carrier passes through the axis of rotation or is parallel to it so that they do not intersect.

Ex.1: find rotation moment around (A,BandC) to the figure shown below?



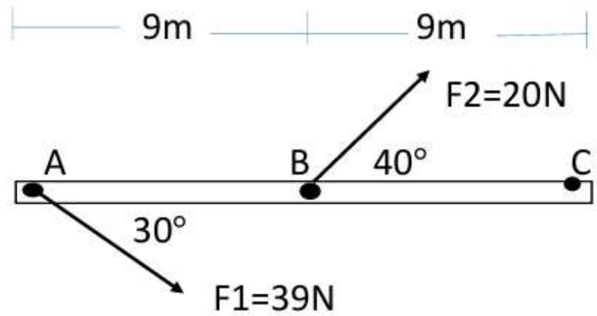
Sol. M- ∑M= ∑Fd
MA=18x13=234 Nm
MB=18x8 + 25x5=269 Nm
M+ MC= 25x13=325 Nm

Ex.2: find rotation moment around (A,B,C) to the figure shown below?



Sol.: ∑M= ∑Fd
MA=17x7=119 Nm
MB =- 33x7= - 231 Nm
MC=- 33x10- 17x3=- 381 Nm

Ex3.: find rotation moment around (A,B) to the figure shown below?



Sol.: $\sum M = \sum F\cos\Theta\, d$

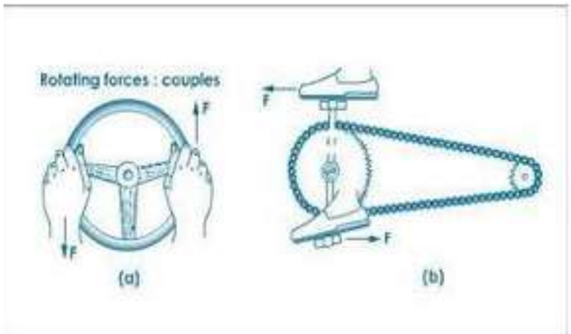
$MA = -20\cos 40° \times 18 = -275.8$ Nm

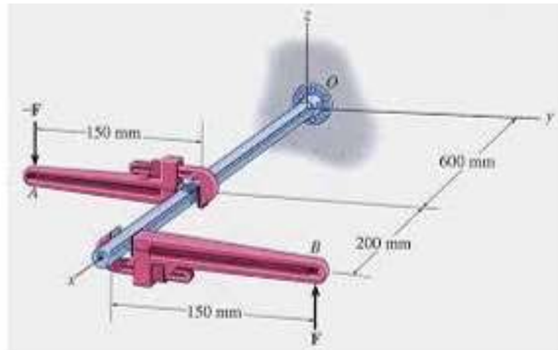
$MB = 39\cos 30° \times 9 = 304$ Nm

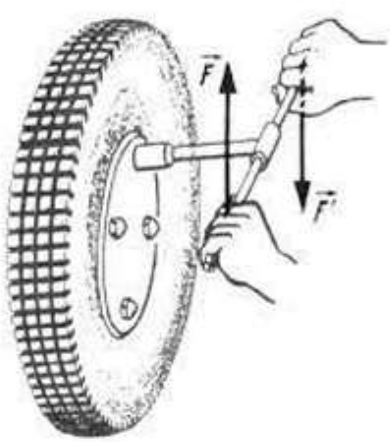
The couple moment

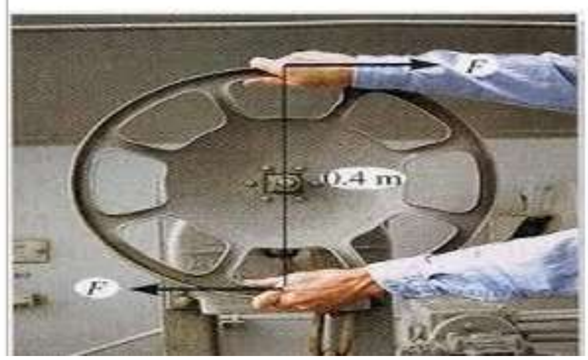
It is Two parallel forces that are equal in magnitude and opposite in direction are separated by a perpendicular distance.

exampls









Note

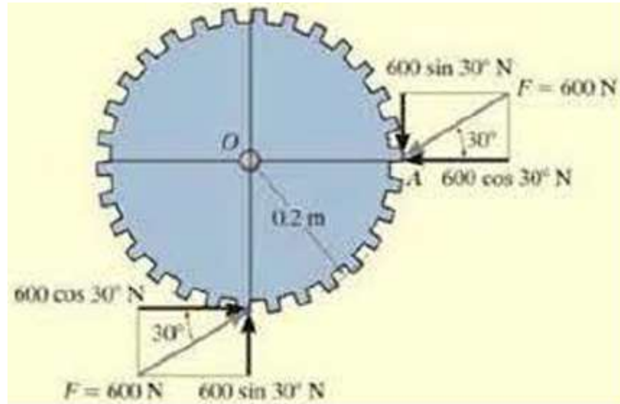
1. Mc=Fd

2.When the two forces are inclined, we analyze the force and calculate the sum of the moments of the two components.

Ex.1: find the couple to the forces shown in figure below if (f=30N, d= 25cm?

Sol.:
a=b
a+b=d
Mc=30 x 25= 750Nm

Ex2: find the couple to the forces shown in figure below?

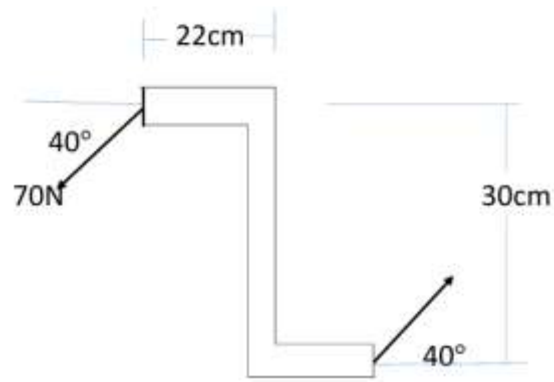


Sol.:

Mc=600 cos 30° x0.2- 600sin30° x0.2

Mc=103.9 -60 = -43.9Nm

Ex.3: find the couple to the forces shown in figure below?



Sol.

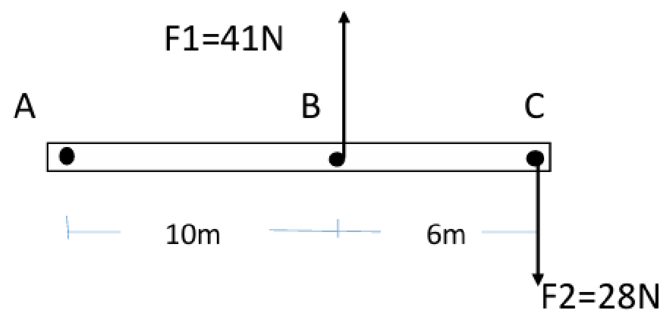
Mc=70 cos40°x30 +70sin 40° x44

Mc=1608.7 +1979.8

Mc =3588.5 Nm

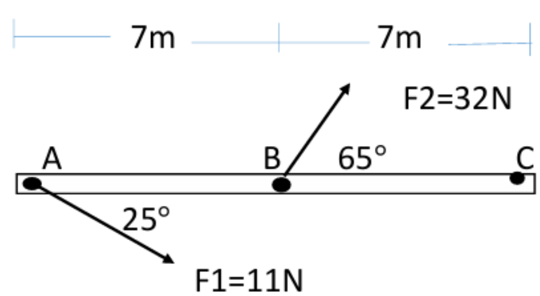
4/ Post test :-

Q1 : find rotation moment around (B,C) to the figure shown below?

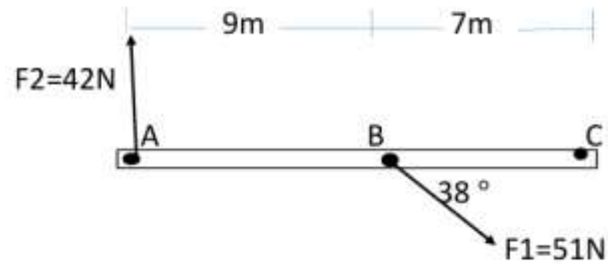


5/ HomeWorks: -

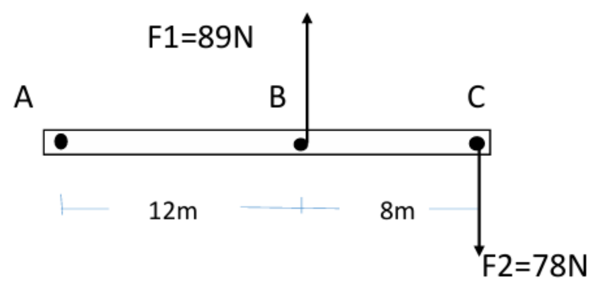
Q1: find rotation moment around (B,C) to the figure shown below?



Q2: find rotation moment around (A and C) to the figure shown below?



Q3: find rotation moment around (A,B and C) to the figure shown below?



5-Centroid

1/ Overview

3 / A –Target population :-

For students of First year
Technological institute of Basra
Dep. Of Mechanic Techniques

3 / B –Rationale :-

Understanding the meaning of the resultant centroid of a area or volume of body is the basis for finding it and their relationship to e other objects.

3 /C – Performance Objectives

After studying the second unit, the student will be able to:-

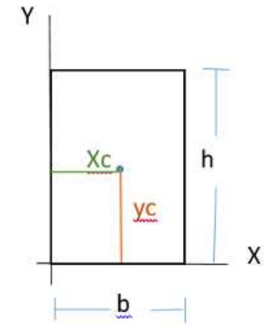
1. Understanding the importance of extracting the center of area or volume.
2. Knowing how to find the centers of compound shapes.

2/Content:-

Centroid: is Distance of the center of the figure from the axis(x 0r y).
Y c: is Distance of the center of the figure from the (x- axis).
X c: is Distance of the center of the figure from the (y-axis).

<u>Centroid of some figures</u>

1.rectangular

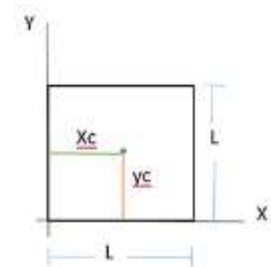


Area=bh

Xc =b/2

Yc =h/2

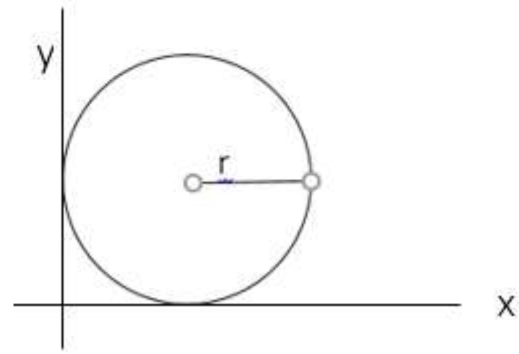
2-square



Area =L

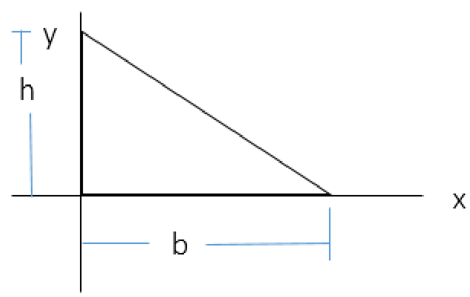
Xc =**yc** =L/2

Cirecl



Area= πr^2
Xc =**yc** =r

Triangle



Area=$\frac{bh}{2}$

X c= $\frac{b}{3}$

Y c=$\frac{h}{3}$

To find the center of a composite figure made up of a set of known figures

4.1- A complex shape is divided into a group of shapes whose centers and areas are known, such as a rectangle, square, and triangle.

4.2- Create a table as shown below.

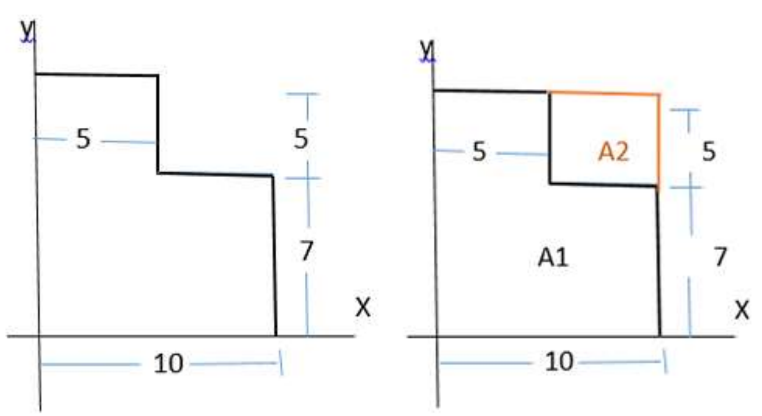
رقم المساحة	مساحة الشكل	مركز الشكل	X c x المساحة
No	A	Xc	A.Xc
∑	A		A.Xc

رقم المساحة	مساحة الشكل	مركز الشكل	Y c x المساحة
No	A	Yc	A.Yc
∑	A		A.Yc

4.3- The center distance is calculated from the equation below:

$$Xc=\frac{\Sigma A\ xc}{\Sigma A} \qquad yc=\frac{\Sigma Ayc}{\Sigma A}$$

Ex1: find the centroid (Xc andYc) of the figure shown below?



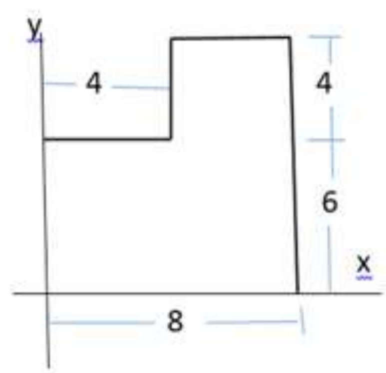
No	A	Xc	A.Xc
A1	10x12 =120	10/2 =5	120x5 =600
A2	5x5 =25	5/2+5 2.5+5=7.5	25x7.5 =187.5
∑	120-25 =95		600-187.5 =412.5

Xc= $\frac{\sum A.Xc}{\sum A} = \frac{412}{95}$ =4.3cm²

No	A	yc	A.yc
A1	10x12 =120	12/2 =6	120x6 =720
A2	5x5 =25	5/2+7 2.5+7=9.5	25x9.5 =237.5
∑	120-25 =95		720-237.5 =482.5

yc= $\frac{\sum A.yc}{\sum A} = \frac{482}{95}$ =5.1cm²

Ex2: find the centroid (Xc and Yc) of the figure shown below?



Slo.

No	A	Xc	A.Xc
A1	8x6 =48	8/2 =4	48x4 =192
A2	4x4 =16	4/2+4 2+4=6	16x6 =96
∑	48+16 =64		192+96 =288

$$Xc = \frac{\sum A.Xc}{\sum A} = \frac{288}{64} = 4.5cm^2$$

No	A	yc	A.yc
A1	8x6 =48	6/2 =3	48x3 =144
A2	4x4 =16	4/2+6 2+6=8	16x8 =128
∑	48+16 =64		144+128 =242

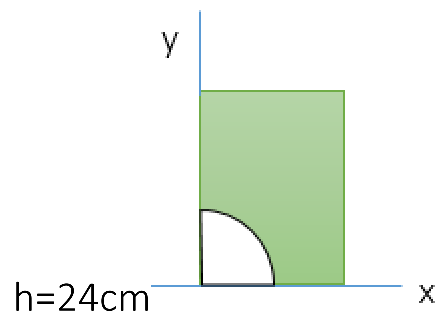
$$yc = \frac{\sum A.yc}{\sum A} = \frac{242}{64} = 4.25cm^2$$

5/ HomeWorks: -

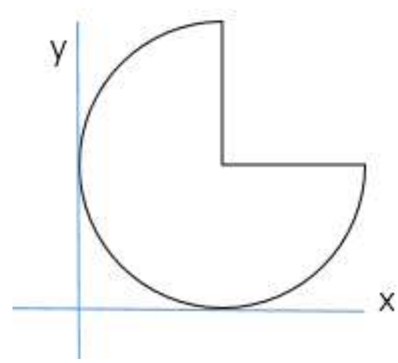
Q1: find the centroid (Xc and Yc) of the figure shown below?

r=5cm

b=10cm



Q2: find the centroid (Xc and Yc) of the figure shown below?
r=7cm



6-Moment Of Inertia

1/ Overview

3 / A –Target population :-

For students of First year
Technological institute of Basra
Dep. Of Mechanic Techniques

3 / B –Rationale :-

Understanding the meaning of the moment of inertia of bodies and areas is the basis for finding it and their relationship to each objects.

3 /C – Performance Objectives

After studying the second unit, the student will be able to:-

1. Understanding the importance of extracting the center of area or volume
2. Knowing how to find the centers of compound shapes

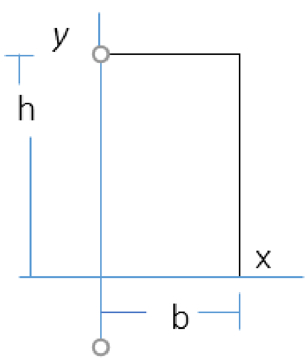
2/ Pretest :

3/Content:-

The moment of inertia
6.1- otherwise known as the mass moment of inertia, angular/rotational mass, second moment of mass, or most accurately, rotational inertia, of a rigid body is defined relatively to a rotational axis. It is the ratio between the torque applied and the resulting angular acceleration about that axis.
6.2- Its units:(line unit^4)

Moment of inertia of some figures

1.rectangular

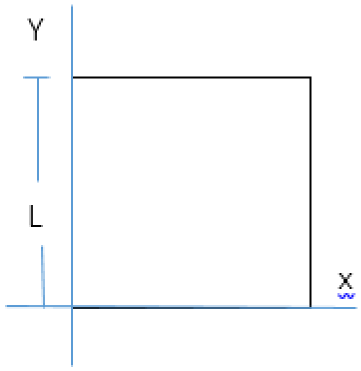


Area=bh

$$\mathbf{Ix} = \frac{bh^3}{12}$$

$$\mathbf{Iy} = \frac{hb^3}{12}$$

Square



Area=L^2

$$\mathbf{Ix} = \mathbf{Iy} = \frac{L^3}{12}$$

To find the moment of inertia of a composite figure made up of a set of known figures

6.3.1- A complex shape is divided into a group of shapes whose moment of inertia and areas are known,such as a rectangle, square, and triangle.

6.3.2- Create a table as shown below.

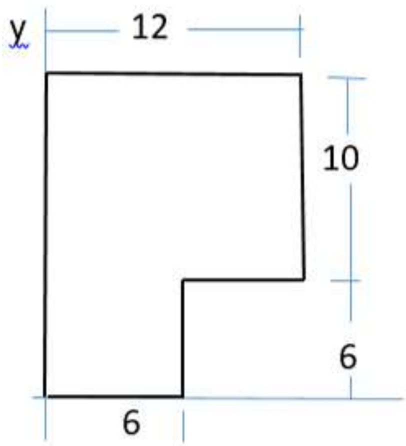
No	Ix	A	yc	A.yc
A1				
A2				
A3				
Σ				

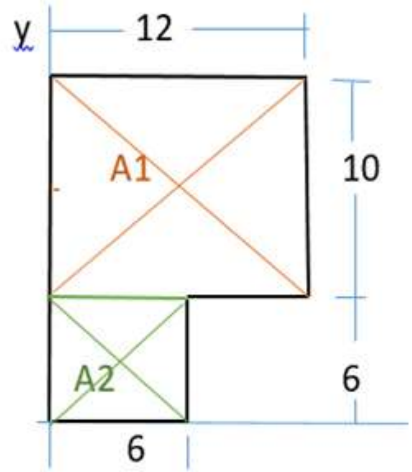
6.3.3-After completing the table, the sum of the two columns (Iy and A.xc) is taken and entered into the following equation: $IX=\sum(Ix+ A.yc)$

No	Iy	A	xc	A.xc
A1				
A2				
A3				
Σ				

6.3.4-After completing the table, the sum of the two columns (Iy and A.xc) is taken and entered into the following equation: $Iy=\sum(Iy+ A.xc)$.

Ex1: find moment of inertia (Ix and Iy) of the figure shown below?





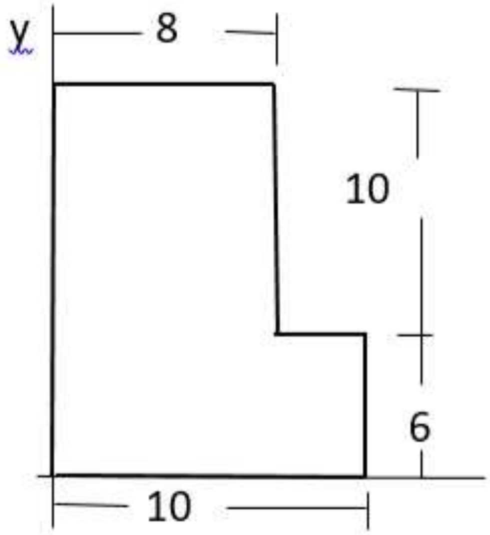
No	Ix	A	Yc	$A.Yc^2$
A1	$\frac{12 \times 10^3}{12}$ 1000	12×10 =120	$\frac{10}{2}+6=11$	120×11^2 =14520
A2	$\frac{6^4}{12}$ =108	6×6 =36	$\frac{6}{2}=3$	36×3^2 =324
Σ	1108			14844

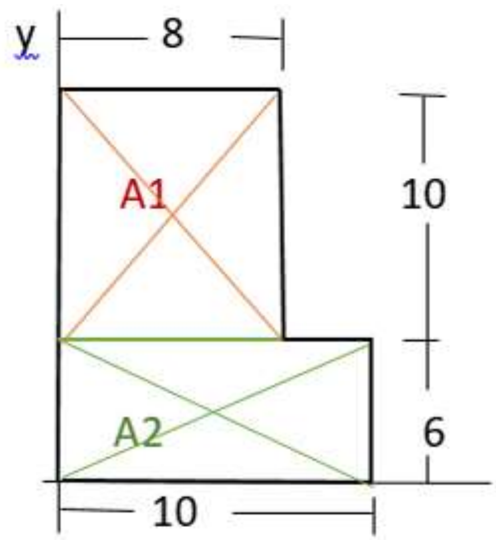
$IX=\sum(Ix + A.yc2)$ $Ix=1108+14844=15952cm4$

No	Iy	A	Xc	A.Xc^2
A1 مستطيل	$\frac{10\times 12^3}{12}$ 1440	12× 10 =120	$\frac{12}{2}$=16	120× 6^2 =4320
A2 مربع	$\frac{6^4}{12}$ =108	6× 6 =36	$\frac{6}{2}$=3	36× 3^2 =324
∑	1548			4644

IY=∑(Iy+ Axc2) IY=1548+4644=6192$cm4$

Ex2: find moment of inertia (Ix and Iy) of the figure shown below?





No	Ix	A	yc	A.yc^2
A1	$\frac{8\times 10^3}{12}$ =666	8× 10 =80	$\frac{10}{2}+6$ $=11$	80× 11^2 =9680
A2	$\frac{10\times 6^3}{12}$ =180	10× 6 =60	$\frac{6}{2}$=3	60× 3^2 =540
∑	846			10220

IX=∑ (Ix+ A.yc2) ,IX=846+10220=11066cm2

No	Iy	A	xc	A.xc^2
A1	$\frac{10\times 8^3}{12}$ =426	8× 10 =80	$\frac{8}{2}=4$	80× 4^2 =1280
A2	$\frac{6\times 10^3}{12}$ =500	10× 6 =60	$\frac{10}{2}$=5	60× 5^2 =1500
∑	926			2780

Iy=∑ (Iy+ A.yc2) ,Iy=926+2780=3706cm2

Ministry of high Education and Scientific Research
Southern Technical University
Technological institute of Basra
Department of mechanic Techniques

Learning package

Engineering Mechanics **1 (M122)**

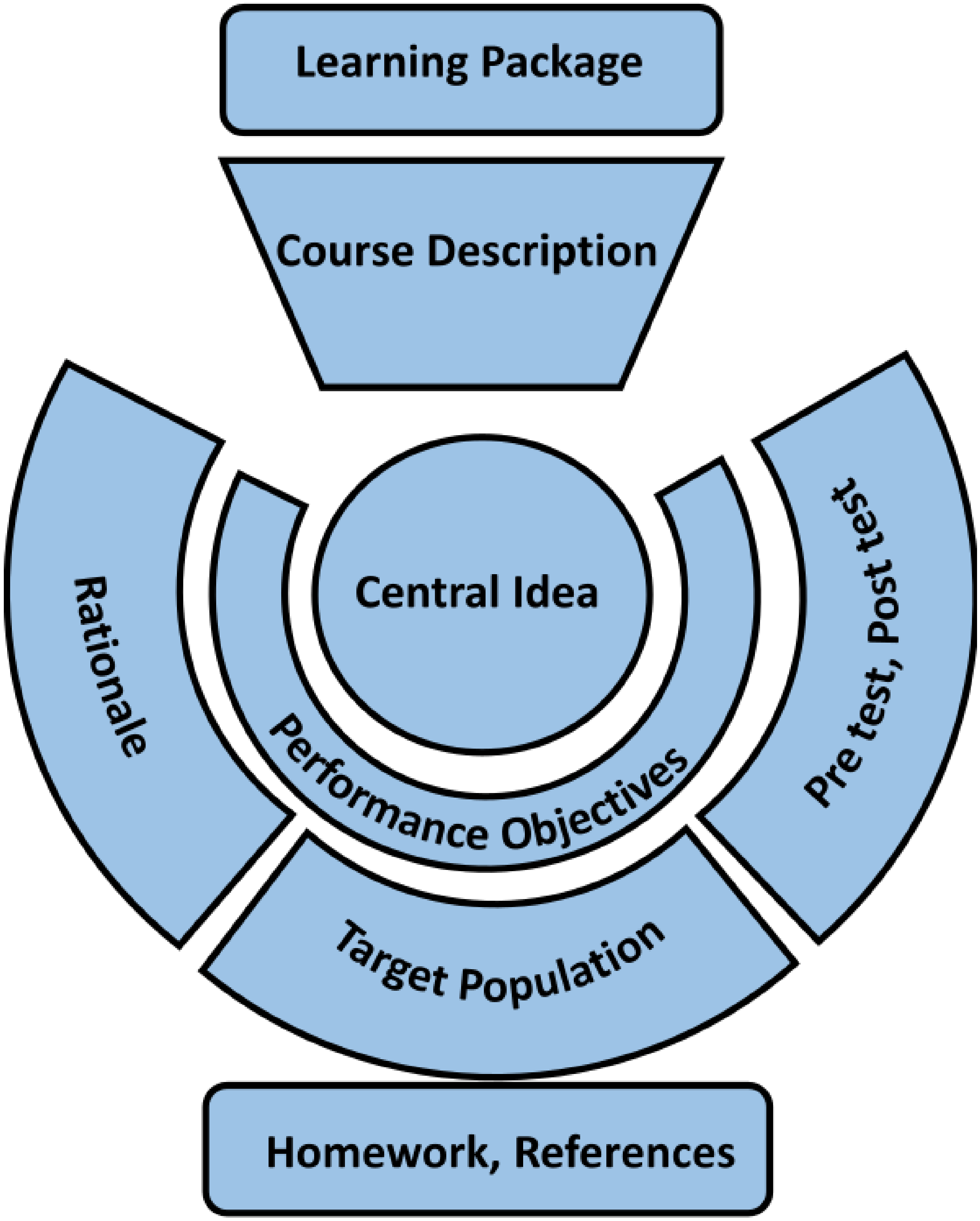
For

First year students

By

Khalda Mohammed
Assistant Teacher
Dep. Of Mechanic Techniques
Production branch

2025



Learning Package
Course Description
Central Idea
Rationale
Performance Objectives
Pre test, Post test
Target Population
Homework, References

First	5		Newton᾽ssecond law	In-person lecture	Question and Answer
Second	5		Type of motion , linear motion with constant speed	In-person lecture	H.W.
Third	5		Linear motion with constant acceleration	In-person lecture	H.W.
fourth	5		Curvilinear motion	In-person lecture	Solve examples
fifth	5		Angular motion , relative motion	In-person lecture	In class assignment
Sixth	5		Work , energy , power	In-person lecture	
Seventh	5		Strength of material,	In-person lecture	
			fundamental concept		
Eighth	5		Loads , stress, strain , elasticity, plasticity and deformation	In-person lecture	Question and answer
Ninth	5		Hook᾽s lows ,tress-strain curve, type of stress	In-person lecture	The student draws the diagram on the board
Tenth	5		Normal stction areress due to an axial load on 1-uniform cross section area 2-variable cross se	In-person lecture	In class assignment
Eleventh	5		Shear stress	In-person lecture	Question and answer
Twelveth	5		Torsion stress	In-person lecture	Qouiz
Thirteenth	5		Thermal stress	In-person lecture	H.W.
fourteenth	5		Beams ,types of loads , types of beams	In-person lecture	H.W.
fifteenth	5		Shear force &bending moment of simple supported beam under an axial load	In-person lecture	Discussion in class
Infra structure					
	Engineering Mechanics static & dynamics Bed four &flower 4th ed. 200				

Course Description

Course Name:
Engineering Mechanics 1
Course Code:
M122
Semester / Year:
Semester
Description Preparation Date:
14/ 05/ 2025
Available Attendance Forms:
Attendance only
Number of Credit Hours (Total) / Number of Units (Total)
75 hours/5 hour weekly/4 unit
Course administrator's name (mention all, if more than one name)
Name: Khalda Mohammed Email: kh.hydar@stu.edu.iq
Course Objectives

1. The student learns the meaning of dynamic mechanics, its divisions, and some concepts that help in understanding the science. **2.** Applying important concepts such as displacement, velocity and acceleration to be able to access the rest of the topics, all in a dynamic rest, i.e. the body is move. **3.** Developing practical skills: Providing practical training through laboratory experiments, allowing students to acquire the skills necessary t link theories to practical reality.	• ..... • ..... • .....

4. Knowing the importance of what the student has learned theoreticall in practical and life situations.

5. Enhancing Critical Thinking: Encouraging students to engage in critic and analytical thinking when solving problems related to mechanic.

Teaching and Learning Strategies

1. Cooperative Concept Planning Strategy.

2. Brainstorming Teaching Strategy.

3. Note–taking Sequence Strategy.

4. Examples, exercises and problems used to achieve the objectives.

Course Structure

Weeks	Hours	Required Learning Outcomes	Unit or subject name	Learning method	Evaluation method
1 2 3 4 5 6 7 8 9 10 11 12 13 14	5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours 5hours	**1.** Basic concepts. Types forces and their relationship systems. **2**DevelopingCritical Thinking and Problem-Solving Ski through Analysis forces **3.**to Use Electronic Laboratory Tools, such as forces drum and shape center finder **4.** Finding the resultan of forces and moments 5. Understand and learn find the centers of shape and the work of inertia.	2.1-dynamic displacement velocity and acceleration, 2.2- calculate Work, energy, and power 2.3- The study of projectiles and its importance in finding the farthest point to which the projectile rises and the farthest	1.Conduct laboratory experiments to construct and te force and resulta analysis. 2. This reinforce theoretical understanding a develops practic skills.. **3.**Reviewing concepts periodically and applying them to new problems t reinforce memory and understandir	Weekly, Monthly, Daily and Written Exams, and Final Term Exam.

			3.4- The study of projectiles and its importance in finding the farthest point to which the projectile rises and the farthest distance it reaches. 3.5- Learn about the types of supports, bridges, and loads and how to represent them.	**4.**Using education software and Interactive application to bet understand concepts. **5.** Linking the understanding of engineering mechanics to othe sciences.	

Course Evaluation	
Distribution as follows: 20 points for Midterm Theoretical Exams for the second semester, 2 points for Midterm Practical Exams for the second semester, 10 points for Daily Exams and Continuous Assessment, and 50 points for the Final Exam.	
Learning and Teaching Resources	
Required textbooks (curricular books, if any)	Holdsworth, Brian, and Clive Woods. Digital logic design. Elsevier, 2002.
Main references (sources)	1 .Engineering Mechanics: Statics 14th ed. Hibbeler. 2. Engineering Mechanics, 5Th Edn: Timoshenko.
Recommended books and references (scientific journals, reports…)	

Ministry of high Education and Scientific Research
Southern Technical University
Technological institute of Basra
Department of mechanic Techniques

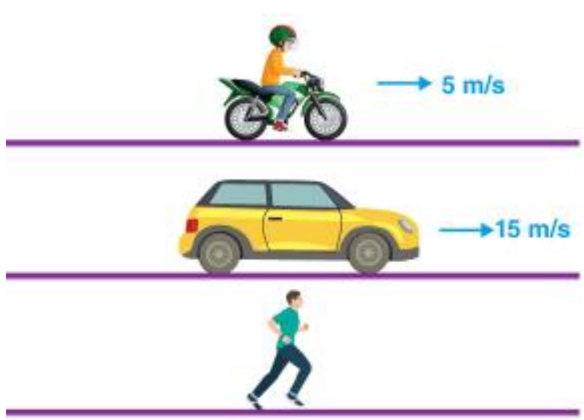
Learning package

In

Engineering Mechanics

For

Students of First Year



Khalda Mohammed
Assistant Teacher
Dep. Of Mechanic Techniques
Production branch

2025

Classroom code wprpjg3

1/ Overview

1 / A –Target population :-

For students of First year
Technological institute of Basra
Dep. Of Mechanic Techniques

1 / B –Rationale :-

Understanding the basic principles is crucial to gaining a comprehensive knowledge of engineering mechanics, which is why I have created this module to facilitate learning on the subject.

1 /C – Performance Objectives

After studying the first unit, the student will be able to:-

1. Know dynamic displacement velocity and acceleration
2. Know calculate Work, energy, and power
3. Know The study of projectiles and its importance in finding the farthest point to which the projectile rises and the farthest.
4. Know the Learn about the types of supports, bridges, and loads and how to represent them.

1-Newton's Laws of Motion

1/ Overview

1 / A –Target population :-

1.1 For students of First year
1.2 Technological institute of Basra
1.3 Dep. Of Mechanic Techniques

1 / B –Rationale :-

These laws became the foundation of classical mechanics and are essential for understanding how objects move and interact.

1/C – Performance Objectives

After studying the second unit, the student will be able to:-

Newton's First Law (Law of Inertia):

Objects remain at rest or in uniform motion unless acted upon by an external force.

1.1 Know that: The concept of inertia.
1.2 That motion doesn't require a force to continue only to change.

Newton's Second Law (F = ma):

1.3-Know that the acceleration of an object depends on the net force acting on it and its mass.

Newton's Third Law:

1.4-For every action, there is an equal and opposite reaction.

1.5-Interactions between objects why rockets launch or how walking works). Forces come in pairs.

1.6-The quantitative relationship between force, mass, and acceleration.

1.7-How to calculate how much force is needed to move an object or how an object will respond to a given force.

1.8-For every action, there is an equal and opposite reaction.

2/ Pretest :

What is the difference between statics and kinematics

3/ Content :-

1.3.1 **Newton's Laws of Motion** are three fundamental principles that describe how objects move and interact with forces. Here's a quick breakdown of each law:

1.3.1.1- Newton's First Law (Law of Inertia)

"An object at rest stays at rest, and an object in motion stays in motion at a constant velocity, unless acted upon by an external force."

If nothing pushes or pulls on something, it keeps doing what it's doing.

Example: A soccer ball will not move unless you kick it. Once kicked, it will keep rolling until friction or another force (like hitting a wall) stops it.

1.3.1.2- Newton's Second Law (Law of Force and Acceleration)

"The force acting on an object is equal to the mass of that object times its acceleration."
Formula: **F=ma**

Where:

F = force (in newtons, N)

m = mass (in kilograms, kg)

a = acceleration (in meters per second squared, m/s^2)

Example: The harder you push (more force) on a shopping cart, the faster it accelerates. A heavier cart (more mass) needs more force to accelerate at the same rate.

1.3.2- Newton's Third Law (Action-Reaction Law)

"For every action, there is an equal and opposite reaction." Forces always come in pairs.

Example 1: When you jump off a boat, you push the boat backward (reaction) while you move forward (action).

This law connects force, mass, and acceleration.

Example 2: The harder you push (more force) on a shopping cart, the faster it accelerates. A heavier cart (more mass) needs more force to accelerate at the same rate.

So, acceleration is directly proportional to force and inversely proportional to mass.

The more force you apply to an object, the faster it accelerates.

The heavier (more massive) the object is, the harder it is to accelerate.

Examples:

1.3.2.1 Pushing a Shopping Cart If you push an empty cart, it accelerates quickly (small mass).

If the cart is full, it accelerates slowly (large mass).

If you push harder, both carts move faster — more force means more acceleration.

1.3.2.2 Kicking a Ball vs. a Bowling Ball a soccer ball (light mass) accelerates quickly when kicked.

A bowling ball (heavy mass) needs more force to get the same acceleration. This shows the effect of mass on acceleration.

1.3.2.3- Car Acceleration a small car accelerates faster than a big truck with the same engine power.

The truck has more mass, so needs more force for the same acceleration.

Example 1: Finding Forces
A box has a mass of **10 kg** and accelerates at **2 m/s²**.
What is the force acting on it?

Solution:

$F = m \times a =$
$F = 10 \times 2 = 20$ N

Example 2: Finding Acceleration
A force of (50 N) is applied to a (5 kg) object.
What is its acceleration?
Solution:
$F = m \times a =$
$\therefore a = \frac{F}{m} =$
$.a = \frac{50}{5} = 10\ m/s^2$

4/ Post test -

A force of (42 N) is applied to a (8 kg) object.
What is its acceleration?

2- Equations of Liner Motion for constant acceleration

1/ Overview

2.1 / A –Target population :-

2.1.1-For students of First year
2.1.2- Technological institute of Basra
2.1.3- Dep. Of Mechanic Techniques

2.1 / B –Rationale :-

The rationale for studying motion with constant acceleration for understanding motion real-world applications**.** Development of analytical skills

2.1/C – Performance Objectives

When a student studies motion due to variable acceleration, they gain deeper and more advanced insights into the behavior of objects in motion.

2.2.1- Realistic modeling of motion. Advanced analytical thinking

They develop skills to:

2.2.2-Analyze motion using **c**alculus (derivatives and integrals).

2.2.3- Acceleration as a function of time, velocity, or position.

2.2.4- The equations of motion for constant acceleration differentiating between uniform motion (constant velocity) and uniformly accelerated motion (constant acceleration).

2.2.5-Recognizing that acceleration changes velocity over time.

2.2.6-Basic physical concepts.

2.2.7Basic equations of motion for constant acceleration.

3/ Content :-

3.1 Equations of liner Motion for constant acceleration

These are used when an object accelerates uniformly (same acceleration):

Equation 1:

$V=V_0+at$

Equation 2:

$S=V_0t+0.5at^2$

Equation 3:

$V^2=V_0^2+2aS$

Where:

V: final velocity

V_0: initial velocity

a: acceleration

t: time

S: displacement

Example 1:

A car starts from rest and accelerates at(a= 3 m/s) for (t=4 seconds).
Find: 1- Final velocity (v) 2. Displacement(s)

Solution:

1. Final velocity:

$V=V_0+at$

1. $V=0+3\times4=12$ m/s
2. Displacement:

$S=V_0t+0.5at2=$
$S= 0+0.5\times3\times16==24m$

Example 2:

A car starts from rest and accelerates at $3m/s^2$ for 5 seconds. What is its final velocity if $(V_0=0)$?

Sol: $V=V_0+at$

$V=0+3\times 5 =15m/s$

Example3: A bike is moving at 4 m/s , accelerates at $2\ m/s^2$\, 6 seconds. How far does it travel in that time?

Sol. : $S=V_0t+0.5at^2$

$S =4\times 6+0.5\times2\times6^2 =24+36=60m$

Example4:

A car slows down from 20m/s to 5 m/s with a constant acceleration of $3m/s^2$. How long does it take and how long is the distance?

Sol. 1- $V^2=V_0^2+2aS$

$5^2=20^2-2\times3\times S$

25=200-6S

$S=\frac{200-25}{6}=29.2m$

2- $V=V_0+at$

5=20-3t

$.t=\frac{20-5}{3}=5s$

4/ Home Work :

An object moves from rest and reaches a velocity of 40 m/s over a distance of 160m. What is its acceleration?

3-Liner Motion for Variable acceleration

1/ Overview

3 / A –Target population :-

1.1 For students of First year
1.2 Technological institute of Basra
1.3 Dep. Of Mechanic Techniques

3 / B –Rationale :-

Studying non-linear motion (motion along curved paths) with variable acceleration is a key step toward understanding complex, real-world physical systems.

3./C – Performance Objectives

2/ Pretest :

3.2.1-What does constant acceleration mean?
3.2.2- What does variable acceleration mean?

3/ Content :

Motion with Non-Constant Acceleration

1. Displacement as a function of time
2. Find displacement (position) from velocity, integrate:

$S=\int v dt+S_0$

3. Velocity as a function of time

$V(t)=\frac{ds}{dt}$

Find **velocity** from **acceleration**, integrate

$V=\int a dt+V_0$

4. Acceleration as a function of time

$a(t)=\frac{dV}{dt}$

Example 1: Acceleration as a function of time if initial velocity (V_0=2 m/s) initial position (S_0=0), find velocity function and displacement as a function?

Acceleration Function $a=6t$

Solution $v=\int a dt+v_0=\int 6t\, dt+2=\frac{6}{2}t^2+2$
$V=3t^2+2$

$S=\int(3t^2+2)dt=\frac{3}{3}\,t^3+2t+S_0$

$S=t^3+2t+0$

$S=t^3+2t$

Example 2: Acceleration as a function of time, if velocity (V_0=3 m/s) initial position (S_0=0), find velocity function and displacement as a function?

Acceleration Function $\qquad a=4t+1$

Solution: $v=\int a dt+v_0$

$V=\int(4t+1)dt$

$V=\frac{4}{2}t^2+t+v_0=2t^2+t+3$

$S=\int vt\ dt+s_0=\int(2t^2+t+3)\,dt+S_0$

$S=\int(2t^2+t+3)\,dt+0=$

$S=\frac{2}{3}\times t^3+\frac{1}{2}t^2+c=\frac{2}{3}\,t^3+3t+0=\frac{2}{3}t^3+\frac{t^2}{2}+t$

Example 3: if initial velocity (V_0=6 m/s) initial position (S_0=2m), find velocity function and acceleration function, when displacement as a function after 5 second?

$S=2t^{3+}t^2+4t+2$

Slo.

S after 5 second $=2\times5^3+5^2+4\times5+2$

$S=250+25+20+2=297m$

$V=6t^2+2t+4$

V after 5 second$=6\times 5^2+2\times5+4$

$V=150+10+4=164m/s$

$.a=12t+2$

(a

4-Curviliner Motion and Projectile

1/ Overview

4 / A –Target population :-

1.3 For students of First year

1.4 Technological institute of Basra

1.3 Dep. Of Mechanic Techniques

4 / B –Rationale:-

Most motions in nature are not straight but curved (such as the motion of cars around turns, airplanes, or planets).

4./C – Performance Objectives

Understanding Real-World Motion:

4.3.1-Learns that most motions in real life (such as a car turning a corner or planets in their orbits) are not straight lines, but curved.

4.3.2-Vector Analysis:

Understands how velocity and acceleration change direction and magnitude, and learns to use vectors to analyze motion in two or more dimensions.

4.3.3-Components of Acceleration:

Learns that acceleration in curved motion is of two types:

4.3.4-1Tangential acceleration: Changes velocity.

4.3.4.2-Central (vertical) acceleration: Changes direction.

Relationship between forces and Motion:

4.3.5-Learns how different forces (such as gravity or friction) affect an object moving along a curved path.

3/ Content :

• **Definition**: The motion of an object thrown into the air, moving under the influence of **gravity alone** (ignoring air resistance).

Always follows a **parabolic path**, which is a type of curved path curvilinear motion

Components of Motion:

- **Horizontal motion**: constant velocity (no acceleration)(a=0)
- **Vertical motion**: accelerated by gravity (a=−g)

$Vx=V_0\cos\theta$

Farthest point $S=(V_0\cos\theta)\,t$

$Vy=V\sin\theta$

Highest point(h.max.) $=0.5gt^2$ or $=\frac{V_y^2}{2g}$

Ex. 1: A ball is thrown with an initial speed of **20 m/s** at an angle of **30°** above the horizontal.
Find:

a) Time of flight
b) Maximum height
c) Horizontal range (distance)

sol.: $Vx=V_0=20\cos 30^\circ=20\times0.866=17.3$ m/s

$V0y=V0\sin\theta=20\sin 30^\circ=20\times0.5=10$m/s

$t=\frac{2V_{0y}}{g}=\frac{2\times10}{9.81}= \quad \approx 2.04s$

$.h.max.=\frac{V_{0x}^2}{2g}=\frac{10^2}{2\times9.81}=\frac{100}{19.6}=5.1m$

Smax.= $(V_0\cos\theta)\ t$

Smax.=$17.3\times 2.04=35.3$m

Ex. 2: A ball is thrown with an initial speed of **35 m/s** at an angle of **45°** above the horizontal.
Find:

a) Time of flight
b) Maximum height
sol.

$Vx=V_0=35\cos 45^\circ=24.75$ m/s

$V_0y=V_0\sin\theta=35\sin 45^\circ=24.75$m/s

$t=\frac{2V_{0y}}{g}=\frac{2\times24.75}{9.81}= \quad \approx 5.05s$

$.h.max.=\frac{V_{0x}^2}{2g}=\frac{24.75^2}{2\times9.81}=\frac{612,6}{19.6}=31.3m$

Smax.= $(V_0\cos\theta)\ t$

Smax.=$24.75\times 5.05=125$m

5- Angular motion Relative motion

1/ Overview

5/ A –Target population :-

5.1- For students of First year
5.2- Technological institute of Basra
5.3- Dep. Of Mechanic Techniques

5 / B –Rationale:-

Understanding rotational phenomena in nature and daily life many objects move around axes, not in a straight line, such as:

5.1-The rotation of a car wheel

5.2-The rotation of the Earth around its axis

5.3-The motion of a fan or wheel

5.4-Studying angular motion helps us understand these phenomena with precise scientific precision.

5/C – Performance Objectives

1. The student learns that there are angular equivalents for linear motion.
2. Accelerated circular motion analysis.
3. Understanding the relationship between force and rotational motion.
4. understand rotational dynamics and angular energy motion.

3/ Content :

Angular motion occurs when an object rotates around a specific axis. Instead of using displacement and linear velocity, we use angular quantities:

Basic Quantity

Quantity	Symbol	Definition	Unit
Angular displacement	θ	The angle at which the object rotates	rad
Angular velocity	ω	The rate of change of the angle with time	(rad/s)
Angular acceleration	α	The rate of change of the angular velocity with time	(rad/s^2)

Comparison between linear and angular motion equations:

Liner equation	angular equation
$V=v_0+at$	$\omega= \omega_0+ \alpha t$
$S=s_0+v_0t+0.5at^2$	$\theta=\theta_0+ \omega_0t+0.5\alpha t^2$
$V^2=v_0^2+2at^2$	$\omega^2= \omega_0^2+2\alpha t^2$

A wheel rotates from rest with an angular acceleration of α $=2$ rad/s^2 what angle will it rotate after 3 seconds?

Solution:

Since the movement started from rest

$\therefore \omega_0= 0$, $\theta_0 =0$

$\theta=0+ 0+0.5\alpha t^2$

$\theta =0.5\times 2 \times 3^2=9$

$\theta=\theta_0+ \omega_0t+0.5\alpha t^2 =9$ rad

4/ Pretest :

Discussion question

What difference between motion along a curved line and angular motion

Feature	Motion along a urved line (curvilinear otion)	Angular otion (rotational motion**)**
Definition	Motion along a curved path in space	Rotation of an object around a fixed axis
Path	Curved, not necessarily circular (e.g., parabolic, elliptical)	Circular motion around a center or axis
Position description	Described by linear position (x, y, z coordinates)	Described by angular position (θ in radians or degrees)
Velocity	Linear velocity $v=ds/dt$	Angular velocity $\omega=d\theta/dt$
Acceleration	Can have tangential and normal (centripetal) components	Angular acceleration $\alpha=d\omega/dt$
Cause of Motion	Linear force (e.g., gravity, tension)	Torque (rotational force)
Inertia	Involves mass (m)	Involves moment of inertia (I)
Examples	- Car turning on a curved road - Ball thrown at an angle (projectile) - Planet orbiting a star	Fan blade spinning - Wheel rotating - Earth spinning on its axis

Work, energy and power

6.3.1. Work Definition: Work is done when a force causes a displacement of an object in the direction of the force.

Formula: $W = F \cdot S \cdot \cos(\theta)$

W: Work (N.m)

F: Force (N)

S: Displacement (m)

θ: Angle between the force and displacement directions

Notes:

- If $\theta = 0°$, $\cos 0^0 = 1$ $\Rightarrow$, $W_{max} = F \cdot d$
- If $\theta = 90°$, $\cos 90^0$ $\Rightarrow$ no work → $W = 0$
- If work is done **against** the direction of motion, it's **negative work**

Example1:

Calculate a work for 10 N horizontal force pushes an object 5 m in the same direction:

Sol.:

$W = 10 \times 5 = 50J$

Example2:

Calculate a work for 12 N slop force (30^0) with the horizon pushes an object 9m in the same direction:

Sol.: W= F·S·cos(θ)

$W=12\times 90 cos30^0= 93j$

6.3.2. Energy

Definition: Energy is the capacity to do work.

Main Types:

6.3.2.1-Kinetic Energy (KE): due to motion

$KE=\frac{1}{2}mv^2 = 0.5mv^2$

6.3.2.2-Potential Energy (PE): Potential Energy

Stored energy due to position or configuration.

Two important types

a. Gravitational Potential Energy

- Stored due to height above the ground.
  PE= mgh
  where m is mass, g is gravity, and h is height.

b. Elastic Potential Energy

- Stored in stretched or compressed objects like springs or rubber bands.
  $PE=\frac{1}{2}kS^2$,$PE = 0.5kS^2$

Where k is spring constant, and S is displacement.

6.3.2.3- Thermal Energy

a- Related to the random motion of atoms and molecules.

b- More motion = more thermal energy = higher temperature.

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6.3.2.4-Electrical Energy

Energy from the movement of **electric charges** (electrons).

Found in power lines, batteries, and electric circuits.

6.3.2.5- Radiant (Light) Energy

Energy carried by electromagnetic waves, including visible light, X-rays, microwaves, etc. does not need a medium to travel (can move through space).

6.3.2.6 Chemical Energy

Stored in the bonds of chemical compounds.

Released in chemical reactions, like burning fuel or digestion in your body.

6.3.2.7- Nucler Energy

Stored in the nucleus of atoms.

Released during nuclear fission (splitting atoms) or fusion (combining atoms), like in the sun or nuclear reactors.

6.3.2.8- Magnetic Energy

Stored in magnetic fields and found in magnets and electromagnets.

Mechanical Energy = KE + PE

- m: mass (kg)
- V: velocit6y (m/s)
- g: gravity (9.8 m/s²)
- h: height (m)

Example:

Calculate Potential Energy (PE) an object of 2 kg at height 10 m has:

Sol. PE=$2gh$

PE=2×9.8×10=196J

6.3.3-Power

Definition: Power is the rate of doing work or transferring energy.

◆ **Formula:**

P=$\frac{W}{t}$

P: Power (watts, W)

W: Work (J)

t: Time (s)

Other forms:

If you know force and velocity:

P=F·v·cos(θ)

Example:

Calculate potential energ

4/ Post test -

Quiz

Calculate potential energy (PE) if the particle move force (200 N) ($\theta = 30^0$) with velocity 25m/s)?

y (PE) if work 200 J of work is done in 4 seconds:

Sol. $P=\frac{W}{t}$ $P=\frac{200}{4}\times=50$ W

7.Strength of Materials

1/ Overview

7 / A –Target population :-

7.1-For students of First year

7.2- Technological institute of Basra

7.3- Dep. Of Mechanic Techniques

7 / B –Rationale :-

The Rationale for Learning About Material Resistance (Strength of Materials).Studying material resistance is essential for engineers, architects, and anyone involved in designing and analyzing structures or mechanical system.

7/C – Performance Objectives

1. Known Ensure Structural Safety and Integrity.
2. Foundation for Engineering Design.
3. Support for Advanced Engineering Courses.
4. Material Selection and Optimization.
5. Problem Solving and Critical Thinking.

3/ Content :

Mechanics of Materials: is a fundamental subject in engineering and physics that deals with how solid objects resist forces and deformations.
Definition:

Strength of Materials studies how materials respond to:

- **Forces** (tension, compression, shear, torsion)
- **Loads** (static or dynamic)
- **Stresses and strains** resulting from those forces

Stress (σ):

$$\sigma = \frac{F}{A} =$$

- Force per unit area
- Measured in Pascals (Pa)

Strain (ε):

$$= \frac{\Delta L}{L0}$$

Deformation per unit length (no units)

Young's Modulus (E):

$$E = \frac{\sigma}{\varepsilon}$$

A material's stiffness

1. **Shear Stress and Strain:** Occur when forces act parallel to surfaces
2. **Torsion:** Twisting of an object due to applied torque
3. **Bending:** Deformation of a beam under load
4. **Elastic and Plastic Deformation:**
   - **Elastic:** returns to original shape
   - **Plastic:** permanent deformation
5. **Ultimate Strength & Yield Strength:** Maximum stress a material can handle before failure

Ex.1- A steel bar has a cross-sectional area of 200 mm² and is subjected to a tensile force of (10,000 N).
Find:

(a) Stress

(b) Strain if Young's Modulus E=200×10^9 Pa times

Sol.
(a) $\sigma = \frac{F}{A}$, $\sigma = \frac{10000}{200}$ =50 N/mm^2

(b) $E=\frac{\sigma}{\varepsilon}$, $\varepsilon=\frac{\sigma}{E}$

Ex.2- A square bar is subjected to a tensile force of 20 KN. The side of the square cross-section is 50 mm. Elongation if length is 1.2 m, E=210 GPa
calculate stress and strain?

Sol. $\sigma = \frac{F}{A}$

$A = L^2 \quad = 50^2 = 2500mm^2$

$F = 20KN = 20000N$

$. \sigma = \frac{20000}{2500} = 8N/mm^2$

$E = \frac{\sigma}{\varepsilon}$, $\varepsilon = \frac{\sigma}{E} =$

$\varepsilon = \frac{8}{210} = 0.038$

4/ Pretest :

Home Work

Conceptual Questions

These test understanding of basic principles:

1. What is the difference between stress and strain?
2. Define Young's Modulus and explain its physical significance.
3. What is the difference between elastic and plastic deformation?
4. What is the factor of safety, and why is it important in design?
5. Explain the types of stresses acting on a structural element.
6. What is Poisson's Ratio?
7. What is the significance of the stress-strain curve?
8. How does temperature affect the strength of materials?
9. Describe the difference between axial, shear, and bending loads.
10. What is buckling, and when does it occu

8-Hooke 's Low Stress and Strain Curve

1/ Overview

8 / A –Target population :-

7.1-For students of First year
7.2- Technological institute of Basra
7.3- Dep. Of Mechanic Techniques

7 / B –Rationale :-

Rationale for studying Hooke's Law and the Stress-Strain relationship curve:

1. Understanding material behavior
2. Basis for structural and mechanical design
3. Determining key material properties.
4. Improving safety and cost-efficiency.

7/C – Performance Objectives

1. Students learn how materials respond to applied forces. whether they stretch, compress, or permanently deform.
2. They distinguish between elastic behavior (temporary deformation) and plastic behavior (permanent deformation). Identifying Material Properties
3. Students can determine: Elasticity, Strength, Ductility and Toughness.

4. These are key for selecting the right material in engineering design.

5. Applying Knowledge to Real-World Engineering Problems

3/ Content :

Hooke's Law: describes the linear relationship between **stress** and **strain** in the **elastic region** of a material.

$F = k \cdot \Delta L$

F = Applied force

ΔL = Extension or compression

k = Spring constant (N/m)

Ex1: A spring has a spring constant $k = 200$ N/m
It is stretched by $\Delta L = 0.05$ m .Find the force applied?

Solution:

$F = k \cdot x = 200 \times 0.05 = 10$

Steps to draw the relationship between stress and strain .

1. Set Up Axes

- X-axis → Strain (ε) → unitless
- Y-axis → Stress (σ) → in MPa or Pa

Important points on the chart

Yield Point starts here

Ultimate
Stress

Fracture

Important areas on the chart
Elastic
Plastic

Fracture

Example 1:

Strain (ε)	Stress (σ in MPa)
0.000	0
0.001	200
0.002	400
0.0025	450
0.006	470
0.1	480
0.12	430 ← *Fracture Point*
S	
0.000	0
0.0005	100
0.0009	180
0.0012	190 ← Fracture Point