EGR 140
Statics
File: Complex

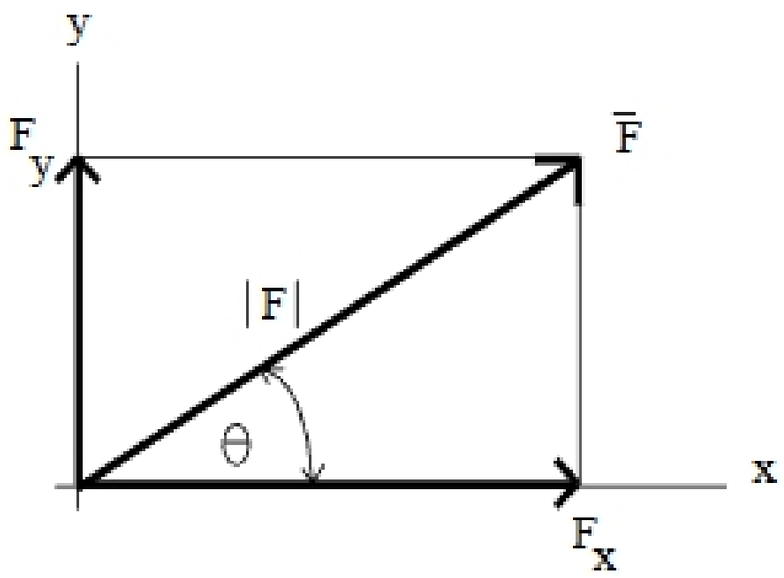
Complex Numbers

The representation of vectors using complex numbers, the conversion between rectangular and polar complex numbers, and calculations using complex numbers will be presented in four ways:

1. by hand
2. using the TI-85/86 calculator
3. using the HP-48G/GX
4. using the TI-89 calculator

Complex Numbers – Background and calculations by hand

Complex number can be used to represent two-dimensional vectors. The complex numbers may be stored in either polar or rectangular form.



Rectangular form: $\boxed{\bar{F} = F_x\mathbf{i} + F_y\mathbf{j}}$

where **i** is a unit vector along the x-axis and **j** is a unit vector along the y-axis.

Polar form: $\boxed{\bar{F} = |F|\angle\theta}$

where $|F|$ is the magnitude of vector $\bar{F}$ and

θ is the angle of vector $\bar{F}$ measured ***counterclockwise from the positive x - axis***

Converting between rectangular form and polar form:

Polar to Rectangular:

$F_x = |F|\cos(\theta)$

$F_y = |F|\sin(\theta)$

Rectangular to Polar:

$$|F| = \sqrt{F_x^2 + F_y^2} \qquad \theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$$

Ex: Convert $\bar{F} = 100\angle 30$ N to rectangular form.

$F_x = 100\cos(30) = 86.6$

$F_y = 100\sin(30) = 50$

so $\bar{F} = 86.6\mathbf{i} + 50\mathbf{j}$ N

Ex: Convert $\bar{F} = 30\mathbf{i} + 40\mathbf{j}$ N to polar form.

$|F| = \sqrt{30^2 + 40^2} = 50$

$\theta = \tan^{-1}\left(\frac{40}{30}\right) = 53.13°$

so $\bar{F} = 50\angle 53.13$ N

Complex Numbers using the TI-85 or TI-86

Be sure that the calculator is in degree mode (press **2nd – MODE** to change the mode).

Complex numbers are stored as follows:
(100/_30) represents the polar number 100/30
(30,40) represents the rectangular number 30**i** + 40**j**

There are two ways to convert between complex number forms:
A) Using mode:

If the calculator is in rectangular mode then the following conversion can be made
(100/_30) ***Enter*** (the value entered in polar form)
(86.6,50) (the result in rectangular form)

If the calculator is in polar mode then the following conversion can be made
(30,40) ***Enter*** (the value entered in rectangular form)
(50/_53.13) (the result in polar form)

B) Using the →POL and →REC functions under the CPLX menu:
(This method works in any mode.)

(100/_30)	(the value entered in polar form)
2nd CPLX	
→REC Enter	
(86.6,50)	(the result in rectangular form)

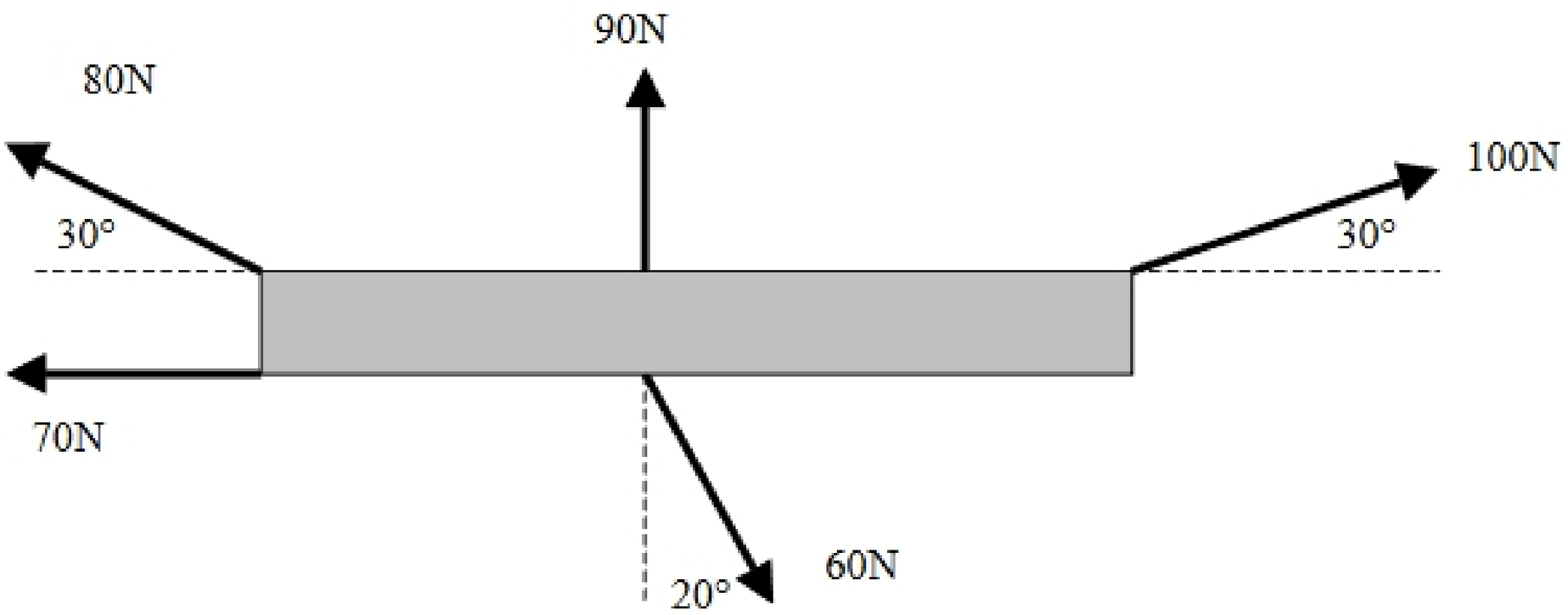
(30,40)	(the value entered in rectangular form)
2nd CPLX	
→POL Enter	
(50/_53.13)	(the result in polar form)

Using variables to store complex numbers with the TI-85/86:

Variables can be used to store complex numbers in either form. For example:

(100/_30) STO→ A	(store this polar number as variable A)
(30,40) STO→ B	(store this rectangular number as B)
A+B Enter	
(147.3/37.66)	(the result is in whatever form is specified by the mode)

Performing calculations using complex numbers with the TI-85/86:
Calculations can be performed using any combination of real and complex numbers (in any form). **Example**: Find the sum of the forces acting on the beam below:



Recalling that angles in polar numbers must be ***measured counterclockwise from the positive x-axis***, the sum of the forces above is easily found as follows:

(100/_30) + (0,90) + (80/_155) + (-70,0) + (60/_290) Enter ***(122.6/_106.8)*** (the result is in whatever form specified by the mode)

or

(100/_30) + (90/_90) + (80/_155) + (70/_180) + (60/_-70) Enter ***(122.6/_106.8)*** (the result is in whatever form specified by the mode)