DSM **2024** **Homework #03**

Deadline: March 15, 2023
(Dropbox file request: https://www.dropbox.com/request/SLf9oyA2uUBzPzDHVgGm)
Name:_____ Group Number:_____

Name:_____

Name:_____

This Homework is to be delivered by the group (and not by the individual students)

Use the program MUBOKAP, presented in class and made available in your dropbox to perform the kinematic analysis of the mechanism presented in the figure (Excavator) to develop one of the tasks assigned. The task consists in digging one of the areas listed in the figure with one of the excavators. The coordinates of the points limiting the areas are in meter. A different bucket size is specified for each excavator, and in a single path it cannot dig more than that area. See Section 2.5.3 of DSMBook-Chapter02-CartesianCoordinates for the details on a similar Excavator model and its model input file (note that the dimensions of your excavator are different from those in the course notes.

The work has two phases (Phase 1: 100%; Phase 2: 50% more extra points)

(1.1) Build a path (or a sequence of paths) for the bucket to perform the excavation prescribed in your application (selected according to your group number). Note that for each pass of the bucket there is a limit of material that can be removed. If more than 2 passes are necessary, consider only the first 2 passes and identify the approximate shape of what is left to dig.

(1.2) Guide the bucket position and orientation with the position drivers directly applied to the bucket body and, obtain the history of the positions of the points to which the hydraulic actuators are connected.

(1.3) Plot the trajectories of the bucket, obtained with the kinematic simulation, and the length of each one of the hydraulic actuators as functions of time.

(2.1) Instead of driving the bucket of the excavator, drive the hydraulic actuators with point2point drivers so that the end kinematics of the bucket is that one prescribed in phase 1. Plot the bucket trajectory and orientation obtained with the new drivers together with the trajectory obtained in phase 1 (driving the bucket directly)

(2.2) Compare the angular velocities and accelerations of the arm and boom using the two types of drivers (the driven bucket in phase 1 and the point2point drivers in phase 2)

All dimension are obtained by measuring the drawings of the mechanisms in the figures and scaling them appropriately (so that the dimensions specified are fulfilled).

NOTE: (New way to calculate the number of your Excavator and your task) Depending on the group number, select one of the 3 excavators and one of the 3 tasks for your homework. The algorithm for the selection is:

TaskNumber = GroupNumber – Integer(GroupNumber/3)x3 + 1.
ExcavatorNumber = InvertedGroupNumber – Integer(InvertedGroupNumber/3)x3 + 1.

The Inverted Group number is obtained by reversing the order of the digits of your group number (for instance group 73 has an inverted group number of 37).

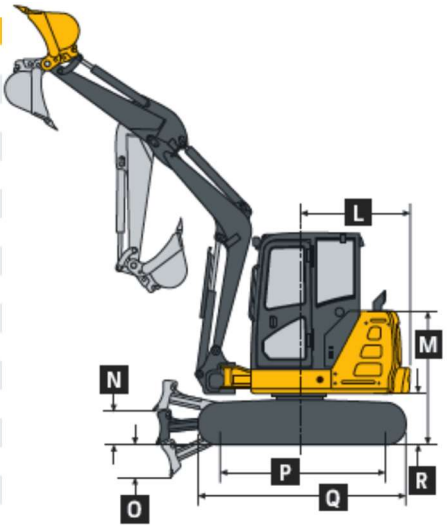
Note that Integer(GroupNumber/3) is the integer obtained by truncation of the real number. In `Matlab` just calculate the task number using:

```
TaskmNumber = GroupNumber - floor(GroupNumber/3)*3+1;
```

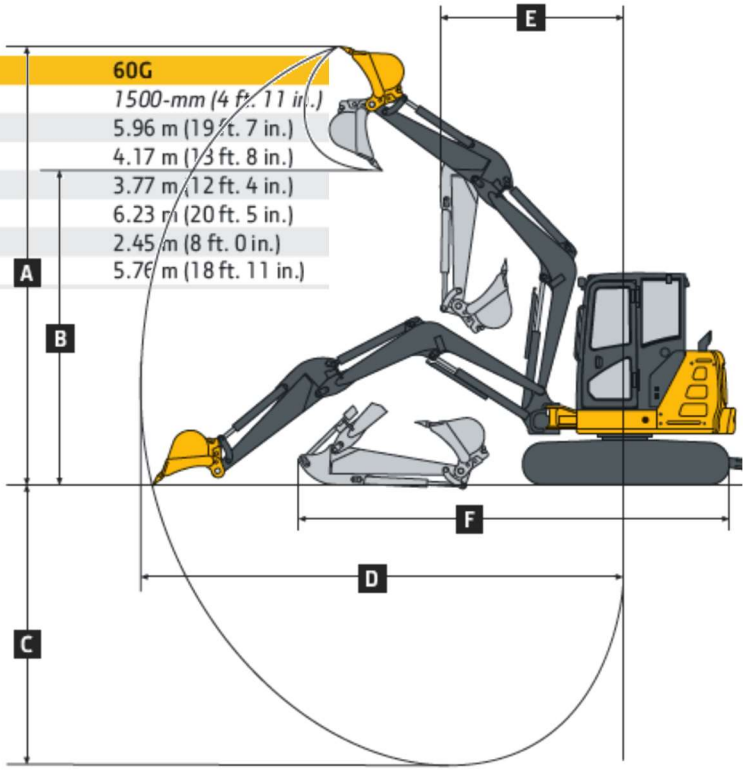
Excavator 1 John Deer 60G

(Bucket Capacity: 0.35 m^2)

Machine Dimensions	
G Upperstructure Width	2.00 m (6 ft. 7 in.)
H Overall Height	2.54 m (8 ft. 4 in.)
I Track Width	400 mm (16 in.)
J Undercarriage Width	2.00 m (6 ft. 7 in.)
K Ground Clearance	340 mm (13 in.)
L Tail Swing Radius	
With Standard Arm	1.30 m (4 ft. 3 in.)
With Long Arm and Extra Counterweight	1.41 m (4 ft. 8 in.)
M Engine Cover Height	1.60 m (5 ft. 3 in.)
N Maximum Blade Lift Above Ground	460 mm (18 in.)
O Maximum Blade Drop Below Ground	370 mm (15 in.)
Blade	
Width	2.00 m (6 ft. 7 in.)
Height	420 mm (16 in.)
P Sprocket Center to Idler Center	1.99 m (6 ft. 6 in.)
Q Track Length	2.50 m (8 ft. 2 in.)
R Counterweight Clearance	620 mm (24 in.)

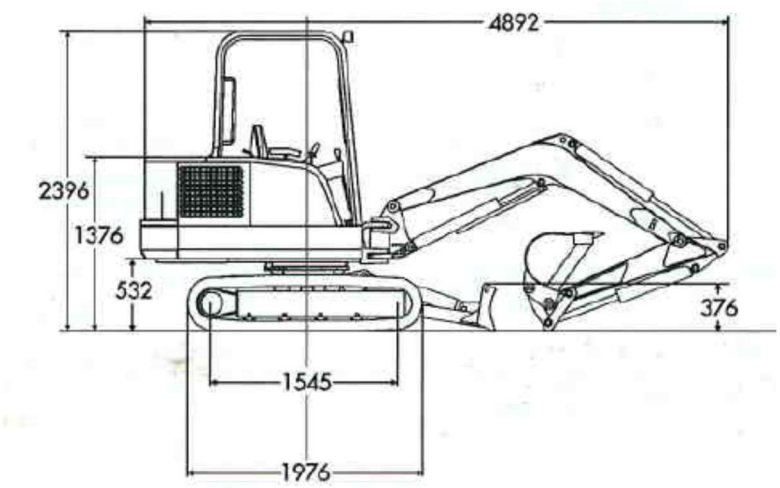


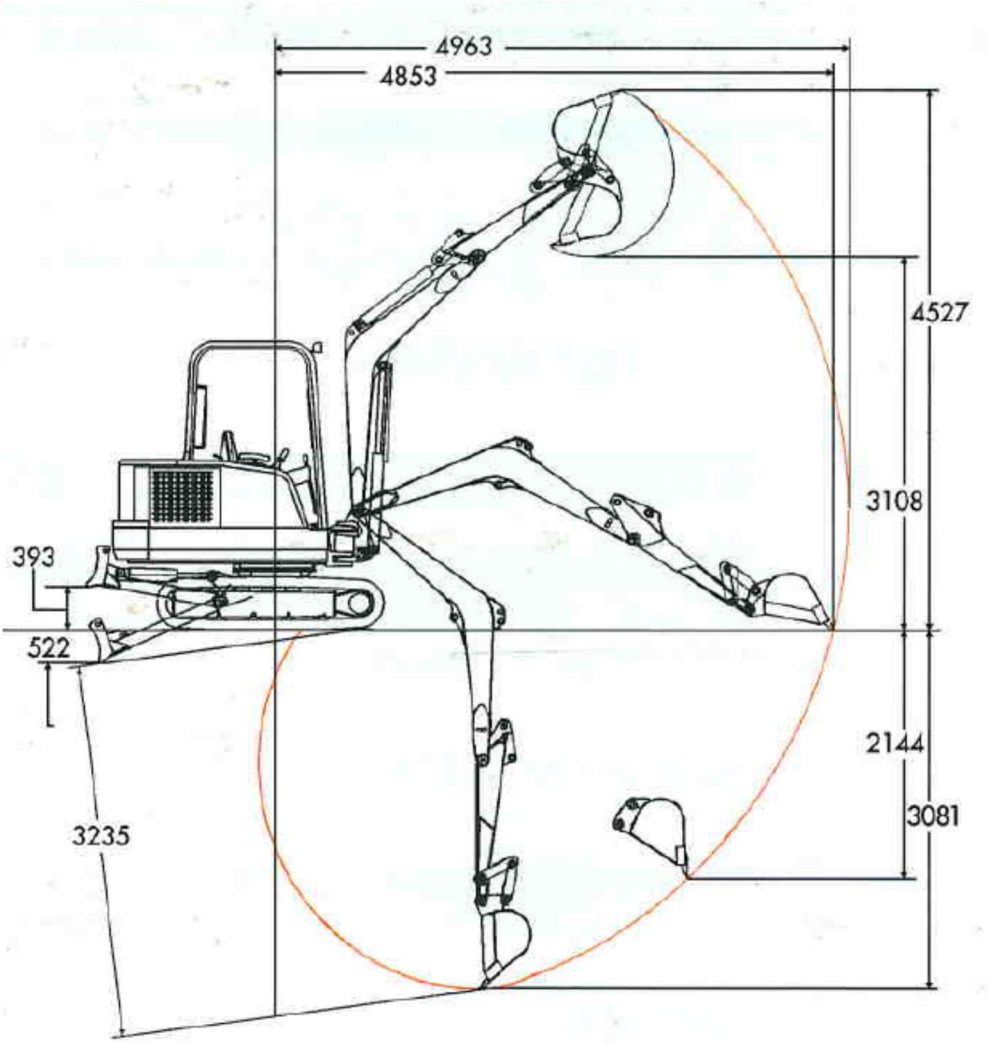
Operating Dimensions	60G
	1500-mm (4 ft. 11 in.)
A Maximum Cutting Height	5.96 m (19 ft. 7 in.)
B Maximum Dumping Height	4.17 m (13 ft. 8 in.)
C Maximum Digging Depth	3.77 m (12 ft. 4 in.)
D Maximum Digging Reach	6.23 m (20 ft. 5 in.)
E Minimum Front Swing Radius	2.45 m (8 ft. 0 in.)
F Transport Length	5.76 m (18 ft. 11 in.)



Excavator 1 Bobcat X331

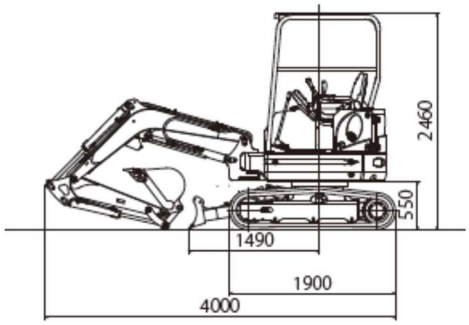
(Bucket Capacity: 0.33 m^2)

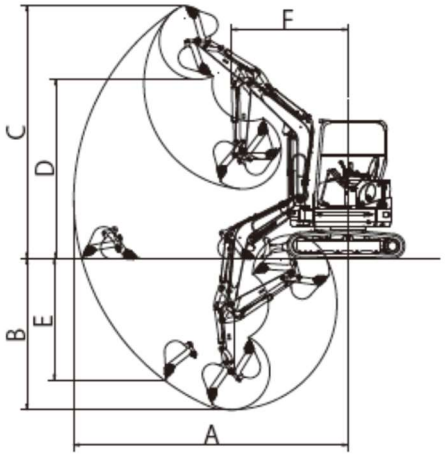




Excavator 1 Kato 25V4 (Standard Arm)

(Bucket Capacity: 0.30 m^2)





		Std. arm	Long. arm
A	Max. digging radius	4560	4840
B	Max. digging depth	2440	2740
C	Max. digging height	4220	4410
D	Max. dumping height	2900	3090
E	Max. vertical digging depth	1840	2120
F	Min. front turning radius	2030	2090
	At right boom swing	1740	1790

Task Numbers (= Area Numbers)