Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

LOCATION: SWANSEA | **LLEOLIAD: ABERTAWE**

LEVEL 5 | **LEFEL 5**

EXAMINATION PERIOD | **CYFNOD ARHOLIADAU**
4TH MAY 2020 AT 1.00 PM

Module Name and Code : Data Acquisition and Dynamics M5X02205

TIME: 2 HOURS

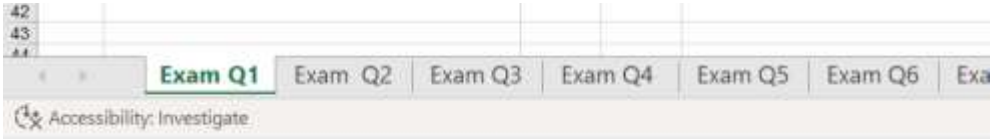
ANSWER ALL QUESTIONS

The exam will be completed by the student in their own home due to Covid19 access restrictions at the university.

You must not communicate with others, either verbally or electronically while undertaking the required tasks.

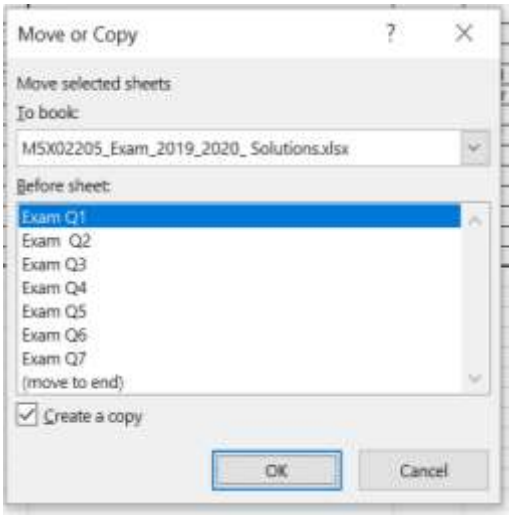
Guidance

- Use the spreadsheet you developed in the first term as the starting point for this exam. Start by saving your spreadsheet as *'YourName* _Exam'
- Each question will ask you to modify the spreadsheet by changing or finding certain values.
- When you have completed a question save the spreadsheet, then create a copy of the current worksheet. Change the name of that copy to the next question number.
- For example - for Exam Q1 when you have completed the question, name the worksheet by changing the name on the tab to Exam Q1 by right clicking on the tab and then entering the new name.



- To generate the worksheet for Exam Q2 right click on the worksheet tab and then left click on Move of Copy

- Check the create or copy box and then OK



- A worksheet called Exam Q1(2) will be created
- Rename the new worksheet tab from Exam Q1 (2) to Exam Q2
- Answer Exam Q2 starting with this new worksheet (which is the same as your final version of the Exam Q 1 worksheet) and then create the next worksheet in the same way. As before.

Examination

Exam Q1

Open the initial spreadsheet you have already developed and after changing lateral acceleration to 7m/s ^{2} save it as instructed and check the measured suspension data is as shown below.

Accel		7 m^2

Measured Suspension Data		
MR fl	Motion Ratio Fronbt Left	1
MR fr	Motion Ratio Fron Right	1
MR rl	Motion Ratio Rear Left	1
MR rr	Motion Ratio Rear Right	1
M fl	Front Left total measured static corner mass [kg]	250
M fr	Front Right measured static corner mass [kg]	250
M rl	Rear Left total measured static corner mass [kg]	250
M rr	Rear Right total measured static corner mass [kg]	250
Mus fl	Front Left unsprung mass [kg]	25
Mus fr	Front Right total unsprung mass [kg]	25
Mus rl	Rear Left unsprung mass [kg]	25
Mus rr	Rear Right unsprung mass [kg]	25
Ks fl	Front Left Spring rate [lb/in]	250
Ks fr	Front Right Spring rate [lb/in]	250
Ks rl	Rear Left Spring rate [lb/in]	250
Ks rr	Rear Right Spring rate [lb/in]	250
Tf	Front Track [m]	1.5
Tr	Rear track [m]	1.5
L	Wheel base [m]	2.5
Rrf	Rolling Radius front [m]	0.275
Rrr	Rolling Radius rear [m]	0.275
Htot	Height of CG of total mass above ground [m]	0.4
Hs	Height of CG of sprung mass above ground [m]	
hf	Height of Front roll centre above ground [m]	0.1
hr	Height of Rear roll centre above ground [m]	0.2

i) Highlight the cell for the calculated value of Hs *(10 Marks)*

ii) Add the following three rows with the relevant calculations for front split, rear split and FRLSD at the bottom of the final column of the spreadsheet *(10 Marks)*

Front Split	1183
Rear Split	1483
FRLSD	-300

iii) Create a Total Rear WT percentage of Total Weight transfer calculation with the equation

= WTr /Total WT *100 and put this below the previous 3 rows

Rear WT percentage [%]	

(10 Marks)

Save, and then Copy worksheet to generate Exam Q2

Exam Q 2 (Based on worksheet Exam Q1)

i) Replace the basic input data with the data detailed in the table below.
Highlight the cell containing the result for weight transfer at the front of the car due to the sprung mass acting about the roll axis [WTsf] .

Accel		8.1 m/s^2

Measured Suspension Data		
MR fl	Front Left Motion Ratio	0.87
MR fr	Front Right Motion Ratio	0.82
MR rl	Rear Left Motion Ratio	1.02
MR rr	Rear Right Motion Ratio	1.02
M fl	Front Left total measured static corner mass [kg]	185.8
M fr	Front Right measured static corner mass [kg]	206.2
M rl	Rear Left total measured static corner mass [kg]	198.8
M rr	Rear Right total measured static corner mass [kg]	219.2
Mus fl	Front Left unsprung mass [kg]	29
Mus fr	Front Right total unsprung mass [kg]	29
Mus rl	Rear Left unsprung mass [kg]	35
Mus rr	Rear Right unsprung mass [kg]	35
Ks fl	Front Left Spring rate [lb/in]	215
Ks fr	Front Right Spring rate [lb/in]	212
Ks rl	Rear Left Spring rate [lb/in]	336
Ks rr	Rear Right Spring rate [lb/in]	337
Tf	Front Track [m]	1.47
Tr	Rear track [m]	1.52
L	Wheel base [m]	2.55
Rfr	Rolling Radius front [m]	0.28
Rrr	Rolling Radius rear [m]	0.28
Htot	Height of CG of total mass above ground [m]	0.45
Hs	Height of CG of sprung mass above ground [m]	
hf	Height of Front roll centre above ground [m]	0.06
hr	Height of Rear roll centre above ground [m]	0.17

Save and Copy the worksheet to generate Exam Q3 *(5 Marks)*

<u>Exam Q3</u> (Based on worksheet Exam Q2)

The front spring rates are changed. Input this data into your spreadsheet.

Ks fl	Front Left Spring rate [lb/in]	235
Ks fr	Front Right Spring rate [lb/in]	235

Highlight these changed cells in your spreadsheet

Answer the following questions below the spreadsheet in a lightly shaded section to highlight your answers to them

Q3.i Would this car be expected to understeer more or less than the car in Q2 when turning right?

(5 Marks)

Q3. ii Justify your answer to the previous question by reference to the load splits, proportion of rear weight transfer and typical tyre performance characteristics.

(5 Marks)

Q3.iii Do not make this change on your spreadsheet! If the front right lower spring pan was wound up to increase the wheel load on that corner by 20 kg what change would occur at the other 3 corners ?

(5 Marks)

Save and then copy worksheet to generate Exam Q4

Exam Q4 (Based on worksheet Exam Q3)

Delete your written answers to Q3 underneath on this worksheet

Make the following data changes.

MR rl	Rear Left Motion Ratio	0.7
MR rr	Rear Right Motion Ratio	0.7

4i) Using the Formula Dependents function trace though the effect of the change through the spreadsheet by highlighting each of the cells affected by this simple change (5 marks)

Answer the following questions below the spreadsheet in a lightly shaded section to highlight them.

4ii) Explain in real terms what has happened to the car by changing the motion ratio from 1.02 to 0.7 in terms of wheel rate, roll angle weight transfer distribution (5 marks)

4iii) If the car has a push rod and bell crank inboard suspension suggest one way in which such a change could be achieved. (5 marks)

Save and then copy the worksheet. To generate Exam Q5

Exam Q5 (Based on worksheet Q4)

Delete your answers to Q4 on this worksheet

Use the spread sheet to find two equal rear spring rates that would need to be used to achieve equal front and rear WT.

Save and then copy the worksheet. To generate Exam Q6 *(5 Marks)*

Exam Q6 (Based on worksheet Q5)

Change the rear spring rates to these:

Ks rl	Rear Left Spring rate [lb/in]	275
Ks rr	Rear Right Spring rate [lb/in]	275

Note the Rear WT proportion and FRLSD in your answer.

Change the static loads for the car as detailed below:

M fl	Front Left total measured static corner mass [kg]	210.8
M fr	Front Right measured static corner mass [kg]	181.2
M rl	Rear Left total measured static corner mass [kg]	173.8
M rr	Rear Right total measured static corner mass [kg]	244.2

Put the answers to the following questions below the spreadsheet in a lightly shaded section to highlight them

Q6i) What has happened to the Rear WT proportion after changing the static corner loads?

- What has happened to the FRLSD?
- How will the car behave in comparison to before the corner weights were changed ? (5 Marks)

Q6ii) On the basis of this result explain why, for motorsport applications, the handling balance of a car could be adjusted by changing spring rates and/or static wheel load distribution if only single direction corners are encountered - in an oval circuit for example - but for a normal road circuit use only spring rate changes could be used. You can use the spreadsheet to illustrate your answer, creating and saving another worksheet called Q 6ii)

(5 Marks)

Now save your completed spreadsheet which should have 6 tabs, one for each question and each tab should have the question number on it.

Make sure the spreadsheet has been named '*YourName* Exam' That is your name in the title not the words 'YourName'!)
Submit the spreadsheet to the exam submission site in the Data Acquisition and Dynamics Moodle before 3.00 pm

Your exam is now complete!