



Programme:		BEng Motorsport Engineering and Design BEng Automotive Engineering			
Module/Unit:		Vehicle Dynamics			
Assignment No:		2	Lecturer: R Dowden	Internal Verifier: M Sandford	
Assignment Title:		Vehicle Track Testing			
Hand Out Date:	Tuesday 7 th Feb 2012	Return Date:	Wednesday 21 st March 2012	Contribution to Overall Module/Unit Assessment (%):	25%
Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, Fail.					
Aim					
To investigate the effect of load distribution on steady state vehicle behaviour					
Outcomes being Assessed (from Module Syllabus):					
Upon successful completion of this module, the student will be able to demonstrate the ability to analyse the fundamental factors influencing the ride and handling of road and competition cars and to specify vehicle suspension parameters to achieve the desired vehicle behaviour					
Procedure					
This work is to be carried out using data obtained from the MCR S2000 car, all required data will be placed in the Moodle Vehicle Dynamics module					
- Construct an Excel spread sheet to calculate wheel load distribution and hence front to rear load split in steady state cornering. The spreadsheet should have the capability for the user to easily change lateral acceleration and to give a solution in the form of a value for the difference between front and rear splits as demonstrated in the Rowley load split calculator. Remember to include static wheel loads in your wheel load calculation. - Use the spreadsheet to calculate the front and rear load splits due to the sprung mass acting about the roll axis alone. - Use the spreadsheet to calculate the roll angle. - Produce Maths channels in Pi Toolbox using the load cell outputs to show - Front and rear load splits produced by the sprung mass acting about the roll axis only. - front axle and rear axle roll angles					

Develop the maths channels in a series of sub channels to make it clear how you have created the final channel and also to make it easier to diagnose any problems with your work.

- 5 Compare the Excel calculated front and rear load splits due to sprung mass acting about the roll axis and the Excel calculated roll angle with the same data produced in Pi Toolbox from a period of steady state lateral acceleration from the track data. Use the mean value from a period of steady state cornering and then set the Excel spreadsheet to the same lateral acceleration for the comparison.
6. Determine the Ackermann steering angle for the steady state corner selected from the data set using the following process.

Using the relationship that $\text{Radius} = V^2/a$. Determine the radius of turn for the car when travelling round the corner selected from the data..

(Remember that V needs to be in m/s and a in m/s^2 so conversions will have to be made on the measured channels).

NB The Pi software uses the form $\text{pow}([\text{channel}], 2)$ to square a channel.

Then, using Ackerman steering angle = wheelbase / Radius of Turn find the theoretical ackerman steering angle for the car as it negotiates the test corner selected.

Compare the actual steered angle with the Ackerman steering angle and hence describe the car's steady state handling balance in terms of the SAE definition of understeer and oversteer.

7. Based on the results obtained evaluate the validity of using load split differences front to rear as a method of predicting the handling balance of a car.

NB

Task 1 gives a method by which understeer level can be predicted and hence the effect of suspension changes assessed before testing. Without detailed knowledge of the tyres' characteristics, however, it has to be calibrated against the car's actual behaviour. That is the purpose of the comparison carried out in Task 6.

If we know that a particular load split difference gives a particular level of understeer then we can adjust the load split difference front to rear by setup change to achieve a required behaviour change.

Tasks 2, 3, 4 and 5 enable the calculated load splits and roll angle to be compared with actual load splits and roll angle to assess the validity of the calculation.

Report

You need to submit the following in your report

Introduction – What the aim of the assignment was

Methodology – This should be a commentary detailing and clarifying the procedure used for both Excel and Toolbox calculations and the steering based understeer measurement.

Results

- a) Screen dumps of relevant pages of Excel spreadsheet for:
 - i) steady state cornering load split difference for a given lateral acceleration
 - ii) steady state roll angle for a given lateral acceleration
 - iii) front and rear load splits due to sprung mass acting about the roll axis alone.
- b) Pi Toolbox results for
 - i) steady state roll angle for a given lateral acceleration
 - ii) front and rear load splits due to sprung mass acting about the roll axis alone.
 - iii) Ackerman steering angle compared with actual steering angle.

Analysis –

Comparison of roll angle and load split results obtained from Pi and Excel (to demonstrate the validity of the CG height measurement used)
Comparison of full load split predicted understeer with steering based understeer

Evaluation – Discussion on limitations of the accuracy of the results obtained, possible causes of the variations occurring between methods, validity of using load splits as a method of predicting handling behaviour.

Marking Scheme

	No	Proportion of overall grade of this element
Screen dumps of Excel spreadsheet for load split difference, load changes and roll angle	1,2,3	25%
PI Toolbox steady state roll angle, differences in splits due to sprung mass acting about the roll axis and Ackerman steering angle compared with actual steering.	4,6	25%
Analysis	5	20%
Evaluation	7	20%
Production of well structured report.	5	10%