



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

MODULE DIRECTORY

PROGRAMME TITLES:

BSc/HND MOTORSPORT ENGINEERING

BSc/HND AUTOMOTIVE ENGINEERING

BSc/HND MOTORCYCLE ENGINEERING

LEVEL 4

SCHOOL OF ENGINEERING

**FACULTY OF ARCHITECTURE,
COMPUTING AND ENGINEERING**

2018-2019

CONTENTS PAGE

	Page No
INTRODUCTION.....	1
MODULES	2
Engineering Science	2
Analytical Methods and Study Skills	4
Engineering Design & Materials	7
Motorcycle Vehicle Systems.....	11
Powertrain Technology.....	14
Engine Control Systems.....	18
Vehicle Systems.....	21

INTRODUCTION

This Module Directory includes all the modules for Level 4 within the School of Engineering in the academic year 2018-2019.

This directory accompanies the Programme of Study Handbook, which will provide you with details of which modules you will be studying for your programme this year in the 'Programme of Study' section. This directory may include modules that are running on other programmes of study within your School/Faculty. If you require assistance in identifying the modules for your programme of study, please contact the Programme Director (whose name and contact details are provided in the accompanying Programme of Study Handbook), or the relevant Faculty Office.

The University has made every effort to make the information as full and as accurate as possible, but you should note that minor changes in the organisation of modules between the planning stage and the actual teaching are inevitable. We shall try to keep any such changes to a minimum, and you will receive plenty of advance warning in the event of any alteration. We would also be grateful if you would let us know about any changes that you think might be helpful if introduced into future handbooks.

MODULES

MODULE CODE: M4X02192
TITLE: Engineering Science
DATED: 03/08/2015

LEVEL: 4
CREDITS: 20

JACS CODE: F311

AIM(S)

- To investigate a number of major scientific principles which underpin the design and operation of engineering systems.
- To give an overview of mechanical principles to provide the basis of further studies of specialist engineering areas.

LEARNING OUTCOMES

Upon the successful completion of this module, the student should be able to demonstrate the ability to:

1. Analyse static and dynamic engineering systems.
2. Analyse energy transfer in thermal and fluid systems.

INDICATIVE CONTENT

- Static and dynamic: A calculative and analytical considerations of the bending equation, $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ and torsion equation, $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$, moments, uniform linear and rotary motion, simple energy systems and mechanical oscillations.
- Analysis of thermal heat transfer through conduction, $Q = \frac{-kA(T_2 - T_1)}{x}$, convection, $Q = hA(T_2 - T_1)$ and radiation, $Q = 56.7\epsilon A \left[\left(\frac{T_2}{1000} \right)^4 - \left(\frac{T_1}{1000} \right)^4 \right]$. Analysis of the fundamentals of gas laws including, Boyle's Law, Charles' Law, the combined/universal gas law, $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ and the ideal gas law.

LEARNING AND TEACHING STRATEGY

Teaching and learning will mainly consist of classroom based lectures, to deliver theory, combined with laboratory based experiments to reinforce understanding of the theory in practical demonstration.

The allocation of teaching to deliver the module is:

Activity type	Hours	Percentage
Scheduled learning	48	24%
Independent learning	152	76%
Placement learning	0	0%
TOTAL	200	100%

ASSESSMENT

Assessment Component 1 – 50%

Written exam Phase Test (1 -2 hours).

Assessment Component 2 – 50%

Written exam Phase Test (1 -2 hours).

Assessment Summary

Activity type	Percentage
Written exam	100%
Coursework	0%
Practical	0%
TOTAL	100%

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Does the module contribute to ESD?	No
If yes please provide brief details (no more than 100 words):	

BIBLIOGRAPHY

Essential

Zammit SJ– *Science for Motor Vehicle Technicians* (Longmann, 1987)

Bolton W- *Engineering Science* (Routledge, 2015)

Tooly M, Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 2004)

Watson K, - *Foundation Science for Engineers* (McMillon, 1998)

Background

Bolton W – *Mechanical Science* (Blackwell Scientific, 2006)

Hannah J, Hillier M – *Mechanical engineering science* (Longman, 1999)

Happian – Smith J, - *An Introduction to Modern Vehicle Design* (Butterworth Heineman, 2002)

MODULE CODE:	M4X02193
TITLE:	Analytical Methods and Study Skills
DATED:	07/10/2015
LEVEL:	4
CREDITS:	20
JACS CODE:	G160

AIM(S)

- To provide the fundamental analytical knowledge and techniques needed to successfully complete the applied modules of the Higher National Engineering programme.
- To enable students to use fundamental algebra, trigonometry and calculus for the analysis, modelling and solution of realistic engineering problems.
- To enable students to cover report writing, spreadsheet analysis, CV writing and presentation skills

LEARNING OUTCOMES

Upon the successful completion of this module, the student should be able to demonstrate the ability to:

1. Write technical reports in the correct format, using a correct referencing system.
2. Analyse and model engineering situations and solve problems using algebraic, trigonometric, and differential calculus methods.
3. Analyse and model engineering situations and solve problems using integrative calculus, complex numbers and matrix manipulation.

INDICATIVE CONTENT

- CV and report writing
- Introduction to formulae in Microsoft Excel
- Algebraic methods
- Trigonometric methods
- Introduction to calculus
- Differential calculus
- Integral calculus
- Complex numbers
- Matrix manipulation and their use in solving a system of equations

LEARNING AND TEACHING STRATEGY

The module will be delivered by weekly lecture/tutorial to present key ideas. Students will apply the theoretical concepts to practical situations.

The module will be implemented using some lectures together with supervised laboratory sessions. The allocation of teaching to deliver the module is:

Activity type	Hours	Percentage
Scheduled learning	48	24%
Independent learning	152	76%
TOTAL	200	100%

ASSESSMENT

Assessment Component 1 – 20%

The first assessment will involve report writing, together with spreadsheet work. (600 – 1000 words)

Exemplar

“Discuss how engine characteristics change by using the spreadsheet provided to simulate the rotation of a piston engine.”

Assessment Component 2 – 40%

The first exam will comprise of algebraic methods; solving linear, quadratic and simultaneous equations, trigonometric methods and differential calculus. (1 – 2 hours)

Assessment Component 3 – 40%

The second exam will involve solving integrals using various methods; complex numbers and de Moivre's theorem, matrix manipulation and Cramer's rule. (1 – 2 hours)

Assessment Summary

Activity type	Percentage
Written exam	80%
Coursework	20%
Practical	0%
TOTAL	100%

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Does the module contribute to ESD?	No
If yes please provide brief details (no more than 100 words):	

BIBLIOGRAPHY

Essential

Lee, S - *An Introduction to Mathematics for Engineers*, (Hodder, 2008)

Osmond, A - *Academic Writing and Grammar for Students*, (Palgrave Macmillan, 2013)

Pears R& SheildsG -*Cite Them Right: The Essential Referencing Guide*, (Palgrave Macmillan, 2010)

Stroud, K.A. - *Engineering Mathematics*, (Palgrave Macmillan, 2013)

Recommended

Rouvel J - *Automotive Mathematics*, (Pearson/Prentice Hall, 2005).

Singh K - *Engineering Mathematics through Applications*, (Palgrave Macmillan, 2003)

MODULE CODE:	M4X02194
TITLE:	Engineering Design & Materials
DATED:	07/10/2015
LEVEL:	4
CREDITS:	20
JACS CODE:	H150

AIM(S)

- To introduce students to both 2D and 3D Computer Aided Design, Drafting and Solid Modelling and a familiarity with the engineering design process.
- To give students an understanding of the theory and application of design methodologies and processes.
- To develop a knowledge base and understanding of the structure, properties and basic selection of classes of materials
- To develop a knowledge and appreciation of the processes used in the manufacture of components with a view to providing basic process selection parameters

LEARNING OUTCOMES

Upon the successful completion of this module, the student should be able to demonstrate the ability to:

- 1 Show knowledge and understanding of design methodologies and processes (problem definition/decision making/communication etc.)
- 2 Demonstrate skills in communicating the design, material and manufacturing of products through the preparation and interpretation of Engineering Drawings to BS8888 through the medium of 2D and 3D CAD tools.
- 3 Demonstrate cognitive skills to allow choice of material and manufacturing processes to meet specific design criteria.
- 4 Demonstrate key transferable skills in problem formulation and decision making, communication and self-management skills

INDICATIVE CONTENT

- Methodologies for the generation of design solutions to conceptual and adaptive design problems, to include; creativity, innovation, evaluation, optimisation, design isolation, manufacture, reliability, sustainability, safety and cost implications.
- Engineering Graphics – basic sketching and drawing skills in the creation and interpretation of engineering drawings. British Standard 8888 (or equivalent standard).

- Computer Aided Drawing – introduction to the use of Solidworks (or equivalent software) for the creation of 3D solid models, assemblies and 2D engineering drawings.
- Methodologies for the generation of design solutions to conceptual and adaptive design problems. To include; creativity, innovation, evaluation, optimisation, design isolation, manufacture, reliability, sustainability, safety and cost implications.
- Material properties and material selection using CES material selection software.
- Introduction to primary and secondary manufacturing processes.
- Tolerancing principles, limit and fit calculations, geometric dimensioning and tolerancing theory and applications

LEARNING AND TEACHING STRATEGY

The theoretical concepts and techniques will be delivered in lecture format. Demonstrations will be given and supervised laboratory work will facilitate the introduction of the software applications required for this module.

Supportive tutorial periods will focus on reviewing retrospectively work covered earlier with the aim of addressing difficulties encountered by individual students. Similarly, further application examples can be undertaken at a pace to meet individual needs (within reason).

Activity type	Hours	Percentage
Scheduled learning	48	24%
Independent learning	152	76%
TOTAL	200	100%

ASSESSMENT

Assessment Component 1 – 50%

Practical Detail

The first element of assessment is intended to assess the student's ability to use the solid modelling software to create individual components and to construct assemblies' models with appropriate degrees of freedom.

This will take the form of an assignment which will may be carried out during a time constrained, supervised laboratory session (assessment session). The component and assembly models will be graded directly. A written report will, therefore, usually not be required.

Assessment Component 2 – 50%

Mini Project

Coursework

The second element of assessment will involve students being issued with a design challenge/problem and involve the application of design methodologies and tools in order to arrive at a design solution.

A report, detailing the strategies applied and the tools employed will be compiled by the students and submitted for assessment. The report will be accompanied by solid models and technical drawings used to specify the final designs.

Exemplar:

Students will be asked to complete a mini-project in small groups – maximum of 3.

The aim of the project is to design or redesign a component of their choice preferably that does work – and must include an assembly.

- 1 *Students are expected to develop a specification and following the course guidelines, justifying all their design decisions*
- 2 *Engineering drawings are compulsory and should be presented in accordance to BS8888. Each student must draw at least one of the parts of the assembly*
- 3 *A 10-minute presentation to the company's 'Chief Designers' and submission of written supporting information in the form of a report no longer than 20 pages (plus appendix) at the time of the presentation (word count - 2500-3000)*

Assessment Summary

Activity type	Percentage
Written exam	0%
Coursework	50%
Practical	50%
TOTAL	100%

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Does the module contribute to ESD?	Yes
If yes please provide brief details (no more than 100 words): Students will have an appreciation of the time, energy and resources conserved through the use of simulation as opposed to manufacture of many prototypes for physical testing.	

BIBLIOGRAPHY

Essential

- Pugh S - Total Design: Integrated Methods for Successful Product Engineering, (Prentice Hall, 1990)
Simmons C & Maquire D - Manual of Engineering Drawing to British and International Standards, (Newnes, 2003)
Pahl G et al - Engineering Design: A Systematic Approach, (Springer, 2006)
Ullman DG - The Mechanical Design Process, (McGraw-Hill Higher Education, 2002)
Kalpakjian, Serope – *Manufacturing Engineering Technology* (Addison-Wesley, 1995)
Hillier - *Fundamentals of Automotive Technology 5th Edition* (Nelson Thornes, 2006)

Background:

- Solidworks software information / help files (updated annually)
Andreas *et al* – *Product Design for Assembly* (IFS, 1989)
Shigley – *Mechanical Engineering Design* (2001)
Beitz, Paul – *Engineering Design and Systematic Approach* (Longman, 1991)
Birsch A – *Product Design*, (Design Council, 1985)
Timmings – *Manufacturing Technology: Volume 1*, (Longman, 1998)
Timmings – *Manufacturing Technology: Volume 2*, (Longman, 1993)

MODULE CODE: M4X02195
TITLE: Motorcycle Vehicle Systems
DATED: 02/11/2015

LEVEL: 4
CREDITS: 20

JACS CODE: H990

AIM(S)

- To provide a sound appreciation of motorcycle technology and to develop knowledge of basic handling concepts and engine performance characteristics.
- To provide the student with a range of exercises to develop their practical measurement skills and data analysis.

LEARNING OUTCOMES

Upon the successful completion of this module, the student should be able to demonstrate the ability to:

1. Describe the basic handling characteristics of a motorcycle.
2. Interpret the fundamental characteristics of the motorcycle engine.

INDICATIVE CONTENT

- Motorcycle dynamics and handling
- Suspension properties and vehicle setup.
- Technical measurement and analysis
- Basic tyre properties
- Fundamental frame design
- Engine performance characteristics
- Practical testing
- Report writing

LEARNING AND TEACHING STRATEGY

Lectures will be supported by practical workshop sessions. Practical work will be workshop based and consist of measurement and practical test exercises that support the theory presented.

The allocation of teaching to deliver the module is:

Activity type	Hours	Percentage
Scheduled learning	48	24%
Independent learning	152	76%
Placement learning	0	0%
TOTAL	200	100%

ASSESSMENT

Assessment Component 1 – 50%

Coursework (2000 words).

Exemplar

1. Acquire accurately measured geometry data from two different motorcycles (Trail, Rake angle, Wheelbase, frame dimensions etc.). Present this data graphically on a motorcycle schematic diagram. These can be supplied if required, but use your own if you can. Determine Centre of Gravity positions for the same two motorcycles, showing all calculations and add this information to your schematic diagrams.
2. Explain how squat affects a motorcycle, how it can be changed, and what other effects this might have to other areas.
3. Use the information acquired above to explain, in detail, the known handling characteristics for the two machines analysed and the differences in their attitude under dynamic situations.
4. Acquire geometry data for two other modern motorcycles (e.g. MotoGP, WSB, Paris Dakar, Custom.) Use this geometry information to explain how the design of the motorcycle has been tailored to its application. How does the geometry of each motorcycle relate to its handling characteristics and performance?
5. Use all this information to recommend any alterations, which could be made to improve the handling characteristics of any of the bikes you have physically measured.

(All information, diagrams and photos should be appropriately referenced to the texts/books/articles from which they originated).

Assessment Component 2 – 50%

Coursework (2000 words).

Exemplar

1. In Excel create a spreadsheet to calculate different gear ratios for the CRF 450, include a swing arm length calculator. In your report, show equations used with a brief explanation on how this type of calculator could be utilised.
2. Expand the calculator to include driving force in each gear and compare to CRF 450 data around Kinsham. Complete an analysis of the data and comment on where improvements could be made in gearing and shifting points.
3. For the same motorcycle as above give a detailed explanation of the behaviour of its suspension system in acceleration/braking and cornering situations.

Consider how you might tailor the spring/damper configurations to suit the motorcycles requirements and situations you may encounter during a race weekend i.e. bumpy/smooth circuit, wet/dry conditions, and geometry changes to the motorcycle etc.

(All information, diagrams and photos should be appropriately referenced to the texts/books/articles from which they originated).

Assessment Summary

Activity type	Percentage
Written exam	0%
Coursework	100%
Practical	0%
TOTAL	100%

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Does the module contribute to ESD?	Yes
If yes please provide brief details (no more than 100 words): This module teaches students the importance of simulation modelling for the motorcycle industry, and how this can replace some of the requirement for live testing, which in turn reduces the environmental impact on both a regional and global scale.	

BIBLIOGRAPHY

Essential

Bradley J- *The Racing Motorcycle: A Technical Guide for Constructors (Volume 1 & 2)*, (Broadband Leisure, 2003)
 Foale T - *Motorcycle Handling and Chassis Design*, (Foale, 2008)

Recommended

Cocco G- *Motorcycle Design and Technology*, (Giorgio NADA Editore, 2005)
 Ibbott A - *Performance Riding Techniques*, (Haynes, 2006)

MODULE CODE: M4X02196
TITLE: Powertrain Technology
DATED: 29/10/15

LEVEL: 4
CREDITS: 20

JACS CODE: H331

AIM(S)

- To allow the student to acquire basic knowledge of a range of powertrain systems and associated technologies.
- To assess their impact and function on overall vehicle design, underpinned by the engineering science fundamentals.

LEARNING OUTCOMES

Upon the successful completion of this module, the student should be able to demonstrate the ability to:

1. Show a detailed knowledge and understanding of the underlying principles of engine and vehicle technologies and practices for analysis powertrain systems.
2. Apply subject specific skills with respect to providing solutions using engineering principles applied to an automotive problem and the interpretation of experimental data to assess validity of solutions proposed.
3. Show cognitive skills with respect to simplification and modelling of real automotive problems, the application of fundamental mechanical engineering principles and the analysis of problems and making recommendations on findings.
4. Demonstrate transferable skills in problem formulation and decision making

INDICATIVE CONTENT

- Engine design features
- Engine types and operation
- Performance characteristics
- Dynamometer testing and rolling road testing
- Engine control systems
- SI ignition systems.
- SI fuel injection systems, open-loop and closed-loop control.

- Transmission systems
- Impact of the above in overall vehicle performance, fuel consumption and drivability

LEARNING AND TEACHING STRATEGY

The implementation of this module is based on lectures, laboratory work and hands-on practical work in the workshop environment. Lectures and hand-outs are used to supplement the student centred learning approach used in this module. The current range of assignments in this module includes testing, measurement analysis and report writing.

Where appropriate a student may use an extra curricula project as the basis for assessment of relevant elements of the work undertaken.

The allocation of teaching to deliver the module is:

Activity type	Hours	Percentage
Scheduled learning	48	24%
Independent learning	152	76%
Placement learning	0	0%
TOTAL	200	100%

ASSESSMENT

Assessment Component 1 – 50%

Coursework: Consisting of a written report of a laboratory experiment (2000 words).

Exemplar

Tasks

Engine Performance Testing and Analysis on the Honda Engine:

1. Carry out an engine dynamometer test to obtain the required raw data of load, speed and fuel consumption rate of a throttle opening of 100%.
2. Enter the collected raw data into a suitable spread sheet... 'individual student'.
3. Calculate the corrected Power, Torque, BMEP, SFC, and Overall Thermal Efficiency... 'individual student'.

Evaluation:

Your work should be written as a standard technical report. As an ABSOLUTE MINIMUM you should include the following:

1. Write an Introduction outlining the aims of the test.
2. Describe the testing equipment and method used.
3. Print all spread sheet data results tables.
4. Plot graphical results for the required relationship (see below) and answer the associated questions.

5. Draw conclusions from your test results.

Write a brief evaluation of how you felt you performed the tasks set, how your own performance could have improved and how the investigation as a whole could have been improved.

Graph to be Plotted	Associated Question
SFC against Engine Speed	Suggest reasons why the SFC varies as it does with engine speed.
Torque against Engine Speed	Suggest reasons why Torque varies as it does with engine speed.
Brake Power against Engine Speed	Suggest reasons why Brake Power varies as it does with engine speed.

Assessment Component 2 – 50%

Coursework: Consisting of a written report of a laboratory experiment (2000 words).

Exemplar

Brief

You are part of a transmission selection team that is required to carry out performance data collection on the vehicle identified.

Tasks

1. Carry out the performance data collection exercise using the vehicle provided on the chassis dynamometer – working group.
2. Select a specific gear ratio, different engine and road speeds, record tractive effort and power at the road wheels – working group.
3. From the data collected calculate:
 - a. Torque at the road wheels at 4800 rpm
 - b. Tractive effort at the road wheels at 6000 rpm
 - c. The differential gear ratio (confirm as 4.1:1)
 - d. The transmission efficiency.
 - e. The maximum tractive effort available in each gear.
 - f. The maximum road speed in all gears.
 - g. The speed ratio.
 - h. The theoretical intermediate gear ratios
 - i. From the actual engine speeds recorded, confirm the theoretical road speeds (kmph)
 - j. From the tractive effort values, calculate the torque at the engine.
 - k. The use of a graph is essential to support your calculations.

Assessment Summary

Activity type	Percentage
Written exam	0%
Coursework	100%
Practical	0%
TOTAL	100%

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Does the module contribute to ESD?	Yes
This module introduces insights into how the modern industry is building a more sustainable approach for future technologies, complying to legislation and protocols whilst managing resources efficiently and effectively with the minimum impact on people or the environment. Consideration of engine and chassis dynamometers helps the learner to appreciate why testing reduces waste of resources.	

BIBLIOGRAPHY

Essential

Stone R - *Introduction to Internal Combustion Engines* (Macmillan, 1999)
Heywood, J. - *Internal Combustion Engine Fundamentals* (McGraw Hill, 1989)
Heisler Heinz – *Vehicle and Engine Technology* (Edward Arnold, 1985)
Zammit S J – *Motor Vehicle Engineering Science for Technicians* (Longman, 1987)

Background

Kett P W – *Motor Vehicle Science* (Chapman & Hall, 1982)
Twigg Peter – *Motor Vehicle Engineers* (Arnold, 1995)
Newton K & Steed W – *The Motor Vehicle* (Butterworth-Heinemann, 1997)

MODULE CODE: M4X02197
TITLE: Engine Control Systems
DATED: 01/09/2015

LEVEL: 4
CREDITS: 20

JACS CODE: H331

AIM(S)

- To provide students with background knowledge and understanding of vehicle electrical and electronic systems, circuits and components.
- To develop their ability to test these systems whilst using computers as an aid for solving problems.

LEARNING OUTCOMES

Upon the successful completion of this module, the student should be able to demonstrate the ability to:

1. Investigate technical applications and solutions for engine electrical and electronic circuits
2. Analyse the solutions and operations of sensors, actuators and displays with the aid of computers

INDICATIVE CONTENT

- Vehicle electrical and electronic circuits
- Sensors, actuators and displays analysis and technical evaluation
- Electromagnetic interference and operation of suppression devices
- Technical applications of engine control systems
- Dedicated computer and scope functions and analysis

LEARNING AND TEACHING STRATEGY

'Concepts' and 'theory' delivered through lecture periods and review of notes (handouts) supplied. Continual complementary example/application problem supportive of theory is considered, with whole class participation through interchange of ideas and discussion. Student centred examples similarly undertaken for consolidation/reflection of principles/practices already considered.

Supportive tutorial periods will focus on reviewing retrospectively work covered earlier with the aim of addressing difficulties encountered by individual students. Similarly, further application examples can be undertaken at a pace to meet individual needs (within reason).

The allocation of teaching to deliver the module is:

Activity type	Hours	Percentage
Scheduled learning	48	24%
Independent learning	152	76%
Placement learning	0	0%
TOTAL	200	100%

ASSESSMENT

Assessment Component 1 – 100%

Coursework Assessed by practical application and one piece of work assigned (4000 words).

Exemplar

The assessment for this module is coursework based assignment which is aimed to assess the student's ability on a range of topics. The student's IT skills, Word and Excel are assessed along with their referencing, report writing and presentation skills. The module provides a theoretical background, complemented through practical investigated techniques, using dedicated instruments whilst considering Health & Safety. One of the teaching and learning assessment processes for this module is to evaluate a combination of outcomes that the student has demonstrated through a practical experiment within a safe working environment.

Assessment Summary

Activity type	Percentage
Written exam	
Coursework	100%
Practical	
TOTAL	100%

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Does the module contribute to ESD?	Yes
If yes please provide brief details (no more than 100 words): This module introduces past and present insights into how the modern industry is building a more sustainable approach for future technologies, complying to legislation and protocols whilst managing resources efficiently and effectively with the minimum impact on people or the environment. Consideration of fuel and ignition management systems encourages the learner to appreciate why consideration of sustainability is in their interest.	

BIBLIOGRAPHY

Essential

Bosch - *Bosch Automotive Handbook 9th Edition*, (Bosch, 2014)

Hillier V – *Fundamentals of Automotive Electronics, 6th Edition*, (Nelson Thornes, 2012)

Bosch, *Automotive Electrics and Electronics-5th Edition*, (Bosch, 2007)

Recommended

Heinz H - *Advanced Engine Technology*, (Edward Arnold, 1995)

Denton T - *Electrical and Electronics Systems 3rd Edition*, (Elsevier Ltd, 2004)

Background

Plint M - *Engine Testing 3rd Edition*, (Butterworth – Heinemann, 1995)

Bird J - *Electrical and Electronic Principles and Technology*, (Newnes, 2007)

MODULE CODE: M4X02198
TITLE: Vehicle Systems
DATED: 29/10/2015

LEVEL: 4
CREDITS: 20

JACS CODE: H331

AIM(S)

- To develop an understanding of the design and application of vehicle suspension systems.

LEARNING OUTCOMES

Upon the successful completion of this module, the student should be able to demonstrate the ability to:

1. Compare and contrast vehicle chassis and suspension design features which achieve specific vehicle behavioural characteristics.
2. Model, measure and analyse vehicle suspension and steering systems in order to identify kinematic and force related characteristics.

INDICATIVE CONTENT

- Tyre construction, behavior and performance
- Suspension layouts and kinematic behavior
- Steering layout and behavior
- Determination of suspension frequencies and spring specification
- Introduction to aerodynamics
- Brake and braking performance
- Driveline performance
- Vehicle construction
- Aesthetic design considerations

LEARNING AND TEACHING STRATEGY

Lectures will introduce the students to the concepts, principles and practices. Workshop sessions and use of data analysis software will develop the skills needed to calculate and validate vehicle handling predictions.
The allocation of teaching to deliver the module is:

Activity type	Hours	Percentage
Scheduled learning	48	24%
Independent learning	152	76%
Placement learning	0	0%
TOTAL	200	100%

ASSESSMENT

Assessment Component 1 – 50%

Coursework: 2000 words

Exemplar

Task Description

Brief

You are divided into small working groups and then allocated two time slots in the Chassis Workshop to take measurements from the project car. You will present your results in this first assignment. The next assignments will enable you to analyse the data collected.

Attendance at your agreed laboratory sessions is mandatory. Failure to attend may result in a penalty equivalent to a late submission, maximum grade of a pass. For attendance dates and times refer to the **Chassis Measurement 1st Year Groupings** document.

Materials and equipment required

The car for investigation will be mounted on the surface tables in the automotive workshop. Use the precision equipment most appropriate to each suspension point. Ensure the steering rack is **centralised and locked** before starting.

SESSION ONE

1. Suspension co-ordinate measurement (session ONE)

- Accurately measure the suspension component co-ordinates assigned to your working group at the static ride height and record the results for your records using the blank form appropriate to the suspension being measured.
- This is an involved process and can take a considerable time to obtain the dimensions for a single co-ordinate. You should aim to take each measurement twice and if possible in two different ways to ensure accuracy.
- Enter your data points into the data entry table for the existing car model in the WinGeo3 software on the computer installed next to the test car.
- It is important that you ensure that the **check inclinations or check lengths calculated** match those measured on the vehicle and so after entering the co-ordinates for any suspension or steering pivot note the check dimension calculated by WinGeo3 and displayed in the data entry

table. Compare this calculated value with the actual value you have obtained and go back and re-measure if necessary until you get agreement between the calculated value and the real thing.

SESSION TWO

2. Measurement of Kinematic Behaviour

- Put the suspension on 25mm of droop (this is classed as +25 mm ride in the WinGeo3 software)
- Using suitable measuring equipment measure the:
 - i. toe
 - ii. camber
 - iii. spring/damper length
- Raise the wheel by 5 mm using the tie rod installed in place of the spring/damper. This is classed as +20mm ride and repeat the measurements.
- Repeat this process until you reach -25mm ride (i.e. 25mm of bump travel).
- Plot graphs of each variable against ride height for ride heights +25 to – 25mm **as you measure the results**. If you see a discontinuity or sudden shift in the curve you must, determine the cause, go back to the beginning and start again. The curves will be smooth unless there is wear in the joints (which there is not in this case).

Having got the data for the actual kinematic behaviour of the car the final part of this data collection assignment is to obtain the information needed to determine the suspension frequency.

3. Spring rate and unsprung mass

- Measure the total corner unsprung mass for the suspension corner being investigated using suitable scales.
- Measure spring rates for the suspension corner being investigated using the spring tester.
- Measure your own mass as this will be required for establishing vehicle total mass for the 'on the start grid' condition. (For the next assignment).

What you need to hand in for assessment

Introduction

What the purpose of the investigation was, the vehicle you used for the investigation, the suspension corner investigated.

Equipment

- i. A brief description of the equipment used for **each task**.
- ii. Comment on suitability, accuracy, possible alternatives.

Methodology

Methods used **in each task** to undertake the required measurements including the different approaches required for different coordinate measurements.

Please select a single point and describe the measurement of the point in detail, for lab 1.

Ideally use a Haynes Manual style approach, write in third person. A logical chronological approach with pictures would help the reader.

Results

Include the following results:

1. The measured co-ordinates with the suspension at static ride height.
2. A printout of the Mitchell WinGeo3 suspension schematic and suspension points for the model used with your specific points highlighted. This can be copied from the lab computer as a screen dump to include in your report.
3. A table comparing the computer generated incline check angle or check lengths with your measured check inclination or check lengths.
4. A table illustrating the determination of toe angle from the measurements recorded on each DTI
5. A table with ride against camber, toe and spring length and graphs of each of these variables against ride height plotted in Excel in the configuration shown on P5 of this brief
6. A table and graph of ride against damper mount length.
7. The unsprung mass of the car suspension corner investigated
8. A table of results and graph of load vs deflection of the spring for suspension corner investigated in the original imperial (standard American) measurements of lbs. and inches and also converted to N/mm

Evaluation

Include details of how well you feel the measurements were taken, and whether improvements could have been made in the methods used.

Also discuss the work you did as part of the group activity, and how well the assignment went.

Assessment Component 2 – 50%

Coursework 2000 words

Exemplar

Brief

Using the data collected in the first assignment you are going to use WinGeo3 to simulate suspension behaviour and then, where possible, compare the results obtained from the software model created with those obtained from the real car. Then you are going to find the suspension frequency for the car for this assignment all work should be done by you as an individual and not working as part of a group.

Resources required

WinGeo 3 software and your results from Assignment 1

Tasks

- Create the WinGeo3 model for the suspension of the car investigated and produce a schematic drawing of the suspension layout.
- Use the Compute/ Ride Iteration function in WinGeo3 to produce separate graphs of camber and toe steer for the right front wheel using the GAP software within WinGeo3.
- Using WinGeo3's Table display function create a new table with ride, right wheel camber and right wheel toe, manipulate the model produced in 5 mm increments of ride heights from full rebound to full bump (remember to press compute after each change) export the data and plot graphs of camber and toe steer for the left front wheel against ride height. This can be done by following the instructions to save it as a CSV file and then reading the table of results in Excel.
- Using the results obtained from this exercise and those real results obtained in Assignment 1 plot:
 - a. the camber change of the wheels relative to ride height for real and predicted results.
 - b. the change in toe steer relative to ride height for real and predicted results.
- You should plot real and predicted camber on one graph and real and predicted toe on another so that the two curves can be compared. Remember the real results should be zeroed to aid the comparison of results.
- Bring up the schematic diagram of the suspension in WinGeo3. Check the [Mark RC] button. Take the car model onto 25 mm of bump i.e. (-25 Ride) Add 3 degrees of roll in 0.1deg increments, (pressing compute after each increment) Then go to 25 mm rebound (i.e. +25 ride) and reduce the roll incrementally as before pressing compute at each stage until zero ride and roll is reached. This will then produce a 'locus' of the roll centre position which will demonstrate how effective the suspension design is at controlling this parameter. Print this diagram off for your report.
- The gradient of spring load vs change in length found in Assignment 1 is the spring rate. Convert the lbs. and inch values obtained from the Longacre equipment to Newtons and mm and record this. Calculate the spring rate. (Note that the units for the calculations will be N/m).
- The gradient of the wheel travel vs change in spring length graph is the Suspension Leverage (referred to as Velocity Ratio in WinGeo3). Record this value at the zero ride height of the curve.
- Use the corner mass and the unsprung mass measured in Assignment 1 and the values of SL and Ks determined above to determine the front suspension natural frequency for the vehicle and the natural frequency of the unsprung mass. Record these values.

What you need to hand in for assessment as a document for Assignment 2

Introduction

What the purpose of the investigations was, and give a summary of what you did and why it was done. This will build on the work done for Assignment 1 so a revised introduction is required

Equipment

A brief description of the software and the vehicle you used for the investigation. You do not need to repeat the method used to obtain the measurements in assignment 1.

Methodology

Methods used **in each task** to undertake the work required, outline the procedure for operating the WinGeo 3 software.

You are not required to repeat the methodology for the workshop laboratory measurement sessions.

Results

In addition to the basic collected data collected for Assignment 1 include the following results:

- Graphs produced with WinGeo3 GAP software
 - Toe steer v ride height
 - Camber v ride height
- Comparison graphs produced in excel of:
 - Toe steer v ride height
 - Camber v ride height
 - For the right front wheel with real (measured) and predicted (WinGeo3) curves compared
- Diagram of roll centre position changing with roll angle
- Calculation of Suspension Leverage SL
- Spring Rate K_s
- Calculation of Wheel rate K_w
- Natural frequency of one corner of the front suspension
- Natural frequency of the unsprung mass for one corner

Note: the tyre spring rate is 256,000 N/m

Please show all calculations. Refer to the suspension handout.

Evaluation

- Discuss the relationship between the real and predicted results and the cause of any errors noted.
- Discuss the probable accuracy of the measured test results and those obtained from the software.
- Discuss the probable accuracy of the tests used and results obtained to determine suspension frequencies.

Assessment Summary

Activity type	Percentage
Written exam	0%
Coursework	100%
Practical	0%
TOTAL	100%

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Does the module contribute to ESD?	No
If yes please provide brief details (no more than 100 words):	

BIBLIOGRAPHY

Essential

Hillier A et al - *Hillier's Fundamentals of Vehicle Technology 6th Edition*. (Oxford University Press, (2012)

Milliken, W F & Milliken D L - *Race Car Vehicle Dynamics*, (SAE, 2014)

Rowley, W - *An Introduction to Race Car Engineering 3rd Edition* (Rowley Race Dynamics, 2006)

Smith, C - *Tune to Win*, (Motorbooks International, 1978)

Smith, C - *Engineer to Win*, (Motorbooks International, 1985)

Smith, S - *Trackside Chassis Tuning Guide*, (Steve Smith Autosports, 2000)

Staniforth, A - *Competition Car Suspension 4rd Edition*, (Haynes, 2006)

Bosch - *Bosch Automotive Handbook 9th Edition*, (Bosch, 2014)

Background

Haney, P - *The Racing & High Performance Tyre*, (SAE, 2003)

Dixon, JC - *Tyres, Suspension and Handling 2nd Edition*. (SAE, 1996)

Journals

Racecar Engineering

Race Technology Magazine