Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	Erbil Technology College	
Department	Automotive Technology	
Module Name	Theory of vehicle design	
Module Code		
Degree	Technical Diploma ☐ Bachelor ■ High Diploma ☐ Master ☐ PhD ☐	
Semester	8th	
Qualification	PhD	
Scientific Title	Lecturer	
ECTS (Credits)		
Module type	Prerequisite ☐ Core ■ Assist. ☐	
Weekly hours		
Weekly hours (Theory)	(3)hr Class	( )Total hrs Workload
Weekly hours (Practical)	(0)hr Class	( )Total hrs Workload
Number of Weeks	12	
Lecturer (Theory)	Dr. Barhm Abdullah Mohamad	
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Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites		

Course Book

Course Description	This course will emphasize the illustration of fundamental concepts in vehicle design, exploring its multidisciplinary nature, which encompasses subjects like powertrain Design, mechanics, materials science, and control systems, among other areas. Progress in these domains plays a pivotal role in fostering the evolution of automotives that are not only more efficient and powerful but also environmentally friendly.
Course objectives	• Offering insights into comprehending and optimizing manufacturing processes within the vehicle structure to enhance both efficiency and power output. • Analysing how Selecting and designing vehicle components with materials that balance strength, weight, and heat resistance. • Educating students to solve problems.
Student's obligation	• Attending classes and participate in the lecture. • Make reports and studies on different topics. • Assignment preparations. • Make quizzes and exams to make sure they got necessary knowledges.
Required Learning Materials	• Handouts, notes and references. • Showing necessary videos and reports. • Showing equipment on different sites if possible.

Evaluation

Task		Weight (Marks)	Due Week	Relevant Learning Outcome
Paper Review				
Assignments	Homework	5		
	Class Activity	2		
	Report	10		
	Seminar	10		
	Essay			
	Project			
Quiz		8		
Lab.		15		
Midterm Exam		10		
Final Exam		40		
Total		100		

Specific learning outcome:	1- Theory of vehicle design. 2- Analyzing problems. 3- Solving selection and design problems.
Course References:	1. J. Happian-Smith, "An Introduction to Modern Vehicle Design," Oxford: Reed Educational and Professional Publishing Ltd, 2002, ISBN 0-7506-50443. 2. S. Amroune, A. Belaadi, N. Menasri, M. Zaoui, B. Mohamad, H. Amin, "New approach for computer-aided static balancing of turbines rotors," Diagnostyka, vol. 20, no. 4, 2019, DOI: 10.29354/diag/114621. 2. Б Мохамед, Я Кароли, АА Зеленцов, Трехмерное моделирование течения газа во впускной системе автомобиля «Формулы Студент» Журнал Сибирского федерального университета, 13(5), pp. 597-610, 2020. DOI: 10.17516/1999-494X-0249. 3. B. Mohamad, J. Karoly, A. Zelentsov, "CFD modelling of formula student car intake system," Facta Universitatis, Series: Mechanical Engineering, vol. 18, no. 1, pp. 153-163, 2020, DOI: 10.22190/FUME190509032M.

Course topics (Theory)	Week	Learning Outcome
Introduction to Vehicle Design	1	Importance of Vehicle Design in the Automotive Industry
Vehicle Performance Metrics and Requirements	2	Factors Influencing Vehicle Performance
Materials and Manufacturing in Vehicle Design	3	Materials Selection in Automotive Design
Automotive Aerodynamics	4	Wind Tunnel Testing and Computational Fluid Dynamics (CFD)
Chassis and Suspension Systems	5	Suspension Types and Geometry
Vehicle Ergonomics and Human-Machine Interface	6	Interior Design Considerations
Safety in Vehicle Design	7	Active and Passive Safety Systems
Design Optimization and Simulation	8	Optimization Techniques in Vehicle Design

Case Studies in Vehicle Design	9	Analysis of Successful Vehicle Designs
Vehicle Electronics and Control Systems	10	Electronic Control Units (ECUs)
Noise, Vibration, and Harshness	11	Isolating and dampening vibrations
AVL advance software	12	Durability testing and vehicle Simulation
Practical Topics	**Week**	**Learning Outcome**

Questions Example Design

Ex1: Consider a vehicle with the following specifications: mass m=1500 kgm=1500kg, engine power P=100 kWP=100kW, rolling resistance coefficient Rr=0.02Rr=0.02, aerodynamic drag coefficient Cd=0.3Cd=0.3, frontal area A=2.5 m2A=2.5m2, and fuel energy content 35 MJ/L35MJ/L.

1. Calculate the force due to rolling resistance (FrFr) using the given parameters.
2. Determine the force due to aerodynamic drag (FdFd) assuming a constant vehicle speed (v=20 m/sv=20m/s).
3. Find the total resistance force (FTotalFTotal) acting on the vehicle.
4. If the vehicle is moving at a constant speed of 20 m/s20m/s, calculate the fuel consumption rate (FCRFCR) in liters per second.
5. Calculate the fuel efficiency (FEFE) in kilometers per liter.

- Vehicle Mass (mm): 1500 kg
- Engine Power (PP): 100 kW
- Rolling Resistance (RrRr): 0.02 (dimensionless)
- Aerodynamic Drag Coefficient (CdCd): 0.3 (dimensionless)
- Frontal Area (AA): 2.5 m^2
- Fuel Energy Content: 35 MJ/L

Constants:

- Acceleration due to gravity (gg): 9.8 m/s^2 (approximately)

Calculations:

1. **Force Due to Rolling Resistance (FrFr):** Fr=Rr×m×gFr=Rr×m×g

   Fr=0.02×1500×9.8Fr=0.02×1500×9.8 Fr≈294NFr≈294N

2. **Force Due to Aerodynamic Drag (FdFd):** Fd=0.5×Cd×A×ρ×v2Fd=0.5×Cd×A×ρ×v2

Let's assume air density (ρρ) is 1.2 kg/m³ (a typical value at sea level). Also, assume the vehicle is moving at a constant speed, so vv is constant.

Fd=0.5×0.3×2.5×1.2×v2Fd=0.5×0.3×2.5×1.2×v2

Let's assume v=20 m/sv=20m/s.

Fd≈3.6×v2Fd≈3.6×v2 Fd≈3.6×202Fd≈3.6×202 Fd≈1440NFd≈1440N

3. **Total Resistance Force (FTotalFTotal):** FTotal=Fr+FdFTotal=Fr+Fd FTotal≈294+1440FTotal ≈294+1440 FTotal≈1734NFTotal≈1734N
4. **Velocity (vv):** Assuming a constant speed scenario, vv remains constant. Let v=20 m/sv=20m/s.
5. **Fuel Consumption Rate (FCR):**
   FCR=FTotal×vFuel Energy ContentFCR=Fuel Energy ContentFTotal×v

   FCR=1734×2035×106FCR=35×1061734×20 FCR≈0.0099 L/sFCR≈0.0099L/s

6. **Fuel Efficiency (FE):** FE=1FCRFE=FCR1

   FE≈10.0099FE≈0.00991 FE≈101.01 km/LFE≈101.01km/L

Results:

- Force Due to Rolling Resistance (FrFr): 294 N294N
- Force Due to Aerodynamic Drag (FdFd): 1440 N1440N
- Total Resistance Force (FTotalFTotal): 1734 N1734N
- Fuel Consumption Rate (FCRFCR): 0.0099 L/s0.0099L/s
- Fuel Efficiency (FEFE): 101.01 km/L101.01km/L

Ex2:Consider a four-wheel-drive vehicle with a total mass (mm) of 2000 kg2000kg and a wheelbase (LL) of 2.8 m2.8m. The vehicle is accelerating from rest to a speed of 30 m/s30m/s over a time period of 10 s10s.

1. Determine the total force (FTotalFTotal) required to accelerate the vehicle.
2. Calculate the weight distribution on each axle when the vehicle is stationary.
3. Assuming an even weight distribution between the front and rear axles when the vehicle is stationary, determine the force exerted on each wheel during acceleration.
4. If the road surface provides a coefficient of friction (μμ) of 0.80.8, calculate the maximum horizontal force each tire can provide during acceleration without slipping.

1. Determine the total force (F_{Total}) required to accelerate the vehicle:

The total force required to accelerate the vehicle can be determined using Newton's second law:

$$F_{\text{Total}} = m \cdot a$$

where acceleration (a) can be calculated as:

$$a = \frac{\Delta v}{t}$$

$$a = \frac{30\,\text{m/s}}{10\,\text{s}}$$

$$a = 3\,\text{m/s}^2$$

Now, plug this acceleration into the first equation:

$$F_{\text{Total}} = 2000\,\text{kg} \cdot 3\,\text{m/s}^2$$

$$F_{\text{Total}} = 6000\,\text{N}$$

2. Calculate the weight distribution on each axle when the vehicle is stationary:

Assuming even weight distribution, the weight on each axle when stationary is half of the total weight:

$$\text{Weight on each axle} = \frac{m}{2}$$

$$\text{Weight on each axle} = \frac{2000\,\text{kg}}{2}$$

$$\text{Weight on each axle} = 1000\,\text{kg}$$

3. Determine the force exerted on each wheel during acceleration:

During acceleration, weight transfer occurs. The force exerted on each wheel can be calculated using the following formula:

$$F_{\text{Wheel}} = \frac{W_{\text{Axle}} \cdot \text{Wheelbase}}{2}$$

$$F_{\text{Wheel}} = \frac{1000\,\text{kg} \cdot 2.8\,\text{m}}{2}$$

$$F_{\text{Wheel}} = 1400\,\text{N}$$

4. Calculate the maximum horizontal force each tire can provide during acceleration without slipping:

The maximum frictional force ($F_{\text{friction,max}}$) can be calculated using the equation:

$$F_{\text{friction,max}} = \mu \cdot W_{\text{Axle}}$$

$$F_{\text{friction,max}} = 0.8 \cdot 1000\,\text{N}$$

$$F_{\text{friction,max}} = 800\,\text{N}$$

So, the maximum horizontal force each tire can provide during acceleration without slipping is $800\,\text{N}$.

Extra notes:
External Evaluator