Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	Technology Institute in Erbil	
Department	Automotive Engineering Technology	
Module Name	Theory of Machine	
Module Code		
Degree	**Technical Diploma** ☐ **Bachelor** ■ **High Diploma** ☐ **Master** ☐ **PhD** ☐	
Semester	**6th Semester, 3rd year.**	
Qualification	**PhD.**	
Scientific Title	**Lecturer**	
ECTS (Credits)		
Module type	**Prerequisite** ☐ **Core** ■ **Assist.** ☐	
Weekly hours		
Weekly hours (Theory)	**(2)hr Class**	**(105)Total hrs Workload**
Weekly hours (Practical)	**(0)hr Class**	**( )Total hrs Workload**
Number of Weeks	**12**	
Lecturer (Theory)	**Dr. Dler Abdullah Ahmed**	
E-Mail & Mobile NO.	**Dler.ahmad@epu.edu.iq**	
Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites		

Course Book

<table>
<tr><td>Course Description</td><td colspan="5">The course of Theory of Machin is designed to cover the fundamentals of machine elements. It is relates to the engineering mechanics which must studied before. The main topics are principles of motion, kinematics and kinetics, and important machine elements.</td></tr>
<tr><td>Course objectives</td><td colspan="5">The main purposes of the theory of machine are to understand, analyze, and design simple mechanisms. As well as students learn to connect this subject with other subjects and apply it to analyze problems in various mechanical systems.</td></tr>
<tr><td>Student's obligation</td><td colspan="5">Missed classes will not be compensated including the quizzes and the scheduled assignments. The students will lose marks on unattended classes with quizzes unless a legal document or authorized leave is presented which should explain the excuse for the absence. However, the absent student should take responsibility for making up the missed lecture.</td></tr>
<tr><td>Required Learning Materials</td><td colspan="5"></td></tr>
<tr><td rowspan="12">Evaluation</td><td colspan="2">Task</td><td>Weight (Marks)</td><td>Due Week</td><td>Relevant Learning Outcome</td></tr>
<tr><td colspan="2">Paper Review</td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Assignments</td><td>Homework</td><td>10</td><td></td><td></td></tr>
<tr><td>Class Activity</td><td>2</td><td></td><td></td></tr>
<tr><td>Report</td><td>8</td><td></td><td></td></tr>
<tr><td>Seminar</td><td>8</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Quiz</td><td>8</td><td></td><td></td></tr>
<tr><td colspan="2">Lab.</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Midterm Exam</td><td>24</td><td></td><td></td></tr>
<tr><td colspan="2">Final Exam</td><td>40</td><td></td><td></td></tr>
<tr><td colspan="2">Total</td><td></td><td></td><td></td></tr>
<tr><td>Specific learning outcome:</td><td colspan="5">1- Apply principles of machine elements and mechanisms of motion.</td></tr>
</table>

	2- Analyze the effect of applied force and motion in different machine elements and solve problems. 3- Interpret various engineering systems, components, and processes to introduce solutions that meet specified needs. 4- Understand some machine elements' functions such as gears, clutches, governors, and making calculations. 5- Prepar reports and seminars in various subjects within the theory of machine during this coarse 6- Think critically in dealing with engineering issues.
Course References:	1. Thoery of Machines, 14th edition,S. Khumri R., 2005 2. Machine elements in mechanical design fourth edition, Robert l .mott 3. A textbook of machine design, 2005, R.S .khurmi, J.K . Gupta 4. Mechanical Engineering Design, Shigley,9th edition

Course topics (Theory)	**Week**	**Learning Outcome**
Introduction, Fundamental Units, Force, Resultant Force,	1	1
Kinematic of Motion, Linear Displacement, Velocity and Acceleration, Angular displacement, Angular velocity and Acceleration,	2	2, 3, 4, 5
Kinetics of Motion, Newton's Law, Moment, couple, Mass moment of Inertia, Torque, Work, Power	3	2, 3, 4, 5
Simple Mechanisms, Kinematic links, Constrained Motion, Degree of Freedom,	4	2, 3, 4, 5
Velocity in Mechanisms, Relative Velocity, Motion of a Link	5	2, 3, 4, 5

Acceleration in Mechanisms, Acceleration Diagram, Acceleration in the slider Crank	6	2, 3, 4, 5, 6
Friction, Types of Friction, Static and Kinetic Friction, Screw Jack, Torque required to lift the Load, Efficiency of Screw Jack	7	2, 3, 4, 5
Belt, Rope, and Chain Drives, Velocity Ratio, Length of Belt, Power Transmitted	8	3, 4, 5, 6
Toothed Gearing, Toothed Wheels, Types of Gear, Spur Gear	9	3, 4, 5, 6
Epicyclic Gear Train, Velocity Ratio,	10	2, 3, 4, 5, 6
Governors, Types of Governors,	11	3, 4, 5, 6
Balancing of Rotating Masses,	12	3, 4, 5, 6
Balancing of Reciprocating Masses		

Questions and Examples:

Example 2.1. *A car starts from rest and accelerates uniformly to a speed of 72 km. p.h. over a distance of 500 m. Calculate the acceleration and the time taken to attain the speed.*

If a further acceleration raises the speed to 90 km. p.h. in 10 seconds, find this acceleration and the further distance moved. The brakes are now applied to bring the car to rest under uniform retardation in 5 seconds. Find the distance travelled during braking.

Solution. Given : $u = 0$; $v = 72$ km. p.h. $= 20$ m/s ; $s = 500$ m

First of all, let us consider the motion of the car from rest.

Acceleration of the car

Let a = Acceleration of the car.

We know that $v^2 = u^2 + 2\,a.s$

$\therefore$ $(20)^2 = 0 + 2a \times 500 = 1000\,a$ or $a = (20)^2/\,1000 = 0.4$ m/s^2 **Ans.**

Time taken by the car to attain the speed

Let t = Time taken by the car to attain the speed.

We know that $v = u + a.t$

$\therefore$ $20 = 0 + 0.4 \times t$ or $t = 20/0.4 = 50$ s **Ans.**

Now consider the motion of the car from 72 km.p.h. to 90 km.p.h. in 10 seconds.

Given : * $u = 72$ km.p.h. $= 20$ m/s ; $v = 96$ km.p.h. $= 25$ m/s ; $t = 10$ s

Acceleration of the car

Let a = Acceleration of the car.

We know that $v = u + a.t$

$25 = 20 + a \times 10$ or $a = (25 - 20)/10 = 0.5$ m/s^2 **Ans.**

Distance moved by the car

We know that distance moved by the car,

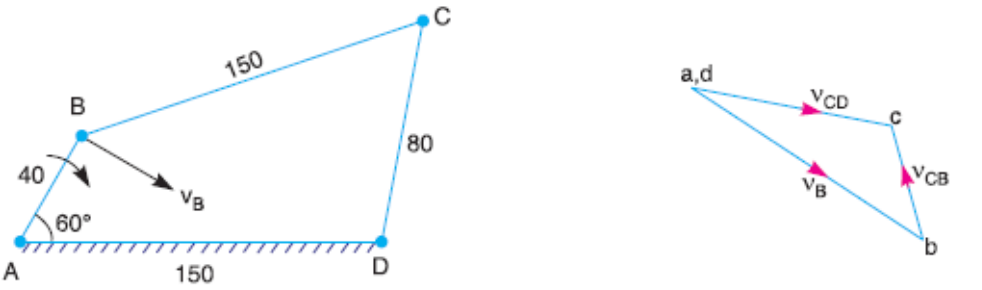
$$s = u.t + \frac{1}{2}a.t^2 = 20 \times 10 + \frac{1}{2} \times 0.5\,(10)^2 = 225\,\text{m}$$ **Ans.**

Example 7.1. *In a four bar chain ABCD, AD is fixed and is 150 mm long. The crank AB is 40 mm long and rotates at 120 r.p.m. clockwise, while the link CD = 80 mm oscillates about D. BC and AD are of equal length. Find the angular velocity of link CD when angle BAD = 60°.*

Solution. Given : $N_{BA} = 120$ r.p.m. or $\omega_{BA} = 2\pi \times 120/60 = 12.568$ rad/s

Since the length of crank $AB = 40$ mm $= 0.04$ m, therefore velocity of B with respect to A or velocity of B, (because A is a fixed point),

$$v_{BA} = v_B = \omega_{BA} \times AB = 12.568 \times 0.04 = 0.503 \text{ m/s}$$



(*a*) Space diagram (All dimensions in mm). (*b*) Velocity diagram.

Fig. 7.7

First of all, draw the space diagram to some suitable scale, as shown in Fig. 7.7 (*a*). Now the velocity diagram, as shown in Fig. 7.7 (*b*), is drawn as discussed below :

1. Since the link AD is fixed, therefore points a and d are taken as one point in the velocity diagram. Draw vector ab perpendicular to BA, to some suitable scale, to represent the velocity of B with respect to A or simply velocity of B (*i.e.* v_{BA} or v_B) such that

$$\text{vector } ab = v_{BA} = v_B = 0.503 \text{ m/s}$$

2. Now from point b, draw vector bc perpendicular to CB to represent the velocity of C with respect to B (*i.e.* v_{CB}) and from point d, draw vector dc perpendicular to CD to represent the velocity of C with respect to D or simply velocity of C (*i.e.* v_{CD} or v_C). The vectors bc and dc intersect at c.

By measurement, we find that

$$v_{CD} = v_C = \text{vector } dc = 0.385 \text{ m/s}$$

We know that $CD = 80$ mm $= 0.08$ m

∴ Angular velocity of link CD,

$$\omega_{CD} = \frac{v_{CD}}{CD} = \frac{0.385}{0.08} = 4.8 \text{ rad/s (clockwise about } D\text{)}$$ **Ans.**

Example 11.1. *An engine, running at 150 r.p.m., drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft being 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Find the speed of the dynamo shaft, when 1. there is no slip, and 2. there is a slip of 2% at each drive.*

Solution. Given : $N_1 = 150$ r.p.m. ; $d_1 = 750$ mm ; $d_2 = 450$ mm ; $d_3 = 900$ mm ; $d_4 = 150$ mm

The arrangement of belt drive is shown in Fig. 11.10.

Let N_4 = Speed of the dynamo shaft .

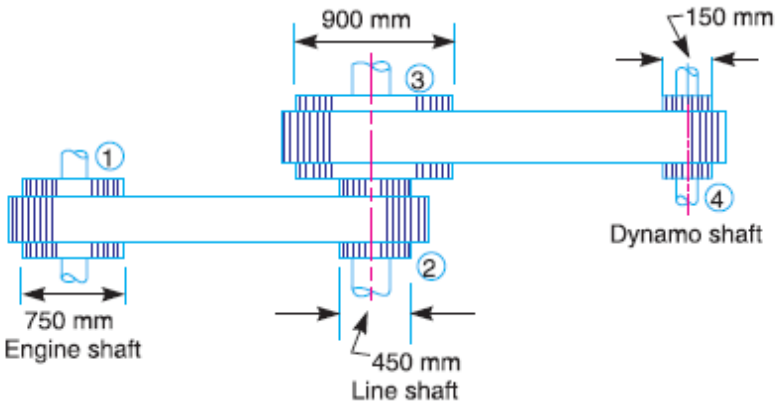


Fig. 11.10

1. *When there is no slip*

We know that $\frac{N_4}{N_1} = \frac{d_1 \times d_3}{d_2 \times d_4}$ or $\frac{N_4}{150} = \frac{750 \times 900}{450 \times 150} = 10$

$\therefore$ $N_4 = 150 \times 10 = 1500$ r.p.m. **Ans.**

2. *When there is a slip of 2% at each drive*

We know that $\frac{N_4}{N_1} = \frac{d_1 \times d_3}{d_2 \times d_4}\left(1 - \frac{s_1}{100}\right)\left(1 - \frac{s_2}{100}\right)$

$$\frac{N_4}{150} = \frac{750 \times 900}{450 \times 150}\left(1 - \frac{2}{100}\right)\left(1 - \frac{2}{100}\right) = 9.6$$

$\therefore$ $N_4 = 150 \times 9.6 = 1440$ r.p.m. **Ans.**

Extra notes:

External Evaluator

Assist. Prof. Dr. Muhammedtahir Malapoor

mohammedtaher.mulapeer@su.edu.krd