Description of individual educational component (module)	
طراحی مکانیزم ها **Mechanisms Design** کارشناسی ارشد *Master of Science (M.Sc)*	
Organisation	Sari Agricultural Sciences and Natural Resources University (SANRU)
Faculty	Agricultural engineering
Department	Mechanics of Biosystems engineering
Responsible person	Assoc. Prof. Dr. –Ing. Davood Kalantari
Type of course unit	Elective Course
Level of course unit	Second cycle
Year of study (if applicable), semester/trimester when the individual educational component is delivered	2rd semester
Number of ECTS credits allocated	3 Iranian Credits (Equal to 6.9 ECTS)
Total hours	--
Contact hours	48
Self-study hours	Not specified
Mode of delivery	Face-to-face
Maximum attendance	20
Name of lecturer(s)	Assoc. Prof. Dr. –Ing. Davood Kalantari
Prerequisites and co-requisites	Prerequisites: Basic Mathematics, Basic Dynamics, Machine Dynamics, Complex Analysis,
Course contents	1. Introduction to the Mechanisms Topic 1. Examples of Mechanisms existing in Agricultural Machinery and agro-mechatronics systems, mechanisms terminology, introducing mechanism components including different links and joints, degree of freedom of a kinematic chain, Gruebler's relationship, kinematic diagrams of mechanisms, Grashof's criterion for a Four-Bar mechanism. 2. Kinematic analysis of mechanisms Topic 2. Position and displacement analysis: linear and angular displacement, angular position of a link, graphical analysis for displacement, analytical and graphical analysis for limiting positions, transmission angle, closed-loop position analysis for a Four-Bar linkage, Topic 3. Velocity analysis: Analytical velocity analysis, relative velocity method, algebraic solutions for a common mechanism, graphical velocity analysis including instantaneous center of revolution method, instant center diagram, Kennedy's theorem, Topic 4. Acceleration analysis: acceleration of a link, linear and angular acceleration, normal and tangential components of acceleration, analytical and graphical acceleration analysis methods, acceleration curves 3. Kinematic analysis of Cams, Topic 5. Application of Cam systems in agricultural machines and equipment, type of cams and followers, follower shapes, follower

	motion schemes including constant velocity, constant acceleration, harmonic motion, cycloidal motion and combined motion, analytical and graphical cam profile design. 4. Kinematic analysis of Gears, Topic 6. Gear terminology, types of gears, spur gear kinematics, Rack and Pinion kinematics, kinematics of Helical, Bevel and Worm gears, planetary gear analysis 5. Force analysis of mechanisms, Topic 7. Static force analysis: torques and moments, Free-Body diagrams, static equilibrium, analysis of two-force member, sliding friction force, Topic 8. Dynamic force analysis: Mass and weight of links, center of gravity, radius of gyration, parallel axis theorem, composite bodies.
Recommended or required reading and other learning resources/tools	1- Erdman, A.G., Sandor, G. N., 1991. Mechanisms Design, Analysis and Synthesis, Vol., 1. Prentice Hall. 2- Myszka, David H., 2012. Machines and Mechanisms, Applied kinematics Analysis. 4th Edition. Prentice Hall. 3- Shiegly, J.E., Uicker, J. J., 1995. Theory of Machines and Mechanisms, 2nd Edition, McGraw Hill. NewYork.
Language of instruction	• Persian/English

Learning outcomes of the course unit
Skills of applying various analytical and graphical calculation and simulation methods in design of different mechanisms for agro-mechatronics systems and agricultural robots; Skills of using commercially available software for mechanism analysis such as Working Model 3D and 4D, ADAMS, Dynamic Designer, and LMS Virtual Lab to build kinematic model of a given mechanism, animate the mechanism and determine the kinematic values of the mechanism.

Planned learning activities and teaching methods
Lectures, tutorials, and problem solving

Assessment methods and criteria
The final grade is based on a three-point system. It may consist of the results of a final written assignment for the final exam (70%), Literature review (20%), and Report quality (10%) according the «Assessment criteria table».

Mapping Programme Key Learning Outcomes to Module Learning Outcomes	
Programme Key Learning Outcomes	**Module Learning Outcomes**

1. The ability to define the basic components of a mechanism, draw the kinematic diagram of a given mechanism, classify different four-bar mechanisms according to their possible motion; 2. The ability to analyze a simple or compound mechanism using analytical or graphical method; 3. The ability to design and develop a new mechanism for a specified purpose in agro-mechatronics, 4. Developing a new mechanism or machine for a specified purpose in agriculture, horticulture and greenhouse	**On successful competition of this module students should be able to:** 1. Analytically and graphically determine the position of all links in a given mechanism, determine the limiting positions of a mechanism, plot displacement diagram of a given point on a mechanism, 2. Use timing charts to synchronize motion and estimate peak velocity and acceleration magnitudes for a given mechanism, 3. Use the relative velocity method to graphically solve for the velocity of a given point on a mechanism, 4. Use the instantaneous center of revolution method to determine the velocity of a given point on a mechanism, 5. Construct a velocity curve to illustrate extreme velocity values, 6. Use the relative acceleration method or analytical method to determine the acceleration of a given point on a mechanism, 7. Use equations to construct cam-follower displacement diagrams, 8. Geometrically construct cam-follower displacement diagrams, 9. Determine the kinematic properties of gear and planetary gear trains, 10. Design and analyze a specified agricultural mechanism or a mechatronic motion module, e.g., an operated robot arm. 11. Modelling and simulation of a given mechanism using standard software such as Working Model or ADAMS.

	Assessment criteria table				
Attribute	**Grade A (18-20 out of 20) (Excellent)**	**Grade B (16-18 out of 20) (Very good)**	**Grade C (14-16 out of 20) (Good)**	**Grade D/E (12-16 out of 20) (Satisfactory)**	**Grade F/FX (<12 out of 20) Failed / Insufficient**
Final Exam-written part (70%)	The complete solution of the task without serious flaws is given. The correct answer is provided.	The roughly complete solution of the task is provided. The correct answer with some minor mistakes in interim steps is received.	The content of the solution is good. The answer with some weaknesses in interim steps is received.	The content of the task is satisfactory but with several weaknesses regarding evidence and/or some lack of clarity.	The task of the work fell short of that required to pass due to lack of evidence base/or very poor clarity.
Literature review (20%)	The literature library assembled by the student was outstanding with no serious missing articles.	The literature library assembled by the student was very good with only a few missing key articles.	The literature library assembled had a number of missing key articles and lacked breadth.	The literature library lacked breadth to a great degree and was missing many key articles.	The literature library was lacking in breadth and key articles to an extent that fell short of a passing grade.
Report quality (10%)	The style and clarity of the report was excellent.	The style and/or clarity of the report were very good.	The style and/or clarity of the report were good.	The style and/or clarity of the report were adequate.	The style and/or clarity of the report fell short of a passing grade.