King Fahd University of Petroleum & Minerals
Department of Mathematics

MATH-640: Calculus of Variations
Instructor: Dr. Abdullah Shah
Time: 1400-1450 AM, B-59, R-1014
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Office: Building 5-419.

Course Description:
Classical calculus of variations. Necessary conditions. Sufficient conditions for extrema. Jacobi and Legendre conditions. Natural boundary
conditions. Broken extrema, Erdmann-Weierstrass condition. Multiple integral problems. Constrained extrema.
Gateaux and Fréchet differentials.
Hamilton principle with applications to mechanics and theory of small
oscillations.
Problems of optimal control.
Direct methods including the Galerkin and the Ritz-Kantorovich methods. Variational methods for eigenvalue problems.

Course main Objective: The objective of the course is to:
1. Provide students with rich knowledge and skills in the field of calculus of variations.
2. Implement concepts of the calculus of variations to define and solve optimal control problems.

Credit hours: 3, **Pre-requisite**: Graduate standing

Textbook:
John L. Troutman, Variational Calculus and Optimum Control, Optimization with Elementary Convexity, 2nd edition, 1996
Reference Books:

1. A First Course in the Calculus of Variations, *American Mathematical Society,* 2014.
2. Naveen Kumar, An Elementary Course on Variational Problems in Calculus, 2005.
3. Richard L. Burden, J. Douglas Faires, Numerical Analysis, 10th Edition, Cengage Learning, 2016.

Course Grade: The final grade will be based on the following distribution:

Exam I		20%
Exam II		20%
Assignments and Project		(10+15) =25%
Final Exam		35%
Total		**100%**

Attendance: Students are expected to attend all classes.
Office Hours:

Courses	SUNDAY	TUESDAY	THURSDAY
MATH-640	15:00-16:00	15:00-16:00	15:00-16:00

Remark: Students can also ask for an appointment by email or MS TEAMS.