ROMANIAN ACADEMY
School of Advanced Studies of the Romanian Academy (SCOSAAR)
COURSE SHEET: 'Control of systems of differential equations'

1. Program Information

1.1 Department	Department of engineering, mechanical, computer sciences
1.2 Institution	Romanian Academy
1.3 Field of studies	Engineering sciences
1.4 Cycle of studies	PHD

2. Course information

2.1 Name of the course			**Control of systems of differential equations**				
2.2 Holder of course activities			Nicolae POP, CSI dr. habil.				
2.3 Holder of seminar activities			Nicolae POP, CSI dr. habil.				
2.4 Holder of laboratory activities							
2.5 Year of study	**I**	**2.6 Semester**	I	**2.7 Type of ssessment**	E*	**2.8 Course regime**	DS**

3. Estimated total time (hours per semester of teaching activities)

3.1 Number of hours per week	15	**From which:**			
3.2 course	9	**3.3 seminar**	6	**3.4 laboratory**	0
3.5 Total hours from the curriculum	210	**From which:**			
3.6 course	126	**3.7 seminar**	84	**3.8 laboratory**	0
3.9 Total hours per semester	210				
3.10 Number of credits	15				

4. Course content

1. Control of linear differential systems
2. Controllability of linear systems, optimal control, Pontriaghin's maximum principle
3. Dynamic programming equation or Hamilton-Jacobi-Bellman equation
4. The quadratic linear regulator and the optimal time problem for linear systems
5. Accessible sets and optimal control problem
6. The geometric form of Pontriaghin's maximum principle
7. The optimal control problem with final free time
8. The maximum principle for optimal control problems
9. The link between the principle of maximum and the principle of dynamic programming
10. Examples of optimal control problem.

5. The objectives of the course and the specific skills acquired

1. The general objective of the discipline: Knowing, understanding the application of optimal control, Pontriaghin's principle, and the Hamilton-Jacobi-Bellman equation, for systems of differential equations. Evidencing the connection between the maximum principle and the principle of dynamic programming.
2. Specific objectives:
   Acquiring knowledge in the application of dynamic programming algorithms and optimal control.
   - Examples of application of optimal control methods in the analysis of dynamic systems governed by systems of differential equations.

6. Bibliography

1. Arnold, V.I., *Mathematical methods of classical mechanics*, vol.60, Graduate Texts in Mathematics. Springer-Verlag, New-York, 1978.
2. Barbu, V., *Metode matematice in optimizarea sistemelor diferentiale*, Editura Academiei, Bucuresti, 1989
3. Barbu, V., Lefter, C., *Optimal control of ordinary differential equation*s, Canada, A. (ed.) et al., Ordinary differential equations, Vol.II, Amsterdam, Elsevier/North Holland, Handbook of Differential Equations, 1-75, 2005
4. Bellman, R., *Dynamic programming*, Princeton University Press, Princeton, N.J., 1957
5. Lefter, C-G., *Calculul variatiilor si controlul sistemelor diferentiale*, Editura Alexandru Myller, Iasi, 2006
6. Mitu, A-M., Popescu, I., Sireteanu, T., *Comportarea dinamica a sistemelor cu caracteristici de tip hysteretic*, MATRIXROM, bucuresti, 2012
7. Pontriaghin, L., Boltianski, V., Gamkrelidze, R., Michtchenco, E., *Theorie mathematique des processus optimaux*, Editions Mir, Moscow, 1974
8. Vrabie, I.I., *Ecuatii diferentiale*, Editura MATRIXROM, Bucuresti, 2000
9. Zabczyk, J., *Mathematical control theory: an introduction*. Systems&Control: Foundations&Applications, Birkhäuser Boston Inc., Boston, MA, 1992

7. Assement

Type of activity	7.1 Evaluation criterias	7.2 Evaluation methods	7.3 Weight of the final grade
7.4 Course	Knowledge acquired	Written exam	55%
7.5 Seminar	Activity	Case studies presented	45%
7.6 Laboratory			
7.7 Standard minim de performanţă: Cunoașterea a 70% din informația conținută în curs			

*E = Exam. C = Colloquium.
**DF = Fundamental Discipline. DS = Specialty Discipline.

Course structure
November 2023 – May 2024 – Teaching activity - Control of systems of differential equations, IMSAR
Exam May 2024
Holder of the course: Dr. Nicolae Pop