SYLLABUS

1. Information about the program

1.1 Higher education institution	Universitatea Politehnica Timișoara
1.2 Faculty[1] / Department[2]	Electronică, Telecomunicații și Tehnologii Informaționale/Communications
1.3 Field of study (name/code[3])	Electronică, Telecomunicații și Tehnologii Informaționale / 20.20.10
1.4 Study cycle	Master
1.5 Study program (name/code/qualification)	Communication Networks Engineering / 20.20.10

2. Information about discipline

2.1a Name of discipline/The educational classe[4]	Traffic Engineering in Telecommunication Networks/DS						
2.1b Name of discipline in Romanian							
2.2 Coordinator (holder) of course activities	Lect. Dr. Eng. Gordana Barb						
2.3 Coordinator (holder) of applied activities[5]	Lect. Dr. Eng. Gordana Barb						
2.4 Year of study[6]	1	**2.5** Semester	2	**2.6** Type of evaluation	E	**2.7** Regime of discipline[7]	DOB

3. Total estimated time (direct activities (fully assisted), partially assisted activities and unassisted activities[8])

3.1 Number of hours fully assisted/week	4 ,of which:	course	2	seminar/laboratory/project			2
3.1* Total number of hours fully assisted/sem.	56 ,of which:	course	28	seminar/laboratory/project			28
3.2 Number of on-line hours fully assisted/sem	,of which:	course		seminar/laboratory/project			
3.3 Number of hours partially assisted/week	,of which:	project, research		training		hours designing M.A. dissertation	
3.3* Number of hours partially assisted/ semester	,of which:	project of research		training		hours designing M.A. dissertation	
3.4 Number of hours of unassisted activities/ week	6.72 ,of which:	Additional documentation in the library, on specialized electronic platforms, and on the field					2
		Study using a manual, course materials, bibliography and lecture notes					2
		Preparation of seminars/ laboratories, homework, assignments, portfolios, and essays					2.72
3.4* Total number of hours of unasssited asctivities/ semester	94 ,of which:	Additional documentation in the library, on specialized electronic platforms, and on the field					28
		Study using a manual, course materials, bibliography and lecture notes					28
		Preparation of seminars/ laboratories, homework, assignments, portfolios, and essays					38
3.5 Total hrs./week[9]	10.72						
3.5* Total hrs./semester	150						
3.6 No. of credits	6						

4. Prerequisites (where applicable)

4.1 Curriculum	• Advanced Topics in Signal Processing; Selected topics in Communication Engineering
4.2 Learning outcomes	• Use of fundamental elements related to telecommunication network architectures, mobile telephony networks, and modern technologies within mobile communication systems • Traffic modeling and simulation, application of traffic engineering methods to IoT and 5G/6G • Configuration of common telecommunication network parameters using simulation software

5. Conditions (where applicable)

5.1 of the course	• Classroom equipped with video projector, internet access, and multimedia resources
5.2 to conduct practical activities	• Laboratories equipped with high-performance computers

6. Learning outcomes acquired through this discipline

Knowledge	• C1.Studentul/Absolventul cunoaște metode, tehnici și paradigme de cercetare • C8.Studentul/Absolventul cunoaște terminologia și convențiile comunicării tehnice • C10.Studentul/Absolventul înțelege conceptele de trafic, lățime de bandă și QoS • C12.Studentul/Absolventul înțelege principiile scalabilității și alocării resurselor
Skills	• A3.Studentul/Absolventul utilizează instrumente colaborative și contribuie la proiecte • A10.Studentul/Absolventul evaluează nevoile rețelei și optimizează resursele • A11.Studentul/Absolventul selectează și aplică metode de comunicare potrivite contextului • A12.Studentul/Absolventul configurează și optimizează resursele TIC
Responsibility and autonomy	• RA4 Studentul/Absolventul asigură corectitudinea și relevanța concluziilor extrase • RA7 Studentul/Absolventul asigură calitatea și respectarea normelor academice • RA10 Studentul/Absolventul propune soluții pentru eficientizarea traficului și gestionează resursele • RA11 Studentul/Absolventul se responsabilizează pentru transmiterea corectă și eficientă a informației

7. Objectives of the discipline (based on the grid of learning outcomes acquired)

- The course aims to prepare master's students with traffic modeling techniques for various telecommunication networks and with traffic engineering concepts that form the basis for designing such networks, enabling them to qualify as development and research engineers in telecommunications companies.
- This course develops the students' ability to use existing simulation software as well as to implement their own models. It also strengthens their skills in using IoT simulations and equipment, and in integrating scientific literature.

8. Content

8.1 Course	Number of hours	Of which online	Teaching methods
Introduction: Classification of traffic in telecommunication networks (voice, data, multimedia, IoT); differences between circuit-switched and packet-switched systems; traffic models at the IP packet level (TCP, UDP) vs. IoT flows with short and frequent packets.	4		The course is conducted using a video projector, internet access, and multimedia resources. It integrates MOOC and OER materials. Interaction with participants is encouraged through discussions, and course assignments are provided.
Traffic mathematical models: Poisson, Erlang, Engset, and Binomial models; queuing models and their applications in dense IoT flows (smart metering, connected vehicles); sharing models applied to IoT and M2M streaming traffic.	6		
Networks and dimensioning methods: Traffic in mobile networks (GSM, UMTS, LTE); radio resource dimensioning for voice and data services; integration of LPWAN networks (LoRa/LoRaWAN, NB-IoT) and general traffic characteristics; IoT impact on resource dimensioning and spectrum management.	6		
IoT networks and critical applications: Types of traffic periodic (smart metering), sporadic (sensor alerting), and critical (autonomous vehicles, e-health); QoS	4		

and QoE requirements; resource allocation for mMTC and URLLC; case studies: smart grid, e-health (latency <5 ms).			
Advanced traffic engineering: Routing and load balancing algorithms (load balancing, traffic offloading).	4		
Traffic in Internet, 5G, and 6G networks: Heterogeneous networks (core, transport, and access); edge computing in IoT traffic processing; 6G perspectives: digital twins, autonomous vehicles, industrial IoT applications.	4		

Bibliography[10]	1. Network Traffic Engineering: Stochastic Models and Applications, Baiocchi, A., John Wiley & Sons, 2020. 2. Introduction to IoT – Sudip Misra, Anandarup Mukherjee, Arijit Roy, Cambridge University Press, 2021. 3. Andras C., Barb G., Danuti F., Popa D., Integrated Digital Networks Guide, Editura Politehnica, 2025.

8.2 Applied activities[11]	Number of hours	Of which online	Teaching methods
P1: Introductory Simulations: Analysis of M/M/1 and M/M/1/K models; comparison between theoretical results and MATLAB simulations; exercises on waiting times in IoT traffic flows.	4		
P2: Radio Resource Dimensioning: Capacity calculation in GSM and LTE; comparison with LPWAN (LoRa/LoRaWAN) in terms of coverage and throughput; case study: urban sensor network.	6		
P3: Zigbee and 6LoWPAN Networks: Comparative analysis of Zigbee vs. Wi-Fi for IoT applications; configuration of a Zigbee device set; traffic measurement.	6		
P4: MATLAB Simulations: Massive IoT in 5G (mMTC); application of load-balancing algorithms; performance evaluation: throughput and latency.	4		
Final Project: Selection of a network type (smart campus, V2X, smart city); definition of performance parameters (latency, energy efficiency, throughput); comparison of different technologies (LoRa, Zigbee, 5G); oral and written presentation.	8		

	Bibliography[12] 1. Network Traffic Engineering: Stochastic Models and Applications, Baiocchi, A., John Wiley & Sons, 2020. 2. Introduction to IoT – Sudip Misra, Anandarup Mukherjee, Arijit Roy, Cambridge University Press, 2021. 3. Andras C., Barb G., Danuti F., Popa D., Integrated Digital Networks Guide, Editura Politehnica, 2025.

9. Evaluation

Type of activity	**9.1** Evaluation criteria[13]	**9.2** Evaluation methods	**9.3** Share of the final grade
9.4 Course	Coverage of the entire course content.	Written exam consisting of 7, 8 topics including theoretical questions and problem-solving exercises. Each topic is graded on a scale from 1 to 10, and the final grade represents the arithmetic mean of the individual topic grades.	50%
9.5 Applied activities	**S:**		
	L:		
	P: Ability to develop traffic models for the considered networks based on the theoretical knowledge acquired.	The grade for practical activities is calculated as the arithmetic mean of the grades obtained in P1-P4.	25%
	Pr: Ability to select a system, analyze it from a traffic perspective, and choose and simulate performance parameters.	The grade is determined by the evaluation of the final project.	25%
	Tc-R[14]:		
9.6 Minimum performance standard (minimum amount of knowledge necessary to pass the discipline and the way in which this knowledge is verified[15]			
• The student must understand the basic principles and mathematical models used in the analysis and dimensioning of traffic in modern telecommunication networks; the specific characteristics of traffic in mobile networks; the QoS/QoE requirements and resource allocation methods for mMTC and URLLC applications.			

Date of completion 23.09.2025	**Course coordinator (signature)**	**Coordinator of applied activities (signature)**
Head of Department (signature)	**Date of approval in the Faculty Council** [16] 07.10.2025	**Dean (signature)**