



NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ELECTRICAL AND ELECTRONICS
ENGINEERING
ELECTRONICS ENGINEERING PROGRAM

SYLLABUS - EE523 TRANSMISSION LINES

I. GENERAL INFORMATION

CODE	: EE523
SEMESTER	: 7
CREDITS	: 3
HOURS PER WEEK	: 4 (Theory – Practice)
PREREQUISITES	: EE521 Electromagnetic Propagation and Radiation
CONDITION	: Compulsory
INSTRUCTOR	: Juan Alvarez

II. COURSE DESCRIPTION

The aim of this course is to learn, describe, analyze and design several medium of radiofrequency signal transmission and reception according to the needs of bandwidth required in communication systems, as well as establish their main basic differences among them from the sphere their applications.

Students also study and analyze several adaptation techniques from transmission parameters, using software tools to design lines or charts for lines of various lengths or terminated at any load impedance through charts, taking into consideration quality parameters.

III. COURSE OUTCOMES

1. Define, analyze and design wired transmission media applied in signal transmission at several frequencies and types, from their transmission and electric parameters with engineering criterion and thoroughness, in their various application spheres.
2. Identify, analyze and assess several characteristics of transmission media terminated at charge impedances different from their characteristic impedance in value, of variable length and, at different frequency which are used in data signal transmission.
3. Computer-aided analyze and simulate several parameters of transmission lines for a proper application, according to the signal frequency, line termination, and transmission medium length.
4. Apply graphical methods to solve application problems of transmission media, for their several applications in the implementation of transmission systems.

IV. LEARNING UNITS

1. TRANSMISSION MEDIA AND SYSTEMS / 12 HOURS

Signal transmission networks / telecommunication networks – Types / Definition and structure of telephone and cable television networks / Definition of terms / Definition of

transmission media / Operating division of CATV and telephone networks / Fields of application of transmission media in telecommunication networks.

2. TRANSMISSION MEDIA – ELECTRICAL PARAMETERS / 30 HOURS

Definition of a transmission medium, factors determining its classification / Tangible transmission media and Types / Structure of metallic and nonmetallic transmission media – Physical and structure characteristics / Frequency spectrum where media transmission is applied / Current and voltage analysis in a transmission medium / The dominant TEM mode and its scattering in electromagnetic fields / Definition of lossless line / Postulates of a transmission medium with 2 perfect conductors / Telephone line or pair cable / Structure characteristics of the telephone pair cable / Telephone line parameters / Resistance of the line to voice or long-wave frequencies, its imbalance and temperature and frequency dependence / National fundamental programs of telecommunication systems / Diagram of general reference circuit / Circuit model of a transmission line / Distributed parameters of a transmission line – Length and transverse parameters / The reason why a telephone line is considered a transmission line / The concept of balanced and imbalanced lines / Analysis of length parameters of the 2-capacitor transmission line, equations determining them according to the frequency, length, conductor diameter, gap between their centers, temperature and type of material / Analysis of transverse parameters of the 2-conductor transmission line / Equations determining them according to the frequency, length, insulator thickness, and type of material / Application examples using tables of insulating and conductor material parameters.

3. PARAMETERS OF MEDIA TRANSMISSION / 18 HOURS

Secondary or transmission parameters of a transmission line / Parameter dependence with regard to length and frequency / Characteristic impedance definition / Characteristic impedance analysis of an infinite or lossless transmission line / Determination of its general equation, Application examples / Characteristic impedance of a finite transmission line / Propagation constant definition / Transmission system values / definition of attenuation and phase constants / Amplitude distortion / determination of their general expressions, units and limit values / Phase or propagation speed / Phase delay / Signal delay time / Group speed and delay / Phase distortion / Spread of signal in the transmission medium / Effects of spread in the transmission medium bandwidth.

4. GENERAL EQUATION OF TRANSMISSION MEDIA – ADAPTED AND UNADAPTED LINES/ 12 HOURS

General differential equation of transmission line / Signal propagation in coupled lines / Input impedance in a transmission line terminated in an arbitrary impedance load / Input impedance of a transmission line terminated in open and short circuits / Calculation of input constant and propagation constant from input impedances measured in lines terminated in open and short circuits / Definition of reflection coefficient / Uncoupled lines and standing waves.

5. LINE ADAPTATION METHODS AND QUALITY PARAMETERS / 12 HOURS

Transmission matrix / Voltages and currents according to input variables / Smith chart / Characteristics / How to use / Line loss and power transmission efficiency / Smith chart in lossy lines / Impedance coupling methods / Coupling with a $\lambda/4$ section / Admittance Smith chart / One-stub coupling.

V. LABORATORY EXPERIENCES

Lab 1: Transmission media and telecommunication cables.

Lab 2: Loop-resistance measurement and resistance imbalance.

Lab 3: Insulation resistance measurement.

Lab 4: Mutual capacitance and capacitance imbalance.

Lab 5: The characteristic impedance and estimate of the attenuation factor in a transmission medium.

VI. METHODOLOGY

The course is carried out in computing lab, theory and practice sessions as follows:

- a. Theory sessions: carried out through instructor's lectures complying with the established schedule. Student active participation is encouraged in every session through questions, problem-solving, discussion of cases, bibliographic information search on the internet.
- b. Practice sessions: carried out with the aim of develop skills and flairs described in the outcomes. The instructor proposes exercises and cases to be solved using the knowledge acquired during theory sessions.
- c. Lab sessions: carried out using the proper software, manuals and charts which help the student visualize the most important aspects of the analysis of transmission media. Cases to be solved will be given in advance so that the reports can include research, updating and an in-depth knowledge of it. Hardware such as computers and multimedia projectors, and aids such as texts, offprints, software and virtual campus will allow a better understanding of the studied topics.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

$$\text{PF} = 0.25 \text{ EP} + 0.25 \text{ EF} + 0.08 \text{ P1} + 0.08 \text{ P2} + 0.08 \text{ P3} + 0.035 \text{ L1} + 0.035 \text{ L2} + 0.035 \text{ L3} + 0.035 \text{ L4} + 0.035 \text{ L5} + 0.085 \text{ TF}$$

EP: Mid-Term Exam

EF: Final Exam

TF: Final Report

P#: Quizzes

L#: Labs

VIII. BIBLIOGRAPHY

1. **CONNOR, F.R.**,
Waves Transmission (Spanish)
2005, Labor Editorial, Barcelona, Spain