B.E. TELECOMMUNICATION - CURRICULUM

TL-MUET BoS TEAM
Effective 19TL

Contents

MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO
DEPARTMENT OF TELECOMMUNICATION ENGINEERING

University's Vision

To become world class educational and research institute and contribute effectively towards building up indigenous and technological capabilities for sustainable socio-economical development.

University's Mission

To equip our undergraduate, postgraduate and doctoral students with advance knowledge and through collaborative opportunity emerged from linkage with academia, industry and government.

Program Mission

To produce quality Telecommunication engineers with in-depth knowledge and skills who can meet current and future needs of society by serving in professional domains and carrying out quality research through collaborative environment.

Program Educational Objectives (PEOs)

The PEOs of Telecommunication Engineering in the bachelor of engineering degree program are:

1. The graduates are expected to be researchers, academic professionals in wired and wireless telecommunication systems having adequate managerial and communication skills.

2. The graduates will engage in self-learning and expected to design, analyse, investigate, and evaluate telecommunication systems using modern tools and technologies.

3. The graduates will appreciate the ethical and social implications of telecommunication technologies and will contribute to the sustainable development as an individual or as a team.

Framework

Duration	4 years
Semesters	8
Weeks per Semester	21 weeks
- Teaching	16 weeks
- Mid Semester Examination	1 week
- Final Examination Preparation	1 weeks
- Final Examination Conduct	2 weeks
- Semester Break	1 week
Summer Break / Summer Semester	8 weeks
Winter Break	2 weeks
Total number of Credit Hours (CHs)	135
Credit Hours per Semester	$16 - 18$
Total number of Courses	41
Engineering Domain Courses	73.33%
Non-Engineering Domain Courses	26.66%
Total number of Contact Hours	3088

Non-Engineering Courses

Knowledge Area	Sub Area	Course	Theory CHs	Lab CHs	Total CHs	Total Courses	G.Total CHs
Humanities	English	Functional English	3	0	3	3	7
		Communication Skills	2	0	2		
		Technical Report Writing Skills	2	0	2		
	Culture	Islamic Studies	2	0	2	2	4
		Pakistan Studies	2	0	2		
	Social Sciences	Professional Ethics	2	0	2	2	4
		Entrepreneurship	2	0	2		
Management Sciences		Engineering Management	3	0	3	2	5
		Telecom Policies and Standards	2	0	2		
Natural Sciences	Mathematics	Applied Calculus	3	0	3	4	12
		Linear Algebra and Analytical Geometry	3	0	3		
		Differential Equations and Fourier Series	3	0	3		
		Complex Variables and Transforms	3	0	3		
	Physics	Applied Physics	3	1	4	1	4
Total			**35**	**1**	**36**	**14**	**36**

Percentage of non-engineering courses $= \dfrac{36}{135} = 26.66\%$

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Engineering Courses

Knowledge Area	Sub Area	Course	Theory CHs	Lab CHs	Total CHs	Total Courses	G.Total CHs
Computing	Programming	Introduction to Programming	3	1	4	2	8
		Object Oriented Programming	3	1	4		
Engineering Foundation		Basic Electronics	3	1	4	7	24
		Introduction to Simulation Tools	0	1	1		
		Circuit Analysis	3	1	4		
		Digital Logic and Design	3	1	4		
		Signals and Systems	3	1	4		
		Electromagnetics	3	0	3		
		Communication Systems	3	1	4		
Major Based Core (Breadth)		Amplifiers and Oscillators	3	1	4	7	26
		Microprocessors and Microcontrollers	3	1	4		
		Antennas and Wave Propagation	3	1	4		
		Probability and Stochastic Processes	3	0	3		
		Optoelectronics	2	1	3		
		Digital Communication	3	1	4		
		Digital Signal Processing	3	1	4		
Major Based Core (Depth)		Computer Communication and Networking	3	1	4	9	31
		Transmission and Switching Systems	3	1	4		
		Wireless Communications	3	1	4		
		Satellite and Radar Communication	3	0	3		
		Queueing Theory	2	1	3		
		Fiber Optics Communication Systems	3	1	4		
		Microwave Engineering	3	1	4		
		Network Protocols and Architecture	2	1	3		
		Emerging Wireless Technologies and RF Planning	2	0	2		
Interdisciplinary Eng. (Elective)		Numerical Analysis and Computer Applications	3	1	4	1	4
Project (Final)						1	6
Total			**71**	**22**	**93**	**27**	**99**

Percentage of engineering courses $= \dfrac{99}{135} = 73.33\%$

Courses, Knowledge Area and Pre-requisites

First Semester

Code	Title	Credit Hours	Knowledge Area	Pre-requisite
IS111/ SS104	Islamic Studies / Ethics	(2+0)	Humanities (Culture)	
PS106	Pakistan Studies	(2+0)	Humanities (Culture)	
MTH108	Applied Calculus	(3+0)	Natural Science (Math)	
CS104	Introduction to Programming	(3+1)	Computing (Programming)	
TL121	Applied Physics	(3+1)	Natural Science (Physics)	
ENG101	Functional English	(3+0)	Humanities (English)	
	TOTAL	(16+2)		

Second Semester

Code	Title	Credit Hours	Knowledge Area	Pre-requisite
CS123	Object Oriented Programming	(3+1)	Computing (Programming)	Introduction to Programming
MTH112	Linear Algebra and Analytical Geometry	(3+0)	Natural Science (Math)	Applied Calculus
ES112	Basic Electronics	(3+1)	Engineering Foundation	
EL102	Circuit Analysis	(3+1)	Engineering Foundation	
TL112	Introduction to Simulation Tools	(0+1)	Engineering Foundation	
	TOTAL	(12+4)		

Third Semester

Code	Title	Credit Hours	Knowledge Area	Pre-requisite
MTH212	Differential Equations and Fourier Series	(3+0)	Natural Science (Math)	Linear Algebra and Analytical Geometry
ES215	Digital Logic and Design	(3+1)	Engineering Foundation	
ES205	Amplifiers and Oscillators	(3+1)	Major Based Core (Breadth)	
ENG201	Communication Skills	(2+0)	Humanities (English)	
IN202	Engineering Management	(3+0)	Management Sciences	
	TOTAL	(14+2)		

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Fourth Semester

Code	Title	Credit Hours	Knowledge Area	Pre-requisite
MTH213	Complex Variables and Transforms	(3+0)	Natural Science (Math)	Differential Equations and Fourier Series
ES256	Microprocessors and Microcontrollers	(3+1)	Major Based Core (Breadth)	
TL231	Signals and Systems	(3+1)	Engineering Foundation	
TL202	Electromagnetics	(3+0)	Engineering Foundation	Applied Physics
SS221	Professional Ethics	(2+0)	Humanities (Social Sciences)	
	TOTAL	(14+2)		

Fifth Semester

Code	Title	Credit Hours	Knowledge Area	Pre-requisite
TL304	Antennas and Wave Propagation	(3+1)	Major Based Core (Breadth)	Electromagnetics
TL345	Digital Signal Processing	(3+1)	Major Based Core (Breadth)	Signals and Systems
TL354	Probability and Stochastic Processes	(3+0)	Major Based Core (Breadth)	Electromagnetics
MTH336	Numerical Analysis and Computer Applications	(3+1)	Inter-disciplinary Eng. (Elective)	Object Oriented Programming
TL323	Communication Systems	(3+1)	Engineering Foundation	
	TOTAL	(15+4)		

Sixth Semester

Code	Title	Credit Hours	Knowledge Area	Pre-requisite
TL371	Digital Communication	(3+1)	Major Based Core (Breadth)	Communication Systems
TL362	Microwave Engineering	(3+1)	Major Based Core (Depth)	Electromagnetics
TL391	Optoelectronics	(2+1)	Major Based Core (Breadth)	Basic Electronics
ENG320	Technical Report Writing Skills	(2+0)	Humanities (English)	Functional English
TL334	Computer Communication and Networking	(3+1)	Major Based Core (Depth)	Communication Systems
	TOTAL	(13+4)		

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Seventh Semester

Code	Title	Credit Hours	Knowledge Area	Pre-requisite
TL474	Fiber Optics Communication Systems	(3+1)	Major Based Core (Depth)	Optoelectronics
TL445	Transmission and Switching Systems	(3+1)	Major Based Core (Depth)	Communication Systems
TL424	Wireless Communications	(3+1)	Major Based Core (Depth)	Antennas and Wave Propagation
TL431	Queueing Theory	(2+1)	Major Based Core (Depth)	Probability and Stochastic Processes
TL498	Thesis/Project	(0+3)		
	TOTAL	(11+7)		

Eighth Semester

Code	Title	Credit Hours	Knowledge Area	Pre-requisite
TL413	Satellite and Radar Communication	(3+0)	Major Based Core (Depth)	Antennas and Wave Propagation
TL456	Network Protocols & Architecture	(2+1)	Major Based Core (Depth)	Computer Communication and Networking
TL484	Emerging Wireless Technologies and RF Planning	(2+0)	Major Based Core (Depth)	Wireless Communications
TL461	Telecom Policies and Standards	(2+0)	Management Sciences	
ENT401	Entrepreneurship	(2+0)	Humanities (Social Sciences)	
TL499	Thesis/Project	(0+3)		
	TOTAL	(11+4)		

Islamic Studies

Pre-requisites	Nil
Co-requisite	Nil
Course Code	IS111
Semester	1st
Effective	17TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To acquaint the students with the proper knowledge of Islam based on Quran and Hadith.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 1: TH: CLOs, Mapping of CLOs to PLOs of Islamic Studies

CLOs	Description	Taxonomy	PLOs
1	Explain the scope and significance of basic beliefs and pillars of Islam, their impact on different aspects of individual's life and society.	C2	8
2	Extend the understanding of Quran, Hadith and life of Holy Prophet Muhammad (S.A.W) as the source of inspiration and guidance.	C2	6

Table 2: Tentative Assessment Methods of CLOs of Islamic Studies

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-60%]	[Q1-20%]	C2	8
2	[Quiz-20%]	[Q2-20%]	[Q2-60%]	C2	6

Contents

I. Quran and Uloom-ul-Quran

- Surah al-Hujurat and Surah al-Furqan cover all topics related to the ethical values of Islamic society including taqwa, simplicity, lawful earning, social justice, rights of parents, elders, neighbors, fear of Allah and truthfulness, excellence of Holy Quran, history of collection and compilation of Holy Quran.

II. Basic Beliefs of Islam

- Tauheed, its importance, effects on the life of believer, shirk and its types, prophethood, its need and necessities, characteristics and finality of prophethood, concept on life hereafter, jihad and its types.

III. Life history of Holy Prophet Muhammad (S.A.W.)

- Life history at makkah (before propehthood)
- Life history at makkah (after propehthood)
- Life history at madina (including brotherhood, charter of madina, victory of makkah and last sermon of holy prophet Muhammad (S.A.W.)
- Importance of hadith and sunnah
- Ten selected ahadiths

IV. Fundamentals of Islam

- Prayer, its importance, pre-conditions, obligations and effects
- Zakat, its aims and objectives, requirements, legal recipients, nisab and benefits
- Fasting, its philosophy, requirements and benefits
- Pilgrimage, requirements, types, obligations, procedure and benefits

V. Islam and Science

- Quran and science, importance of science and technology in Islam, historical contribution of Islam and Muslims in the development of science.
- Verses of Holy Quran that cover different fields of science e.g. social, management and natural science.

Recommended Books

1. Islam: The Universal Religion - A. A. Umrani
   (Latest Edition "1st", 1994)

2. Sirat-e-Mustaqeem - A. Q. Natiq
   (Latest Edition "1st", 1992)

3. Islam aur Hamari Zindagi - S. M. Saeed
   (Latest Edition "1st", 1988)

4. Quran Science and Muslims - M. Shabudden
   (Latest Edition "1st", 2000)

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Ethics

Pre-requisites	Nil
Co-requisite	Nil
Course Code	SS104
Semester	1st
Effective	17TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To acquaint the students with the proper knowledge based on ethical and moral values of various famous religions.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 3: TH: CLOs, Mapping of CLOs to PLOs of Ethics

CLOs	Description	Taxonomy	PLOs
1	Establish stable and healthy civilized society.	C3	6
2	Develop uniformity of moral beliefs and behaviour.	C3	8

Table 4: Tentative Assessment Methods of CLOs of Ethics

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-60%]	[Q1-20%]	C3	6
2	[Quiz-20%]	[Q2-20%]	[Q2-60%]	C3	8

Contents

I. Islam

- Introduction, role of beliefs and arkans of Islam in character building, ethical values including brotherhood, equality, liberty, tolerance, social justice, rights of non-muslim, effects of corruption and respect of law.

II. Hinduism

- Introduction, doctrines, religious books, concept of re-birth, celebration days, cast systems, trimurti, ethical teaching.

III. Budhism

- Introduction, doctrines, eight nobel paths of buddha, critical study of renunciation of material and wordly life.

IV. Christianity

- Introduction, doctrines, religious books, human honor, self reforms, celebration days and ethical teaching.

V. Judaism

- Introduction, doctrines, religious books, ethical values, ten commandments of prophet Moses.

Recommended Books

1. A Comparative Study of the Religions of Today - Mohammed Ali Muhiyaddin
   (1st Edition)

2. Comparative Study of Religions - A. Rasheed
   (Latest Edition "1st", 2001)

3. Ikhlaqiyat Mazahib-e-Aalam ki Nazar Main - Aadil Faraz
   (Latest Edition "1st", 2002)

4. Mazahib-e-Aalam jo Taqabili Jaezo - M. Hashim Channa
   (Latest Edition "1st", 1988)

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Pakistan Studies

Pre-requisites	Nil
Co-requisite	Nil
Course Code	PS106
Semester	1st
Effective	17TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The course is designed to acquaint the students with the rationale of the creation of Pakistan. It deals in detail with the salient aspects of Pakistan movement, focusing on the main objectives of national life. The course moves further to give a broader perspective of the social, political, constitutional, economic and geographical aspect of Pakistan's endeavours to develop and progress in the contemporary world. For this purpose, the main strands of Pakistan's foreign policy are also included.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 5: TH: CLOs, Mapping of CLOs to PLOs of Pakistan Studies

CLOs	Description	Taxonomy	PLOs
1	Trace the Muslim nationalism in South Asia and the creation of Pakistan.	C2	6
2	Discuss the constitutional and political history of Pakistan and to analyse contemporary challenges of Pakistan.	C2	6

Table 6: Tentative Assessment Methods of CLOs of Pakistan Studies

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-30%]	[Q1-40%]	[Q1-30%]	C2	6
2	[Quiz-20%]	[Q2-10%]	[Q2-70%]	C2	6

Contents

I. The Historical Background of Pakistan

- Evolution and growth of Muslim society in Subcontinent
- Muslim Revivalist and Reformist Movements
- The Factors that shaped the Muslim Nationalism in the Subcontinent
- The Factors that led birth to Pakistan
- Ideology of Pakistan with special reference to Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah
- Role of Sindh in Making of Pakistan

II. History of Internal and External Affairs of Pakistan

- The Constitutional and Political Developments in Pakistan (1947-1973)
- The Constitution of 1973; Salient Features and Amendments
- Political Development in Pakistan (1973 to date)
- Determinants of Foreign Policy of Pakistan

- Pakistan's Relations with Big Powers

III. Contemporary Pakistan (Issues and Challenges)

- Geo-Strategic Significance of Pakistan
- Economic Potential and its Utilization
- Challenges to National Security of Pakistan
- Internal Political, Economic and Legal Problems
- Futuristic Outlook of Pakistan

Recommended Books

1. Pakistan's Foreign Policy 1947-2016: A Concise History - Abdul Sattar
   (Latest Edition "4th", ISBN-10: 0199407126 or ISBN-13: 978-0199407125)

2. The Future of Pakistan - Stephen P. Cohen
   (Latest Edition "1st" , ISBN-10: 0815721803 or ISBN-13: 978-0815721802)

3. Frontline Pakistan: The Struggle with Militant Islam - Zahid Hussain
   (Latest Edition "1st", ISBN-10: 0067008127 or ISBN-13: 978-0067008126)

4. The Struggle for Pakistan: A Muslim Homeland and Global Politics - Ayesha Jalal
   (Latest Edition "1st", ISBN-10: 0674052897 or ISBN-13: 978-0674052895)

5. A Concise History of Pakistan - Muhammad Reza Kazimi
   (Latest Edition "1st", ISBN-10: 0199065128 or ISBN-13: 978-0199065127)

6. Constitutional and Political History of Pakistan - Hamid Khan
   (Latest Edition "2nd", ISBN-10: 0195477871 or ISBN-13: 978-0195477870)

7. A History of Pakistan - Roger D. Long
   (Latest Edition "1st", ISBN-10: 0199400245 or ISBN-13: 978-0199400249)

8. Islam, Ethnicity and Power Politics: Constructing Pakistan's National Identity - Rasul Bakhsh Rais
   (Latest Edition "1st", ISBN-10: 0199407592 or ISBN-13: 978-0199407590)

9. Deadly Embrace: Pakistan, America, and the Future of the Global Jihad - Bruce Riedel
   (Latest Edition "2nd", ISBN-10: 0815722745 or ISBN-13: 978-0815722748)

10. Pakistan: The Formative Phase 1857-1948 - Khalid Bin Sayeed, George Cunningham
    (Latest Edition "2nd", ISBN-10: 0195771141 or ISBN-13: 978-0195771145)

11. Pakistan: A New History - Ian Talbot
    (Latest Edition "1st", ISBN-10: 0199391084 or ISBN-13: 978-0199391080)

12. Jinnah of Pakistan - Stanley Wolpert
    (Latest Edition "1st", ISBN-10: 0195678591 or ISBN-13: 978-0195678598)

Reference Material

1. A Short History of Pakistan - Ishtiaq Husain Qureshi
   (Latest Edition "1st", ISBN-10: 9694040086)

2. History of Pakistan - Rafiullah Shehab
   (Latest Edition "1st", 1989)

3. Our Freedom Fighters, 1562-1947: Twenty-one Great Lives - G. Allana
   (Latest Edition "1st", 1976)

4. The Making of Pakistan: A Study in Nationalism - K. K. Aziz
   (Latest Edition "1st", ISBN-10: 969350870X or ISBN-13: 978-9693508703)

5. The Emergence of Pakistan - Chaudhri Muhammad Ali
   (Latest Edition "1st", 1983)

6. Pakistan's Foreign Policy: Indian Perspectives - K. Arif
   (Latest Edition "1st", 1984)

7. The Economy of Pakistan - Khawaja Amjad Saeed
   (Latest Edition "1st", ISBN-10: 0199060800 or ISBN-13: 978-9693508703)

8. International Affairs - Safdar Mahmood
   (Latest Edition "2nd", 1967)

9. Political System of Pakistan - Khalid Bin Sayeed
   (Latest Edition "1st", 1987)

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Applied Calculus

Pre-requisites	Nil
Co-requisite	Nil
Course Code	MTH108
Semester	1st
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To acquaint the students with the idea of calculus and its applications in the engineering field.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 7: TH: CLOs, Mapping of CLOs to PLOs of Applied Calculus

CLOs	Description	Taxonomy	PLOs
1	Determine the functions and their derivatives.	C3	1
2	Compute the integral calculus with applications.	C3	1
3	Apply the vector calculus in the field of engineering.	C3	1

Table 8: Tentative Assessment Methods of CLOs of Applied Calculus

CLOs	Quiz / Assignment / Lab Rubrics	Mid Exam	Final Exam	Lab Exam	Project / OEL/CEP	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-70%]	[Q1-10%]			C3	1
2	[Quiz-40%]	[Q2-30%]	[Q2-30%]			C3	1
3	[Quiz-40%]		[Q3-60%]			C3	1

Contents

I. Introduction to Functions

- Mathematical and physical meaning of functions, graphs of various functions, types of functions.

II. Introduction to Limits

- Theorems of limits and their applications to functions, right hand and left hand limits, continuous and discontinuous functions and their applications

III. Derivatives

- Introduction to derivatives, geometrical and physical meaning of derivatives, partial derivatives and their geometric significance, application problems (rate of change, marginal analysis)

IV. Higher Derivatives

- Leibnitz theorem, Rolle's theorem, mean value theorem, taylors and maclaurins series.

V. Evaluation of limits using L'Hospital's rule

- Indeterminate forms $(0/0), (\infty/\infty), (0 \times \infty), (\infty - \infty), 1^\infty, \infty^0, 0^0$

VI. Application of Derivatives

- Asymptotes, tangents and normal, curvature and radius of curvature, differentials with application.

VII. Application of Partial Derivatives

- Euler's theorem, total differentials, maxima and minima of function of two variables

VIII. Integral Calculus

- Methods of integration by substitution and by parts, integration of rational and irrational algebraic functions, definite integrals, improper integrals, gamma and beta functions, reduction formulae

IX. Application of Integral Calculus

- Cost function from marginal cost, rocket flights, area under curve

X. Vector Calculus

- Vector differentiation and vector integration with their physical interpretation and applications, $\bigtriangledown$ operator, gradient, divergence and curl with their application

Recommended Books

1. Brief Calculus and its Applications - Daniel Dale Benice
   (Latest Edition "2nd", ISBN-10: 0395824648 or ISBN-13: 978-0395824641)

2. Applied Calculus - Raymond F. Coughlin
   (Latest Edition "2nd", ISBN-10: 020506910X or ISBN-13: 978-0205069101)

3. Calculus with Analytical Geometry - S. M. Yousuf, Muhammad Amin
   (Latest Edition "7th")

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Introduction to Programming

Pre-requisites	Nil
Co-requisite	Nil
Course Code	CS104
Semester	1st
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

To acquaint the students with the basics of computers.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 9: TH: CLOs, Mapping of CLOs to PLOs of Introduction to Computing & Programming

CLOs	Description	Taxonomy	PLOs
1	Discuss history and introduction to computer systems. Use hardware of computer to understand working / construction of various computer peripherals, processing units, and storage media.	C2	1
2	Discuss the background history in the context of programming languages / environment / style / conventions along with compilers and portability.	C3	3
3	Practice to code the problem statements and analyze by debugging and executing in programming language.	C3	3

Table 10: PR: CLOs, Mapping of CLOs to PLOs of Introduction to Computing & Programming

CLOs	Description	Taxonomy	PLOs
4	Design different projects in C/C++ and perform a task to solve the problem statement and execute programs in C/C++.	P2	3

Table 11: Tentative Assessment Methods of CLOs of Introduction to Computing & Programming

CLOs	Quiz / Assignment / Lab Rubrics	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-70%]	[Q1-10%]			C2	1
2	[Quiz-40%]	[Q2-30%]	[Q2-30%]			C3	3
3	[Quiz-10%]	[Q3-30%]	[Q3-60%]			C3	3
4	[Lab-50%]			[Test-30%] [ViVa-20%]		P2	3

Contents

I. Introduction to computers and programming

- background, history and context, programming languages, programming environment, compilers, the edit-compile-link-execute model, portability, programming style and conventions
- introduction to programs and software, system software, application software, operating systems, compilation and interpretation, problem specification, algorithms, flow chart, pseudo code

  II. Programming techniques

     - data types and declaration, header file and linkage, variables and constants, arrays, input/output, termination, remark, control structures, branching, conditional structures, repetition and loops, basic library functions

Lab Outline

- Operating Systems: introduction to various operating systems (Microsoft Windows, Linux: Ubuntu/SUN Solaris) and office tools (OpenOffice/LibreOffice, Microsoft Office)

- Programming: coding, compilation, execution and debugging of simple C++ programs, implementation of simple control structures, implementation of functions, implementation of different function styles, input/output, loops, conditional branching, arrays, multidimensional arrays, array as function arguments, strings, null character, string functions, pointer variable, returning multiple values from functions, pointers and arrays, pointers arithmetic, pointers and strings, double indirection.

- Introduction to Python

Recommended Textbooks

1. Using Information Technology: A Practical Introduction to Computers and Communications - Brian Williams and Stacey Sawyer
   (7th Edition, ISBN-10: 0072260718 or ISBN-13: 978-0072260717)

2. The C Programming Language - Brian W. Kernighan, Dennis M. Ritchie
   (2nd Edition, ISBN-10: 0131103628 or ISBN-13: 978-0131103627)

3. Python Programming: An Introduction to Computer Science - John Zelle
   (2nd Edition, ISBN-10: 1590282418 or ISBN-13: 978-1590282410)

4. Computer Organization and Architecture: Designing for Performance - William Stallings
   (7th Edition, ISBN-10: 0131856448 or ISBN-13: 978-0131856448)

5. Object-Oriented Programming in C++ - Robert Lafore
   (4th Edition, ISBN-10: 0672323087 or ISBN-13: 978-0672323089)

6. Understanding Pointers in C - Yashavant Kanetkar
   (3rd Edition, ISBN-10: 8176563587 or ISBN-13: 978-8176563581)

7. A Practical Guide to Solaris - Mark G. Sobell
   (1st Edition, ISBN-10: 020189548X or ISBN-13: 078-5342895483)

Approval:	Board of Studies of Telecom. Engg:	Res. No. 20.3	Dated: 03-10-2017
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MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO
DEPARTMENT OF TELECOMMUNICATION ENGINEERING

Applied Physics

Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL121
Semester	1st
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

To acquaint the students with the physics of semiconductors, electrostatics, and electrical circuits.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 12: TH: CLOs, Mapping of CLOs to PLOs of Applied Physics

CLOs	Description	Taxonomy	PLOs
1	Familiarize with the physics of semiconductors, electrostatics, magnetism and electrical circuits.	C2	1
2	Understand the basic concepts of AC/DC based electrical circuits.	C3	2
3	Design AC/DC circuit containing different components.	C4	3

Table 13: PR: CLOs, Mapping of CLOs to PLOs of Applied Physics

CLOs	Description	Taxonomy	PLOs
4	Perform experiments in laboratory to validate the laws and theories of physics.	P2	1

Table 14: Tentative Assessment Methods of CLOs of Applied Physics

CLOs	Quiz / Assignment / Lab Rubrics	Mid Exam	Final Exam	Lab Exam	Project / OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-30%]	[Q1-30%]			C2	1
2	[Quiz-40%]	[Q2-30%]	[Q2-30%]			C3	2
3	[Quiz-40%]				60%	C4	3
4	[Lab-40%]			ViVa-30% [Test-30%]		P2	1

Contents

I. Semiconductor Physics

  - insulators, conductors, superconductors, semiconductors, energy levels in a semiconductor, hole concept, intrinsic and extrinsic regions, electron hole pair, distribution of electrons and holes in conduction and valence band, recombination and life time, doped semiconductors, law of mass action, PN junction, forward and reverse characteristics, diodes and transistors.

II. Electrostatics

- electric current, electric charge, coulomb's law, electric field intensity and electric potential, capacitors and charge storage concepts

III. Electric Circuits

- electric quantities, simple resistive circuits (series and parallel), kirchhoff law (KVL, KCL), voltage-divider rule, current-divider rule, resistive bridges and ladders, nodal analysis, loop analysis, linearity and superposition, source transformation, circuit theorems, power calculations, analysis of RC and RL circuits.

IV. Magnetism

- magnetism, magnetic fields, magnetic effects of electric current, faraday's and lenz's laws, ampere's law and its applications, eddy currents, inductors and inductance, induced current and their applications (transformers, generators etc.).

V. AC fundamentals

- AC waveform, period and frequency, radians and angular frequency, peak, instantaneous and rms values, average and effective values, AC voltage and current in capacitors and inductors, average power.

Lab Outline

The laboratory experiments will make students understand the phenomena of electromagnetic induction, heating effect of electric current, and the tools to analyze electric circuits and PN junction devices. For example, evaluation of series/parallel resistive circuits, charging/discharging mechanism of RC and RL circuits as well as non-linear characteristics of diode are investigated through hardware/simulations tools.

Recommended Books

1. University Physics - Hugh D. Young, Roger A. Freedman
   (Latest Edition "13th" Edition, ISBN-10: 0321696891 or ISBN-13: 978-0321696892)

2. Physics - David Halliday, Robert Resnick, Kenneth S. Krane
   (Latest Edition "4th" Edition, ISBN-10: 0471804584 or ISBN-13: 978-0471804581)

Reference Material

1. Basic Engineering Circuit Analysis - J. David Irwin, Robert M. Nelms
   (Latest Edition "11th" Edition, ISBN-10: 111853929X or ISBN-13: 978-1118539293)

2. Hughes Electrical and Electronic Technology - Edward Hughes
   (Latest Edition "11th" Edition, ISBN-10: 0273755102 or ISBN-13: 978-0273755104)

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Functional English

Pre-requisites	Nil
Co-requisite	Nil
Course Code	ENG101
Semester	1st
Effective	13TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The aim of this course is to enable students to use four skills of language with confidence and use different components of grammar.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 15: TH: CLOs, Mapping of CLOs to PLOs of Functional English

CLOs	Description	Taxonomy	PLOs
1	Write varied contents including official letters, e-mails, and applications and summarize the texts using appropriate grammatical mechanisms and cohesive devices.	C3	12
2	Apply skimming, scanning and detailed reading and listening strategies to understand gist of the text/conversation.	C3	2
3	Demonstrate their skills using english language to express their point of view, show arguments and deliver a presentation in a real life situations.	C3	10

Table 16: Tentative Assessment Methods of CLOs of Functional English

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-60%]	[Q1-20%]	C2	12
2	[Quiz-20%]	[Q2-40%]	[Q2-40%]	C3	2
3	[Quiz-20%]		[Q3-80%]	C3	10

Contents

I. Reading

- Interactive reading, apply the skills of surveying skimming, scanning and detailed reading and identify topic sentence.

II. Writing

- Audience related writing, composition of sentences, paragraph, short descriptive writing, precis and letter and application, identify contextual clues with the help of cohesive devices.

III. Listening

- Collect gist and important points from a listening text or any other oral source viz. Lecture, speech or conversation.

IV. Speaking

- Taking part in different real life situations, answer question, argue and explain one's point of view, ask for information-turn taking techniques and presentation skills.

V. Grammar

- Mechanics of english language, punctuation, vocabulary, conversion of words, tenses and sentence structure.

Recommended Books

1. A Practical English Grammar: Exercises 1 (Bk. 1) - Audrey Thomson, Agnes Martinet
   (Latest Edition "3rd", ISBN-10: 0194313433 or ISBN-13: 978-0194313438)

2. Academic Writing Course (Collins study skills in English) - R.R. Jordan
   (Latest Edition "1st", ISBN-10: 0003700046 or ISBN-13: 978-0003700046)

3. Listening Comprehension and Note Taking Course (Collins study skills in English) - K. James, R. R. Jordan, A. J. Matthews
   (Latest Edition "1st", ISBN-10: 0003700011 or ISBN-13: 978-0003700015)

4. A New English Course: An Approach to GCSE English Language for Individual Study of Class Use - Rhodri Jones
   (Latest Edition "3rd", ISBN-10: 0435105019)

5. Axelrod and Cooper's Concise Guide to Writing - Rise B. Axelrod, Charles R. Cooper
   (Latest Edition "6th", ISBN-10: 0312668902 or ISBN-13: 978-0312668907)

6. English for Undergraduates - T. A. Kirkpatrick, D. L. Kirkpatric, D. H. Howe
   (Latest Edition "1st", ISBN-10: 0195472195 or ISBN-13: 978-0195472196)

7. Essential Grammar in Use: A Self-Study Reference and Practice Book for Elementary Learners of English - Raymond Murphy
   (Latest Edition "4th", ISBN-10: 1107480558 or ISBN-13: 978-1107480551)

8. How To Write Better English (Penguin Writers' Guides) - Robert Allen
   (Latest Edition "1st", ISBN-10: 0141016760 or ISBN-13: 978-0141016764)

9. Oxford Practice Grammar: With Answers - John Eastwood
   (Latest Edition "2nd", ISBN-10: 0194313697 or ISBN-13: 978-0194313698)

10. Selected text from DAWN newspaper, readers digest, new scientist and other relevant material of teacher's choice.

Approval:	Board of Studies of ELDC	Res. No. 01	Dated: 07-12-2012
	Board of Studies of Telecom. Engg:	Res. No. 20.3	Dated: 03-10-2017
	Board of Faculty of EEC Engineering	Res. No. 12.4	Dated: 16-10-2017
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MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO
DEPARTMENT OF TELECOMMUNICATION ENGINEERING

Object Oriented Programming

Pre-requisites	Introduction to Programming
Co-requisite	Nil
Course Code	CS123
Semester	2nd
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

This course aims to provide students with a detail understanding of the design and analysis of object oriented programs.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 17: TH: CLOs, Mapping of CLOs to PLOs of Object Oriented Programming

CLOs	Description	Taxonomy	PLOs
1	Discuss and define the basic principles of object oriented programming.	C2	1
2	Illustrate architecture, working and construction of various structures in object oriented programming using C++/Java.	C2	1
3	Practice to code the problem statements and analyze by debugging and executing in C++/Java.	C3	3

Table 18: PR: CLOs, Mapping of CLOs to PLOs of Object Oriented Programming

CLOs	Description	Taxonomy	PLOs
4	Perform a task to solve the problem statement and execute programs in C++/Java.	P4	2
5	Design different projects in C++/Java/Python.	P7	3

Table 19: Tentative Assessment Methods of CLOs of Object Oriented Programming

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-80%]	[Q1-20%]				C2	1
2	[Quiz-70%]	[Q2-10%]	[Q1-20%]			C2	1
3	[Quiz-10%]		[Q2-60%]			C3	3
4	[Quiz-100%]					P4	2
5	[Quiz-40%]			[Test-30%]	[Q1-30%]	P7	3

Contents

I. Perspective

- Procedural versus object oriented programming languages, concepts of object oriented programming, C++ and object-oriented programming, why C++/Java/Python?, features, pros/cons of C++/Java/Python

II. Data Structures in C++

- Structure, accessing structure members, structure as function arguments, pointers to structures, the typedef keyword

III. Object-Orientation

- Object oriented design strategy and problem solving, objects and classes, member functions, public and private members, dynamic memory management, implementation of stacks and queues, priority queues, tree, binary tree, binary search tree, depth-first/breadth first traversal, hashing, searching: (linear search, binary search, depth first / breadth first search), constructors and destructors, templates, object encapsulation, data hiding, derived classes, class hierarchies, inheritance and polymorphism, inheritance hierarchies and multiple inheritance, operator overloading, templates and container classes, exception handling, stream class, practical design through object oriented programming

Lab Outline

- Object oriented programming environment, implementation of object oriented programs: classes, methods, objects, abstract classes and inheritance, overloading and overriding, class aggregation, implementation of polymorphism, use of constructors and destructors, memory management, testing and debugging.
- Recommended Platforms: Java, C++, Python

Recommended Books

1. Object-Oriented Programming in C++ - Robert Lafore
   (Latest Edition "4th", ISBN-10: 0672323087 or ISBN-13: 978-0672323089)

2. Effective Java - Joshua Bloch
   (Latest Edition "2nd", ISBN-10: 0321356683 or ISBN-13: 860-1300201986)

3. Python 3 Object-Oriented Programming - Dusty Phillips
   (Latest Edition "2nd", ISBN-10: 1784398780 or ISBN-13: 978-1784398781)

4. Fundamentals of Data Structures in C++ - Ellis Horowitz, Sartaj Sahni, Dinesh Mehta
   (Latest Edition "2nd", ISBN-10: 0929306376 or ISBN-13: 978-0929306377)

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MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO
DEPARTMENT OF TELECOMMUNICATION ENGINEERING

Linear Algebra and Analytical Geometry

Pre-requisites	Applied Calculus
Co-requisite	Nil
Course Code	MTH112
Semester	2nd
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To develop the knowledge of matrix algebra, the system of linear equations, analytic geometry of three dimension and multiple integrals.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 20: TH: CLOs, Mapping of CLOs to PLOs of Linear Algebra and Analytical Geometry

CLOs	Description	Taxonomy	PLOs
1	Determine the basic operation of matrix algebra and solution of system of linear equations.	C3	1
2	Analyze the concepts of two and three dimensional geometry.	C4	1
3	Determine the area and volume of bounded regions using multiple integrals.	C3	1

Table 21: Tentative Assessment Methods of CLOs of Linear Algebra and Analytical Geometry

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-70%]	[Q1-10%]	C3	1
2	[Quiz-40%]	[Q2-30%]	[Q2-30%]	C4	1
3	[Quiz-40%]		[Q3-60%]	C3	1

Contents

I. Introductions to Matrices and Elementary Row Operations

- Brief introduction of matrices, types of matrices, introduction to elementary row operations, echelon and reduced echelon forms, rank of a matrix, inverse of a matrix using elementary row operations.

II. System of Linear Equations

- System of non-homogeneous and homogeneous linear equations, gaussian elimination method, gauss jordan method, consistence criterion for solution of homogeneous and non-homogeneous system of linear equations, application of system of linear equations.

III. Determinants

- Introduction to determinants, properties of determinants of order n, rank of a matrix by using determinants.

IV. Analytic Geometry of 3-Dimensions

- Introduction, coordinates in R^3

V. Line

- Coordination of a point dividing a line segment in a given ratio, straight line, in R^3, vector form of a straight line, parametric equations of a straight line, equation of a straight line in symmetric form, direction ratios and direction cosines, angle between two straight lines, distance of a point from a line.

VI. Plane

- Equation of a plane, angle between two planes, intersection of two planes, a plane and a straight line, skew lines, cylindrical and spherical coordinates.

VII. Sphere

- General equation of sphere, latitude and longitude directions, direction of Qibla.

VIII. Multiple Integrals

- Evaluation of double and triple integrals in cartesian and polar coordinates.

Recommended Books

1. Brief Calculus and its Applications - Daniel Dale Benice
   (Latest Edition "2nd", ISBN-10: 0395824648 or ISBN-13: 978-0395824641)

2. Applied Calculus with Linear Programming for Business, Economics, Life Sciences and Social Sciences - Raymond A. Barnett
   (Latest Edition "5th", ISBN-10: 0536024499 or ISBN-13: 978-0536024497)

3. Calculus with Analytical Geometry - S. M. Yousuf, Muhammad Amin
   (Latest Edition "7th")

4. Mathematical Methods - S. M. Yousuf, Abdul Majeed, Muhammad Amin
   (Latest Edition "2nd")

Approval:	Board of Studies of BSRS	Res. No. 01	Dated: 26-03-2018
	Board of FOST&H	Res. No. 3.1	Dated: 11-04-2018
	Academic Council	Res. No. 17(ii)	Dated: 23-04-2018

Basic Electronics

Pre-requisites	Nil
Co-requisite	Nil
Course Code	ES112
Semester	2nd
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

Diodes and transistors are the building blocks of every electronic and communication system. The aim of this subject is to provide the knowledge about the construction and working of basic electronic devices. Good knowledge about this subject will enable them to build large electronic systems successfully.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 22: TH: CLOs, Mapping of CLOs to PLOs of Basic Electronics

CLOs	Description	Taxonomy	PLOs
1	Explain the basics, working and characteristics of Semiconductor material and diodes.	C2	1
2	Analyze the working and behaviour of transistors and their types and be able to understand different transistor applications.	C4	2

Table 23: PR: CLOs, Mapping of CLOs to PLOs of Basic Electronics

CLOs	Description	Taxonomy	PLOs
3	Reproduce basic electronic circuits on board using discrete components i.e. resistors, diodes and transistors, and develop project using discrete components and/or circuit simulation platform.	P3	5
4	Demonstrate effectively as an individual or in a group while performing laboratory experiments.	A3	3

Table 24: Tentative Assessment Methods of CLOs of Basic Electroncis

CLOs	Quiz / Assignment / Lab Rubrics	Mid Exam	Final Exam	Lab Exam	Project / OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-30%]	[Q1-30%]			C2	1
2	[Quiz-40%]	[Q2-30%]	[Q2-30%]			C4	2
3	[Lab-40%]			[Test-30%]	[30%]	P3	5
4				[ViVa-100%]		A3	3

Contents

I. Introduction to Diodes

- Atomic structure of elements, energy level diagram of intrinsic and extrinsic semiconductor, doping, formation of P/N type material, semiconductor diodes, forward and reverse characteristics of diode, types of diodes, equivalent circuits of diodes, diode as a switch, special purpose diodes, applications of diodes, half wave and full wave rectifiers, clipper and clamper circuits, voltage multipliers

II. Bipolar Junction Transistors

- Bipolar Junction Transistor (BJT), transistor operation, types of transistor, transistor biasing configurations, DC and AC analysis of BJT, transistor as a switch and an amplifier

III. Field Effect Transistors

- Field Effect Transistor (FET), FET biasing and configuration techniques, DC and AC analysis of FET and its applications as a switch and amplifier, MOSFET

Lab Outline

The emphasis is first on understanding the characteristics of diodes and transistors. Based on this understanding students are required to construct more complex circuits such as rectifier circuits and power supplies.

- Diode: Data sheet reading, analyzing diode characteristics on a curve tracer, finding a defective diode among a batch of non-defective diodes, various kinds of diode and their uses, and drawing of symbols.
- Transistor: Determining type (N and P) of an unknown bipolar transistor, labeling leads of an unknown transistor, analyzing transistor characteristics on a curve tracer, finding a defective transistor among a batch of non-defective transistors, various kinds of transistors and their uses, and drawing of symbols.
- Simulation of Basic Electronic Circuits using PSpice/Multisim

Recommended Books

1. Electronic Devices and Circuit Theory - Robert L. Boylestad, Louis Nashelsky
   (Latest Edition "10th", ISBN-10: 0135026490 or ISBN-13: 978-0135026496)

2. Introductory Electronic Devices and Circuits: Electron Flow Version - Robert T. Paynter
   (Latest Edition "7th", ISBN-10: 0131716395 or ISBN-13: 978-0131716391)

3. A Practical Book on Basic Electronics - Qurban A. Memon, Irfan A. Halepoto
   (Latest Edition "1st", ISBN-10: 9698680144)

4. The First Practical Book on Electronic Workshop - B. S. Chowdhry and Ahsan Ursani
   (Latest Edition "1st", ISBN-10: 9698680039)

Reference Material

1. Microelectronic Circuits - Adel S. Sedra, Kenneth C. Smith
   (Latest Edition "6th", ISBN-10: 0195323033 or ISBN-13: 978-0195323030)

2. Microelectronic Circuit Design - Richard C. Jaeger, Travis Blalock
   (Latest Edition "5th", ISBN-10: 0073529605 or ISBN-13: 978-0073529608)

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Circuit Analysis

Pre-requisites	Applied Physics
Co-requisite	Nil
Course Code	EL102
Semester	2nd
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The subject aims to give adequate knowledge and clear understanding about the concepts of basic electrical engineering and tools to analyze electric circuits.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 25: TH: CLOs, Mapping of CLOs to PLOs of Circuit Analysis

CLOs	Description	Taxonomy	PLOs
1	Explain AC/DC based electrical circuits as well as the related theorems to help solve and draw the equivalent circuits.	C2	2
2	Differentiate between steady state/transient analysis of circuits along with different forms of sinusoidal / exponential excitations and their responses.	C2	3

Table 26: PR: CLOs, Mapping of CLOs to PLOs of Circuit Analysis

CLOs	Description	Taxonomy	PLOs
3	Perform experiments in laboratory to validate the laws and theories of circuit analysis.	P4	9

Table 27: Tentative Assessment Methods of CLOs of Circuit Analysis

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1.1	[Quiz-40%]	[Q1-40%]	[Q1-20%]			C2	2
2.1	[Quiz-40%]	[Q2-20%]	[Q1-40%]			C2	3
1.1p	[Quiz-40%]			[ViVa-30%] [Test-30%]		P4	9

Contents

I. Introduction

- Review of KVL, KCL, nodal and loop analysis, serial/parallel connections of two terminal circuit elements

II. Elementary Transient Analysis

- Differential and Integral forms of circuit equations, initial voltage on a capacitor, initial current in an inductor, first-order circuits, solution of single first order differential equations, homogeneous, particular and total solutions, exponential responses, second-order circuits.

III. Sinusoidal Steady-State Analysis

- Network response to sinusoidal driving functions, complex impedance and admittance functions, development of concept of phasor, power consideration, complex power, maximum power transfer, circuits, series and parallel RLC circuits, quality factor.

IV. Network Theorems

- Linear and non-linear networks, superposition theorem, reciprocity theorem, maximum power transfer theorem, equivalent networks, thevenin's theorem, thevenin's equivalent network, norton's theorem, norton's equivalent networks, T-equivalent networks.

Lab Outline

Learn the use of basic instruments in electrical engineering such as function generators, power supplies, oscilloscopes. Design and implement circuits using R, RL, RC, RLC combination and observe resonance and impedance characteristics. Verify node voltage and current in RLC circuits as well as circuit theorems using laboratory instruments. Circuit transformation should also be verified using laboratory instruments. Related concepts are established through simulation tools such as PSPICE, Multisim etc.

Recommended Books

1. Basic Circuit Theory - Charles A. Desoer, Ernest S. Kuh
   (Latest Edition "1st", ISBN-10: 0070851832 or ISBN-13: 978-0070851832)

2. Basic Electrical Engineering - Arthur Eugene Fitzgerald, David E. Higginbotham, Arvin Grabel
   (Latest Edition "5th", ISBN-10: 007021154X or ISBN-13: 978-0070211544)

3. Schaum's Outline of Electric Circuits - Mahmood Nahvi, Joseph Edminister
   (Latest Edition "6th", ISBN-10: 0071830456 or ISBN-13: 978-0071830454)

4. Fundamentals of Electric Circuits - Matthew Sadiku, Charles Alexander
   (Latest Edition "5th", ISBN-10: 0073380571 or ISBN-13: 978-0073380575)

5. Basic Engineering Circuit Analysis - J. David Irwin, R. Mark Nelms
   (Latest Edition "9th", ISBN-10: 0470128690 or ISBN-13: 978-0470128695)

6. Electric Circuits - James W. Nilsson, Susan Riedel
   (Latest Edition "9th", ISBN-10: 0136114997 or ISBN-13: 978-0136114994)

7. The Analysis and Design of Linear Circuits - Roland E. Thomas, Albert J. Rosa, Gregory J. Toussaint
   (Latest Edition "7th", ISBN-10: 1118065581 or ISBN-13: 978-1118065587)

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MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO
DEPARTMENT OF TELECOMMUNICATION ENGINEERING

Introduction to Simulation Tools

Pre-requisites	Introduction to Programming
Co-requisite	Nil
Course Code	TL112
Semester	2nd
Effective	16TL batch and onwards
Theory Marks	0
Practical Marks	50
Credit Hours	0 + 1
Minimum Contact Hours	0 + 45
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The subject aims to provide an introduction to the basic concepts and techniques used in system simulation using various simulation tools.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 28: PR: CLOs, Mapping of CLOs to PLOs of Introduction to Simulation

CLOs	Description	Taxonomy	PLOs
1	Perform a task to solve the problem statement and execute programs in programming language.	P4	5
2	Respond to the questions regarding simulation tool and practices.	A2	8

Table 29: Tentative Assessment Methods of CLOs of Introduction to Simulation

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]			[Test-30%]	[Q1-30%]	P4	5
2				[ViVa-100%]		A2	8

Lab Outline

I. Introduction to Simulation

- What is simulation, objectives of simulation, advantages and disadvantages of simulation, areas of application, steps in a simulation study
- Terminologies
    - state variable, entities, attributes, activity, event, endogenous, exogenous, continuous-time and discrete-time model, continuous-state and discrete-state models, deterministic and probabilistic models, static and dynamic models, linear and nonlinear models, open and closed models, stable and unstable models
- Common mistakes in simulations
    - Inappropriate level of detail, improper language, unverified model, invalid model, improperly handled initial condition, too short simulations, poor random-number generator, improper selection of seed
- Types of Simulation
    - Monte-Carlo simulation, Trace-Driven simulation, Discrete-Event Simulation

II. Simulation Tools

- Introduction and familiarization of Matlab/Simulink environment

- - Loops, functions, plotting, and array manipulation using Matlab
  - - Basic mathematical, circuit analysis, and related examples using Simulink
- - Introduction and familiarization of GNU Octave environment
  - - Basic mathematical operation and plotting using GNU Octave
- - Installation and familiarization of OrCAD EE (PSpice) Designer environment
  - - Design of simple circuits and their analysis using PSpice
- - Installation and familiarization of Quite Universal Circuit Simulator (Qucs)
  - - Design of simple circuits and their analysis using Qucs
- - Installation and familiarization of OMNeT++/NS-3
  - - Demonstration of simple example using OMNeT++/NS-3
- - Installation and familiarization of Riverbed Modeler Academic Edition
  - - Demonstration of simple example using Riverbed Modeler Academic Edition

Laboratory Resources

1. MATLAB and Simulink - http://www.mathworks.com/
2. GNU Octave - http://www.gnu.org/software/octave/
3. OrCAD PSpice Designer - http://www.orcad.com/products/orcad-pspice-designer/overview
4. Quite Universal Circuit Simulator (Qucs) - http://qucs.sourceforge.net/
5. OMNeT++ Discrete Event Simulator - https://omnetpp.org/
6. NS-3 - https://www.nsnam.org/
7. OPNET/Riverbed Modeler - http://www.riverbed.com/
8. NI Multisim - http://www.ni.com/multisim/
9. NI LabVIEW - http://www.ni.com/labview/

Recommended Textbooks

1. Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice - Jerry Banks
   (1st Edition, ISBN-10: 0471134031 or ISBN-13: 978-0471134039)

2. The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling - Raj Jain
   (1st Edition, ISBN-10: 0471503363 or ISBN-13: 978-0471503361)

3. Introduction to Matlab 7 for Engineers - William J. Palm III, William Palm
   (2nd Edition, ISBN-10: 0072922427 or ISBN-13: 978-0072922424)

4. Matlab: A Practical Introduction to Programming and Problem Solving - Stormy Attaway
   (3rd Edition, ISBN-10: 0124058760 or ISBN-13: 978-0124058767)

5. A Concise Introduction to Matlab - William Palm III
   (1st Edition, ISBN-10: 0073385832 or ISBN-13: 978-0073385839)

6. Spice: A Guide to Circuit Simulation and Analysis using PSPICE - Paul W. Tuinenga
   (3rd Edition, ISBN-10: 0134360494 or ISBN-13: 978-0134360492)

7. The SPICE Book - Andrei Vladimirescu
   (1st Edition, ISBN-10: 0471609269 or ISBN-13: 978-0471609261)

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	Academic Council	Res. No. 12	Dated: 17-10-2017

Differential Equations and Fourier Series

Pre-requisites	Linear Algebra and Analytical Geometry
Co-requisite	Nil
Course Code	MTH212
Semester	3rd
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To give an idea about the formation, solution and the physical application of ordinary and partial differential equations as well as the concept of fourier series.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 30: TH: CLOs, Mapping of CLOs to PLOs of Differential Equations and Fourier Series

CLOs	Description	Taxonomy	PLOs
1	Determine the formation and the solution methods of first order linear and non-linear differential equation.	C3	1
2	Compute higher order linear and partial differential equations.	C3	1
3	Apply fourier series of various functions.	C3	1

Table 31: Tentative Assessment Methods of CLOs of Differential Equations and Fourier Series

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-70%]	[Q1-10%]	C3	1
2	[Quiz-20%]	[Q2-40%]	[Q2-40%]	C3	1
3	[Quiz-20%]		[Q3-80%]	C3	1

Contents

I. First Order Linear and Non-Linear Differential Equations

- Introduction, formation and solution of first order, first degree differential equations.

II. Higher Order Linear Differential Equations

- Homogeneous linear equations of order n with constants coefficients, solutions of higher order differential equations according to the roots of auxiliary equation, non-homogeneous linear equations, cauchy euler equation, method of variations of parameters, applications of higher order linear differential equations.

III. Introduction to Partial Differential Equations

- Solution of laplace equation, wave equation and equation by variable separable method, heat equation (simple case)

IV. Fourier series

- Fourier coefficients, convergence of fourier series, fourier series of odd and even functions

Recommended Books

1. Introductory Course in Differential Equations for Students in Classical and Engineering Colleges - Daniel Alexander Murray
   (Latest Edition "1st", ISBN-10: 1418181536 or ISBN-13: 978-1418181536)

2. Advanced Engineering Mathematics - H. K. Dass
   (Latest Edition "20th", ISBN-10: 8121903459 or ISBN-13: 978-8121903455)

3. Higher Engineering Mathematics - B. S. Grewal
   (Latest Edition "40th", ISBN-10: 8174091157 or ISBN-13: 978-8174091154)

4. Mathematical Methods - S. M. Yousuf, Abdul Majeed, Muhammad Amin
   (Latest Edition "2nd")

5. Ordinary Differential Equations with Numerical Techniques - John L. Van Iwaarden
   (Latest Edition "1st", ISBN-10: 0155675508 or ISBN-13: 978-0155675506)

6. Advanced Engineering Mathematics - Erwin Kreyszig
   (Latest Edition "8th", ISBN-10: 0471154962 or ISBN-13: 978-0471154969)

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Digital Logic and Design

Pre-requisites	None
Co-requisite	Nil
Course Code	ES215
Semester	3rd
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

This course is a comprehensive study of the principles and techniques of modern digital systems and is the foundation of computer and microprocessor based systems found in auto-mobiles, industrial control system. The course will enable students to develop exciting designs that they have always wondered about, but now can experience first-hand.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 32: TH: CLOs, Mapping of CLOs to PLOs of Digital Logic Design

CLOs	Description	Taxonomy	PLOs
1	Explain the elements of digital system abstractions such as digital representations of information, digital logic, boolean algebra.	C2	1
2	Apply different methods to simplify combinational logic functions and sequential machines.	C3	1
3	Analyze and design combinational and synchronous sequential circuits.	C4	2

Table 33: PR: CLOs, Mapping of CLOs to PLOs of Digital Logic Design

CLOs	Description	Taxonomy	PLOs
4	Reproduce combinational and sequential logic circuits and develop lab project using development kits, integrated circuits and simulation platforms.	P3	3

Table 34: Tentative Assessment Methods of CLOs of Digital Logic Design

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-50%]	[Q1-50%]				C2	1
2	[Quiz-25%]	[Q2-25%]	[Q1-50%]			C3	1
3			[Q2-100%]			C4	2
4	[Quiz-30%]		[Q3-30%]	[ViVa-15%] [Test-15%]	10%	P3	3

Contents

  I. Number Systems

     - Review of number systems, binary numbers, hexadecimal numbers, octal numbers, decimal to binary and binary to decimal number conversion, hexadecimal to binary and binary to hexadecimal conversion,

binary coded decimal numbers, grey code, binary to grey and grey to binary number conversion, parity in codes.

II. Boolean Algebra and Boolean Operations

- Review of digital electronics, logic, events and binary variables, introduction to fundamental boolean operations, NOT, OR, AND operation and truth tables, other boolean operations as XOR, NOR, NAND, XNOR, truth tables, boolean algebra, boolean expressions, boolean rules, demorgan's theorems, two's complement of a binary number.

III. Logic Gates

- Introduction to digital logic gates, symbols of logic gates, positive logic, negative logic, implementing simple Boolean expressions with logic gates, concept of universal gate, NAND gate as a universal gate, NOR gate as a universal gate.

IV. Expression Simplification

- Reducing an expression using boolean rules, introduction to Karnaugh map, reducing an expression using Karnaugh-map, implementing logic circuits using universal gate, deriving SOP and POS expressions directly from K-map, few examples with K-map, hazzard free design.

V. Combinational Logic Circuits

- Few examples of combinational logic circuits including half adder, full adder, parallel adder, parallel adder subtractor, deriving sum-of-products (SOP) and product-of-sums (POS) expressions from a truth table, logic comparators, encoders, decoders, multiplexers, de-multiplexers

VI. Introduction to Sequential Circuits

- Flip-flop (RS, JK, D, T, Master-Slave), registers, shift registers, counters

VII. Introduction to Sequential Machines

- Classification of sequential machines, concept of pulse and level digital signal, understanding word statement and its key words, state diagram, state table, flow table.

VIII. Transition Tables

- Assigning states to the state table of a pulse input machine, assigning states to the state table of a level input synchronous machine, assigning states to a level input asynchronous machine, races in an asynchronous level machine, introducing cycles to eliminate races, obtaining transition table for pulse input machine, synchronous level input machine.

Lab Outline

Basic logic gates; simulation and hardware implementation of combinational circuits such as MUX/DeMUX, encoder/decoder; simulation and hardware implementation of sequential circuits such as flip-flops, registers, shift registers, counters; project solving a real-life problem.

Recommended Books

1. Digital Electronics: Principles and Applications - Roger L. Tokheim
   (Latest Edition "7th", ISBN-10: 0073126349 or ISBN-13: 978-0073126340)

2. Digital Fundamentals - Thomas L. Floyd
   (Latest Edition "11th", ISBN-10: 0132737965 or ISBN-13: 978-0132737968)

3. Digital Systems: Principles and Applications - Ronald J. Tocci, Neal Widmer, Greg Moss
   (Latest Edition "11th", ISBN-10: 0135103827 or ISBN-13: 978-0135103821)

4. Digital Design - M. Morris R. Mano, Michael D. Ciletti
   (Latest Edition "4th", ISBN-10: 0131989243 or ISBN-13: 978-0131989245)

5. Logic and Computer Design Fundamentals - M. Morris R. Mano, Charles R. Kime, Tom Martin
   (Latest Edition "5th", ISBN-10: 0133760634 or ISBN-13: 978-0133760637)

Reference Material

1. Digital Integrated Electronics - Herbert Taub, Donald L. Schilling
   (Latest Edition "1st", ISBN-10: 0070857881 or ISBN-13: 978-0070857889)

2. Digital Electronics: A Practical Approach - William Kleitz
   (Latest Edition "6th", ISBN-10: 0130896292 or ISBN-13: 978-0130896292)

3. Analog and Digital Circuit Design - Shahzad Mahmood
   (Latest Edition "1st", 2003)

4. Switching Circuits for Engineers (Electrical Engineering) - Mitchell P. Marcus
   (Latest Edition "3rd", ISBN-10: 0138799083 or ISBN-13: 978-0138799083)

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Amplifiers and Oscillators

Pre-requisites	Basic Electronics
Co-requisite	Nil
Course Code	ES205
Semester	3rd
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to develop skills required to design systems and circuits using analog techniques. More specifically, the course aims at the design of amplifier and oscillator circuits used in communication systems as well as in depth understanding of various related parameters such as impedance, stability, gain, noise, bandwidth. The course will also acquaint students with the working mechanism of operational amplifier and its applications.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 35: TH: CLOs, Mapping of CLOs to PLOs of Amplifiers and Oscillators

CLOs	Description	Taxonomy	PLOs
1	Analyze the small and large signal analysis at low, mid and high frequencies.	C4	2
2	Categorize small and large signal amplifier networks.	C4	4
3	Design of analog filters, oscillators and voltage regulators using operational amplifiers.	C5	3

Table 36: PR: CLOs, Mapping of CLOs to PLOs of Amplifiers and Oscillators

CLOs	Description	Taxonomy	PLOs
4	Assemble laboratory projects in a team and ability to conduct experiments related to different applications of operational amplifiers.	P4	9
5	Respond to the questions regarding amplifier and oscillators.	A2	8

Table 37: Tentative Assessment Methods of CLOs of Amplifiers and Oscillators

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-30%]	[Q1-60%]	[Q1-10%]			C4	2
2	[Quiz-40%]	[Q2-20%]	[Q1-40%]			C4	4
3	[Quiz-30%]		[Q2-70%]			C5	3
4	[Quiz-40%]			[Test-30%]	[Q1-30%]	P4	9
5				[ViVa-100%]		A2	8

Contents

I. Amplifier Fundamentals

- Gain calculation – system analysis, single stage BJT and FET amplifier, frequency response.

II. Practical Amplifier Considerations

- Input and output impedance, real and apparent gain, amplifier loading, impedance matching of amplifiers.

III. Power Amplifiers

- Classes of power amplifiers, series-fed class A amplifiers, power efficiency and dissipation, harmonic distortion, single-ended class A amplifiers, transformer-coupled push-pull amplifiers, other push-pull amplifiers, complementary symmetry amplifiers.

IV. Tuned Amplifiers

- Single tuned amplifiers, coupling of tuned amplifiers, double tuned amplifiers, stagger tuned amplifiers.

V. Feedback Amplifiers

- General feedback concepts, voltage feedback amplifiers, current feedback amplifiers, effect of feedback on frequency response, series and shunt feedback amplifiers, effect of feedback on non-linear distortion and noise.

VI. Transistor Amplifier at High Frequency

- Design and analysis of high frequency amplifiers using S-plane technique.

VII. Multi-Stage Transistor Amplifier

- The multi-stage amplifier at mid-frequencies, approximation for low and high frequencies.

VIII. Operational Amplifiers

- Basics, mathematical operations, practical considerations, differentiators and integrators, single supply biasing and norton amplifiers, analysis of op-amp action, op-amp specifications: interpreting op-amp data sheet, offset voltage and current, temperature rating, output swing, CMRR, slew rate.
- Precision rectifiers, peak detectors, comparators, clampers, sample and hold circuit, digital-to-analog and analog-to-digital converters.

IX. Oscillators

- Hartley oscillators, colpitt oscillators, RC phase shift oscillators, wein-bridge oscillators, crystal oscillators based on BJT and FET.

Lab Outline

Transistor curve tracer, AC voltage dividers, characterization and design of emitter and source followers, characterization and design of AC variable-gain amplifier, design of test circuits for BJTs and FETs, design of FET ring oscillators, design and characterization of emitter-coupled transistor pairs, tuned amplifier and oscillator, design of oscillators, integraterd timers.

Recommended Books

1. Basic Electronics: Devices, Circuits, and Systems - Michael M. Cirovic
   (Latest Edition "2nd", ISBN-10: 0835903702 or ISBN-13: 978-0835903707)

2. Electronic Circuit Analysis and Design - William H. Hayt, Gerold W. Neudeck
   (Latest Edition "2nd", ISBN-10: 0471125016 or ISBN-13: 978-0471125013)

3. Electronics Fundamentals: Circuits, Devices and Applications - Thomas L. Floyd, David M. Buchla
   (Latest Edition "8th", ISBN-10: 0135072956 or ISBN-13: 978-0135072950)

4. Basic Operational Amplifiers and Linear Integrated Circuits - Thomas L. Floyd, David M. Buchla
   (Latest Edition "2nd", ISBN-10: 0130829870 or ISBN-13: 978-0130829870)

5. Microelectronic Circuit Design - Richard Jaeger, Travis Blalock
   (Latest Edition "4th", ISBN-10: 0073380458 or ISBN-13: 978-0073380452)

Reference Material

1. Electronic Principles: Physics, Models and Circuits - Paul E. Gray, Campbell L. Searle
   (Latest Edition "1st", ISBN-10: 0471323985 or ISBN-13: 978-0471323983)

2. Introductory Electronic Devices and Circuits: Electron Flow Version - Robert T. Paynter
   (Latest Edition "7th", ISBN-10: 0131716395 or ISBN-13: 978-0131716391)

3. Operational Amplifiers - George Clayton, Steve Winder
   (Latest Edition "4th", ISBN-10: 0750646438 or ISBN-13: 978-0750646437)

4. Electronic Devices (Conventional Current Version) - Thomas L. Floyd
   (Latest Edition "9th", ISBN-10: 0132549867 or ISBN-13: 978-0132549868)

5. Microelectronic Circuits - Adel S. Sedra, Kenneth C. Smith
   (Latest Edition "7th", ISBN-10: 0199339139 or ISBN-13: 978-0199339136)

6. Burr-Brown IC Data Book - 1994 - Data Conversion Products - Burr-Brown Corp (Latest Edition "1st")

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Communication Skills

Pre-requisites	Functional English
Co-requisite	Nil
Course Code	ENG201
Semester	3rd
Effective	13TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To make students proficient in using four skills of language and use different components of communication.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 38: TH: CLOs, Mapping of CLOs to PLOs of Communication Skills

CLOs	Description	Taxonomy	PLOs
1	Compose varied texts including formal letters, CV, cover letter for jobs, and technical reports using mechanisms of academic writing integrated with paraphrasing and summarizing techniques.	C5	10
2	Interpret and infer the texts critically and apply the knowledge in real life situations by participating in public speaking acts and group discussions.	C2	9

Table 39: Tentative Assessment Methods of CLOs of Communication Skills

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-60%]	[Q1-20%]	C5	10
2	[Quiz-20%]	[Q2-60%]	[Q2-20%]	C2	9

Contents

    I. Introduction to communication skills

       - Communication principles, the process of communication, importance of good communication skills in business environment, communication in business organizations (internal-operational, external-operational, personal, challenge of communication in the global market).

    II. Study skills

       - Brain storming, time-management, effective reading strategies, note-taking, organization, summarizing.

    III. Components of communication

       - Context, sender-encoder, message, medium, receiver-decoder, feedback.

    IV. Non-verbal communication

       - Appearance and dress codes, body language-silence-time-space, importance of listening in communication

    V. Functional english

- Defining factors in everyday communication (in business organization, in social exchanges), role-play/speaking activities.

VI. Public speaking

- Difference between speaking and writing, reading texts of good public speeches and analysis of their components, listening to famous public speeches, exercises in public speaking

VII. Formal presentations

- Difference between informal and formal presentations, modes of formal presentations (extemporaneous, prepared, reading out from a written text, combination of the above mentioned), purpose of oral presentations (entertain, persuade, inform, sell), mechanics of presentations (organization, preparation including avas, rehearse, present), teacher shall model presentations both, with and without avas.

VIII. Correctness of written communication

- Punctuation, grammar: some basic principles, error correcting exercises.

IX. Written communication

- Systematic approach to effective written communication (language, style, tone, organization), practice of written communication for a variety of situations.

Recommended Books

1. Effective Business Communications - Herta A. Murphy, Herbert W. Hildebrandt, Jane P. Thomas (7th Edition, ISBN-10: 007044398X or ISBN-13: 978-0070443983)

2. Ultimate Cover Letters - Martin John Yate (3rd Edition, ISBN-10: 0749464054 or ISBN-13: 978-0749464059)

3. The Ultimate Job Search Letters Book: Write a Perfect Letter and Get That Job - Martin John Yate (1st Edition, ISBN-10: 0749440694 or ISBN-13: 978-0749440695)

4. Career Roadmap Guide for Engineers (A One Stop Solution for All Engineering Professionals) - Junaid Shaikh (1st Edition, ISBN-13: 978-9699526008)

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Engineering Management

Pre-requisites	Nil
Co-requisite	Nil
Course Code	IN202
Semester	3rd
Effective	13TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To provide wide knowledge and understanding of economic analysis to the engineering students and to make them able to learn management techniques and principles which are utmost important for engineering fields.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 40: TH: CLOs, Mapping of CLOs to PLOs of Engineering Management

CLOs	Description	Taxonomy	PLOs
1	Explain the basic principles and fundamentals of managing technical organizations.	C2	8
2	Apply appropriate management techniques for managing contemporary organizations.	C3	6
3	Correlate the skills, abilities, and tools needed to obtain a job on a management track in an organization of their choice.	C4	7

Table 41: Tentative Assessment Methods of CLOs of Engineering Management

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-60%]	[Q1-20%]	C2	8
2	[Quiz-20%]	[Q2-40%]	[Q2-40%]	C3	6
3	[Quiz-20%]		[Q3-80%]	C4	7

Contents

I. Overview of Engineering Management

- Introduction to engineering management, management and its characteristics.

II. Project Management

- Defining project management, its objectives and basic functions, project identification, project life cycle and project stakeholders, managerial levels, roles and skills, effective goal setting, management by objectives.

III. Introduction to Planning and Scheduling

- Types and tools for planning, WBS, examples and class exercise, activity on node (AON), critical path method (CPM), examples and class exercise, introduction to precedence diagram method (PDM), PDM relationships (SS, FS, FF, SF), examples and class exercise, crashing network techniques, program evaluation and review techniques (PERT), examples and class exercise.

IV. Introduction to Engineering Economics

- Time value of money, simple and compound interest, cash flow diagrams, discounting, depreciation and break even analysis, methods of economic comparisons for project selection, comparisons of assets and internal rate of return benefit/cost analysis and cost effectiveness analysis

V. Introduction to the Management of Human Resource and its Foundation

- Evolution of management thought in changing environment, management ethical and social responsibilities, risk management, strategic human resources planning, recruitment, selection, orientation, training and development, career development, motivation, leadership, reward and compensation, discipline and counseling, benefits, health, communication programs, labour relations, collective bargaining.

Recommended Books

1. Human Resource Management - Leon C. Megginson, Geralyn McClure Franklin, M. Jane Byrd (Latest Edition "1st", ISBN-10: 087393377X or ISBN-13: 978-0873933773)

2. Principles of Engineering Economy - Eugene L. Grant, W. Grant Ireson, Richard S. Leavenworth (Latest Edition "8th", ISBN-10: 047163526X or ISBN-13: 978-0471635260)

Approval:	Board of Studies	Res. No. 9.4.1	Dated: 05-06-2013
	Board of Faculty of EEC Engineering	Res. No. 6.15	Dated: 16-07-2013
	Academic Council	Res. No. 81.20	Dated: 31-07-2013

Complex Variables and Transforms

Pre-requisites	Differential Equations and Fourier Series
Co-requisite	Nil
Course Code	MTH213
Semester	4th
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To introduce the concept of complex numbers, complex variables, laplace transforms and fourier transforms.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 42: TH: CLOs, Mapping of CLOs to PLOs of Complex Variables and Transforms

CLOs	Description	Taxonomy	PLOs
1	Compute complex number and complex variables, complex differentiation and integration.	C3	1
2	Apply transformations, laplace and fourier to their geometrical and physical applications.	C3	1
3	Analyse fourier transforms for the solution of the differential equations.	C4	1

Table 43: Tentative Assessment Methods of CLOs of Complex Variables and Transforms

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-70%]	[Q1-10%]	C3	1
2	[Quiz-20%]	[Q2-40%]	[Q2-40%]	C3	1
3	[Quiz-20%]		[Q2-80%]	C4	1

Contents

I. Complex Numbers System and Complex Variable Theory

- Introduction to complex number systems, De moiver's theorem and its applications, complex functions, cauchy-riemann equations (in cartesian and polar coordinates), complex integration, singularities, poles, residues and contour integration and applications.

II. Laplace Transform

- Laplace and inverse laplace transform of elementary functions and their properties, applications of laplace transformation in various fields of engineering.

III. Fourier Transform

- Fourier transform and inverse fourier transforms, solution of differential equations using fourier transform.

Recommended Books

1. Advanced Engineering Mathematics - H. K. Dass
   (Latest Edition "20th", ISBN-10: 8121903459 or ISBN-13: 978-8121903455)

2. Higher Engineering Mathematics - B. S. Grewal
   (Latest Edition "40th", ISBN-10: 8174091157 or ISBN-13: 978-8174091154)

3. Advanced Engineering Mathematics - Erwin Kreyszig
   (Latest Edition "8th", ISBN-10: 0471154962 or ISBN-13: 978-0471154969)

4. Schaum's Outlines: Laplace Transforms - Murray R. Spiegel
   (Latest Edition "1st", ISBN-10: 007060231X or ISBN-13: 978-0070602311)

5. Schaum's Outlines: Complex Variables - Murray R. Spiegel
   (Latest Edition "1st", ISBN-10: 0070602301 or ISBN-13: 978-0070602304)

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Microprocessors and Microcontrollers

Pre-requisites	Digital Logic Design
Co-requisite	Nil
Course Code	ES256
Semester	4th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to teach the architecture, programming, interfacing, and applications of microprocessors and microcontrollers.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 44: TH: CLOs, Mapping of CLOs to PLOs of Microprocessors and Microcontrollers

CLOs	Description	Taxonomy	PLOs
1	Explain microprocessor micro-controller architecture, its internal registers, addressing modes and instruction set.	C2	1
2	Analyze micro-controller memories internal blocks peripherals, ADC, interrupts, timers, serial protocols (RS232, SPI, I2C) etc to program both in assembly and high level language (C++/Python)	C4	2
3	Design a small micro-controller based system prototype for a particular situation or specific needs.	C5	3

Table 45: PR: CLOs, Mapping of CLOs to PLOs of of Microprocessors and Micro-controllers

CLOs	Description	Taxonomy	PLOs
4	Explain the practical aspects of Microprocessors and Micro-controllers.	C2	4
5	Perform experiments in laboratory using development kits, Ics and simulation software individually in a team.	P4	11
6	Respond to the questions related to Micro-processors and Micro-controllers.	A2	10

Table 46: Tentative Assessment Methods of CLOs of Micro-processors and Micro-controllers

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-60%]				C2	1
2	[Quiz-40%]	[Q2-20%]	[Q1-40%]			C4	2
3	[Quiz-40%]	[Q3-60%]				C3	3
4	[Quiz-40%]			[Quiz-40%]	[Q1-20%]	C2	4
5	[Quiz-40%]			[Test-30%]	[Q1-30%]	P4	11
6				[ViVa-100%]		A2	10

Contents

I. Introduction to basic microprocessors, difference between microprocessors & micro-controllers, instruction set architecture (ISA), programming techniques, hardware model, read/write cycles, exception/interrupt processing, memory systems, I/O devices, DMA, interfacing to memory and I/O devices.

II. Introduction to micro-controllers (PIC/AVR/Arduino/Raspberry Pi), application, basic core architecture, pin configuration, Application, Basic Core Architecture, and Pin Configuration, micro-controller instruction set and programming, Handling of Timers, Counter, ADC, Interrupts, Introduction to communication protocols (like RS232, SPI, I2C).

Lab Outline

Study of microprocessor ISA using its training boards, implementation of interfacing techniques (using gates, decoders, and SPLDs) to memory system and different I/O devices, learning and implementation of interrupt driven I/O, learning and implementation of simple micro-controller based circuits and semester mini projects (interfacing of sensors, LCD, keypad, stepper motor).

Recommended Books

1. The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4 and Core2 with 64 bit Extensions - Barry B. Brey
(Latest Edition "8th", ISBN-10: 8131795411 or ISBN-13: 978-8131795415)

2. Microprocessors and Interfacing: Programming and Hardware - Douglas V. Hall
(Latest Edition "2nd", ISBN-10: 0070257426 or ISBN-13: 978-0070257429)

3. PIC Micro-controller: An Introduction to Software and Hardware Interfacing - Han-Way Huang, Leo Chartrand
(Latest Edition "1st", ISBN-10: 1401839673 or ISBN-13: 978-1401839673)

4. Schaum's Outline of Theory and Problems of Microprocessor Fundamentals - Roger L. Tokheim
(Latest Edition "2nd", ISBN-10: 0070649995 or ISBN-13: 978-0070649996)

5. Microprocessors: Principles and Applications - Charles M. Gilmore
(Latest Edition "2nd", ISBN-10: 0028018370 or ISBN-13: 978-0028018379)

Reference Material

1. The 8051 Micro-controller and Embedded Systems - Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay
(Latest Edition "2nd", ISBN-10: 013119402X or ISBN-13: 978-0131194021)

2. AVR Micro-controller and Embedded Systems: Using Assembly and C - Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi
(Latest Edition "1st", ISBN-10: 0138003319 or ISBN-13: 978-0138003319)

3. Embedded Systems: Introduction to Arm Cortex-M Micro-controllers - Jonathan W. Valvano
(Latest Edition "5th", ISBN-10: 1477508996 or ISBN-13: 978-1477508992)

4. Embedded Systems: Real-Time Interfacing to Arm Cortex-M Micro-controllers - Jonathan W. Valvano
(Latest Edition "2nd", ISBN-10: 1463590156 or ISBN-13: 978-1463590154)

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Signals and Systems

Pre-requisites	
Co-requisite	Complex Variables and Transforms
Course Code	TL231
Semester	4th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to introduce the theoretical and practical basis for signals and systems analysis and give students skills in using the techniques to design components for telecommunication systems.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 47: TH: CLOs, Mapping of CLOs to PLOs of Signals and Systems

CLOs	Description	Taxonomy	PLOs
1	Interpret signal types and signal representation, signal operations in time and frequency domains.	C2	1
2	Analyze the performance of continuous and discrete signals and their system modeling.	C4	2
3	Demonstrate the system modeling and interpret stability criteria.	C3	4
4	Design continuous time analog filters.	C5	3

Table 48: PR: CLOs, Mapping of CLOs to PLOs of Signals and Systems

CLOs	Description	Taxonomy	PLOs
5	Apply various operations on signals and observe their characteristics.	C3	3
6	Perform basic operations on signals.	P4	6
7	Organize and manage tasks for the project team, respond to the questions related to signal processing.	A4	9

Table 49: Tentative Assessment Methods of CLOs of Signals and Systems

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-60%]				C2	1
2	[Quiz-20%]	[Q2-40%]	[Q1-40%]			C4	2
3	[Quiz-20%]		[Q2-80%]			C3	4
4	[Quiz-30%]		[Q3-70%]			C5	3
5	[Quiz-100%]					C3	3
6	[Quiz-40%]			[Test-30%]	[Q1-30%]	P4	6
7				[ViVa-100%]		A4	9

Contents

I. Introduction

- Classification of signals, basic operations on signals, signal representation and models, system characteristics, signal calculus, power representations signals, linear time-invariant (LTI) systems, zero-state and zero-input responses, characterization of systems using system equations and impulse response, system order, properties of LTI systems, causality and stability.

II. Time Domain Analysis

- Sinusoidal and complex exponential signals, singularity function signals, signal energy and signal power, orthogonal signals, signal representation by generalized fourier series, convolution evaluation and properties.

III. System Representation in Laplace Domain

- Review of laplace transform, pole-zero plots, system, stability, S-domain transfer function, obtaining transfer function from the system equation.

IV. Frequency Domain Representation and Analysis of Signals and Systems

- Spectra and bandwidth of signals, review of fourier series and fourier transform for representation of signals, standard signals in the frequency domain, energy density spectrum, power density spectrum, auto-correlation function, system frequency response, phase delay and group delay.

V. Continuous-Time Filters

- Filter response terminology, N^{th} order filter functions (low pass, high pass, band pass, notch, and all pass), examples of passive filter circuits (low pass, high pass, band pass notch, and all-pass), frequency transformation
- Ideals filters: introduction and background
- Analog filter designs: butterworth, chebyshev I and II, elliptic

VI. Sampled Continuous - Time Signals and Systems

- Ideal sampling, sampling theorem, practical sampling effects, discrete-time signals as vectors, DT-systems as linear transformation of these vectors, constant coefficient difference equations, solving difference equations, determining unit pulse response.

Lab Outline

The laboratory experiments will cover simulations of continuous-time/discrete-time signals, linear time-invariant systems, fourier series and fourier transform, effects of changing the time period of periodic signals, sampling, digital filters and convolution of signals. Hardware based experiments using spectrum analyzer and network analyzer.

Recommended Books

1. Signal and Linear System Analysis - Gordon E. Carlson
   (Latest Edition "2nd", ISBN-10: 0471124656 or ISBN-13: 978-0471124658)

2. Signals and Systems - Simon Haykin, Barry Van Veen
   (Latest Edition "2nd", ISBN-10: 0471164747 or ISBN-13: 978-0471164746)

3. Signals and Systems - Alan V. Oppenheim, Alan S. Willsky, with S. Hamid Nawab
   (Latest Edition "2nd", ISBN-10: 0138147574 or ISBN-13: 978-0138147570)

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Electromagnetics

Pre-requisites	Applied Physics
Co-requisite	Nil
Course Code	TL202
Semester	4th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The course aims to introduce the basic concepts of electromagnetics and parameters necessary for the analysis and design of electromagnetic systems. Moreover, the course aims to acquaint students with basic analysis/techniques required when formulating and solving electromagnetic problems along with the technical foundation required for more advanced electromagnetics engineering courses.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 50: TH: CLOs, Mapping of CLOs to PLOs of Electromagnetics

CLOs	Description	Taxonomy	PLOs
1	Explain a given problem to identify 1D, 2D and 3D symmetries with their respective coordinate systems.	C2	1
2	Analyze electromagnetic field effects in different coordinate systems in order to find boundary conditions between different mediums.	C4	2
3	Analyze the electric and magnetic field strengths produced by static and moving charges in a variety of configurations.	C4	2

Table 51: Tentative Assessment Methods of CLOs of Electromagnetics

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
4	[Quiz-40%]	[Q1-60%]		C2	1
5	[Quiz-20%]	[Q2-40%]	[Q1-40%]	C4	2
6	[Quiz-40%]		[Q2-60%]	C4	2

Contents

I. Vector Analysis

- Basic laws of vector algebra, orthogonal coordinate systems, transformations between coordinate systems gradient of a scalar field, divergence of a vector field, curl of a vector field, laplacian operator

II. Maxwell's Equations

- Faraday's law, continuity equation, modified ampere's law and displacement current, maxwell's equations for free space and conducting medium, influence of medium on the field, electromagnetic wave equation in free space and general wave equation, polarization

III. Electrostatics

- charge and current distributions, coulomb's law, gauss's law, electric scalar potential, electrical properties of materials, conductors, dielectrics, electric boundary conditions, capacitance

IV. Magnetostatics

- Magnetic forces and torques, the biot-savart law, magnetic forces between two parallel conductors, maxwell's magnetostatic equations, vector magnetic potential, magnetic boundary conditions, and inductance.

V. Wave Reflection and Transmission

- Conductors and dielectrics, poynting theorem and flow of power, wave reflection and transmission at normal incidence, reflection/refraction of waves at the boundary of two charge-free medium, brief introduction to transmission lines and their applications.

Recommended Textbooks

1. Elements of Electromagnetics - Matthew N. O. Sadiku
   (Latest Edition "6th", ISBN-10: 0199321388 or ISBN-13: 978-0199321384)

2. Engineering Electromagnetics - William Hayt, John Buck
   (Latest Edition "8th", ISBN-10: 0073380660 or ISBN-13: 978-0073380667)

3. Basic Engineering Electromagnetics: An Applied Approach - Richard Coren
   (Latest Edition "1st", ISBN-10: 0130603694 or ISBN-13: 978-0130603692)

4. Electromagnetics - John Daniel Kraus, John D. Kraus
   (Latest Edition "4th", ISBN-10: 0070356211 or ISBN-13: 978-0070356214)

Reference Material

1. Electromagnetics for Engineers - Fawwaz T. Ulaby
   (Latest Edition "1st", ISBN-10: 0131497243 or ISBN-13: 978-0131497245)

2. Electromagnetic Waves and Radiating Systems - Edward Conrad Jordan, Keith George Balmain
   (Latest Edition "2nd", ISBN-10: 8120300548 or ISBN-13: 978-8120300545)

3. Electromagnetic Concepts and Applications - Richard E. Dubroff, S. V. Marshall, G. G. Skitek
   (Latest Edition "4th", ISBN-10: 0133011518 or ISBN-13: 978-0133011517)

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Professional Ethics

Pre-requisites	Nil
Co-requisite	Nil
Course Code	SS221
Semester	4th
Effective	13TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The course introduces contemporary ethical issues facing the professional community. Topics include moral reasoning, moral dilemmas, equity, justice and fairness, ethical standards, and moral development. Upon completion, students should be able to demonstrate an understanding of their moral responsibilities and obligations as members of the workforce and society.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 52: TH: CLOs, Mapping of CLOs to PLOs of Professional Ethics

CLOs	Description	Taxonomy	PLOs
1	Describe professional ethics, evolution of ethics, social responsibility from several dimensions as well as describe the major ethical perspectives.	C2	1
2	Apply ethical decision-making framework and understand how organization influences ethical decision-making.	C3	12
3	Design an effective ethics program.	C5	6

Table 53: Tentative Assessment Methods of CLOs of Professional Ethics

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-60%]	[Q1-20%]	C2	1
2	[Quiz-20%]	[Q2-50%]	[Q2-30%]	C3	12
3	[Quiz-20%]		[Q3-80%]	C5	6

Contents

I. An Overview of Professional Ethics

- Professional ethics defined, social responsibility and business ethics, development of business/professional ethics, framework for studying business ethics.

II. Ethical Issues in Business

- Foundation of ethical conflict, classifications of ethical issues, ethical issues related to participants and functional areas of business, recognizing an ethical issue.

III. Social Responsibility

- Economic dimension, legal dimension, ethical dimension and philanthropic dimension.

IV. Ethical Decision-Making Framework

- Ethical issue intensity, individual factors, stages of cognitive moral development, corporate culture, significant others, opportunity, business ethics evaluations and intensions, using the ethical decision-making framework to improve ethical decisions.

V. How the Organization Influences Ethical Decision-Making

- Organizational structure and business ethics, role of corporate culture in ethical decision-making, group dimension of organization structure and culture, implications of organizational relationship for ethical decisions.

VI. Development of an Effective Ethics Program

- An effective ethical compliance, program and codes of ethics and compliance standards, manager's responsibility, delegation of authority, effective communication of ethical standards, establishing system to monitor, audit and enforce ethical standards.

Recommended Books

1. Business Ethics: Ethical Decision Making and Cases - O. C. Ferrell, John Fraedrich, Linda Ferrell (Latest Edition "9th", ISBN-10: 1111825165 or ISBN-13: 978-1111825164)

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Antennas and Wave Propagation

Pre-requisites	Electromagnetics
Co-requisite	Nil
Course Code	TL304
Semester	5th
Effective	21TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	48 + 48
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to introduce the knowledge of electromagnetic waves propagation and antenna systems and their applications in engineering fields.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 54: TH: CLOs, Mapping of CLOs to PLOs of Antennas and Wave Propagation

CLOs	Description	Taxonomy	PLOs
1	Determine antenna parameters, basics elements and antenna analysis.	C3	4
2	Describe the wave propagation mechanisms, propagation losses and link budgeting.	C2	1
3	Examine a suitable class of antenna for given specifications.	C4	2
4	Design project based on Antennas.	C6	3

Table 55: PR: CLOs, Mapping of CLOs to PLOs of Antennas and Wave Propagation

CLOs	Description	Taxonomy	PLOs
5	Organize experiments on real components and devices and on numerical electromagnetic software ((HFSS and ADK).	P4	3

Table 56: Tentative Assessment Methods of CLOs of Antennas and Wave Propagation

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-60%]				C3	4
2	[Quiz-20%]	[Q2-40%]	[Q1-40%]			C2	1
3	[Quiz-20%]		[Q2-80%]			C4	2
4	[Quiz-20%]		[Q3-80%]			C6	3
5	[Quiz-20%]			[Test-80%]		P4	3

Contents

I. Review

- Maxwell's equations for free space and conducting medium, influence of medium on the field, electromagnetic waves and general wave equation, the speed of light, polarization.

II. Antennas

- Overview of transmission line parameters related to antenna design and performance (reflection mechanisms, VSWR, transmission and return losses), antenna fundamentals: (types of antennas, radiation mechanism)
- Overview of plane and solid angles, near-field, far-field regions, polarization, radiation pattern, performance oriented antenna parameters (radiated power, directivity, gain, efficiency, radiation resistance and input impedance), dipole, monopole antennas, loop antennas, traveling wave antennas (long wire, V and rhombic antennas), broadband antennas, helical, yagi-uda, log-periodic antennas, aperture antennas-horn and dish reflector antennas, microstrip antennas, rectangular, circular microstrip patch antennas,
- Properties of receiving antennas: reciprocity, effective antenna area and radar cross section.
- Antenna arrays: expression for electric field from two and three element arrays, uniform linear array, method of pattern multiplication, binomial array, use of method of images for antennas above ground.

III. Wave Propagation

- Radio/plane-wave propagation: review of waves and phasors, time-harmonic fields, plane-wave propagation in lossless/conducting/free-space media, wave polarization, effects of ground and atmosphere on propagation, basic propagation modes, free space, ground reflection and diffraction, ground wave propagation, sky wave propagation, atmospheric effects on radio wave propagation, space (terrestrial) wave propagation.

Lab Outline

- **Introduction about the antenna characteristics:** basic antenna parameters, patterns, beam area, radiation intensity, beam efficiency, diversity and gain, antenna apertures, effective height, bandwidth, radiation, efficiency, antenna temperature and antenna filed zones.

- **Antenna modeling and analysis:** conical horn antenna, slot coupled patch antenna, dipole antenna, helical antenna, yagi-uda array, log periodic antenna, antenna for special applications – sleeve antenna, turnstile antenna, omni directional antennas, substrate integrated waveguide (SIW) antenna, satellite antennas for ground penetrating RADAR's, embedded antennas, ultra-wide band antennas, liquid metal alloy based antenna, plasma antenna.

- **Antenna measurements:** scattering parameters, VSWR, return loss, insertion loss, radiation pattern measurement, gain and directivity measurements, anechoic chamber measurement.

- **Simulation of Maxwell equations:** wave equation for lossy and lossless media.

- Antenna modeling and analysis using HFSS/MATLAB

Recommended Books

1. Antenna Theory: Analysis and Design - Constantine A. Balanis
   (Latest Edition "3rd", ISBN-10: 8126524227 or ISBN-13: 978-8126524228)

2. Essentials of Radio Wave Propagation - Christopher Haslett
   (Latest Edition "1st", ISBN-10: 052187565X or ISBN-13: 978-0521875653)

3. The Mobile Radio Propagation Channel - John David Parsons
   (Latest Edition "2nd, ISBN-10: 047198857X or ISBN-13: 978-0471988571)

4. Antenna Theory and Design - Warren L. Stutzman, Gary A. Thiele
   (Latest Edition "3rd", ISBN-10: 0470576642 or ISBN-13: 978-0470576649)

5. Antennas and Radiowave Propagation - Robert E. Collin
   (Latest Edition "1st", ISBN-10: 0070118086 or ISBN-13: 978-0070118089)

6. Antennas - John D. Kraus, Ronald J. Marhefka
   (Latest Edition "3rd", ISBN-10: 007123201X or ISBN-13: 978-0071232012)

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Digital Signal Processing

Pre-requisites	Signals and Systems
Co-requisite	Nil
Course Code	TL345
Semester	5th
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to introduce the fundamentals of digital signal processing, including the concepts of analog-to-digital and digital-to-analog conversion, design of linear phase FIR and IIR filters to meet prescribed specifications, digital spectral analysis and multirate signal processing.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 57: TH: CLOs, Mapping of CLOs to PLOs of Digital Signal Processing

CLOs	Description	Taxonomy	PLOs
1	Solve DT systems to check their characteristics and response in time domain.	C3	1
2	Analyze discrete time signals and systems using transform domain techniques.	C4	2
3	Analyze and design digital filters.	C4	3

Table 58: PR: CLOs, Mapping of CLOs to PLOs of Digital Signal Processing

CLOs	Description	Taxonomy	PLOs
4	Observe graphs from time and frequency-domain analysis for signals and systems.	P1	4

Table 59: Assessment Methods of CLOs of Digital Signal Processing

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-30%]	[Q1-70%]				C3	1
2	[Quiz-40%]		[Q1-60%]			C4	2
3	[Quiz-20%]		[Q2-80%]			C4	3
4	[Quiz-40%]			[Test-30%]	[Q1-30%]	P1	4

Contents

I. Introduction

- Review of discrete-time signals and systems along with their representation, analogue-to-digital conversion, uniform sampling theorem, quantisation and its effects, coding of quantized samples, quantisation noise to signal ratio, digital-to-analog conversion, analysis of digital signals and systems versus discrete-time signals and systems.

II. Time-Domain DSP

- Characterization of a discrete-time system using difference equation and pulse transfer function, signal energy and signal power of a DT signal, convolution sum and its use in DT systems, correlation, and normalized correlation, the concept of self-similarity and autocorrelation, using autocorrelation for timing recovery.

III. Fourier Transform

- Discrete-Time fourier transform, periodicity of DTFT and the proof of nyquist theorem, discrete fourier transform (DFT), properties of DFT, introduction to fast fourier transform (radix-2, decimation in time, decimation in frequency), magnitude and phase response using DFT.

IV. Z Transform

- Z-transform for the analyses of discrete-time systems, inverse Z-transform, solution of difference equations using Z-transforms, obtaining the pulse transfer function from the difference equation, pole-zero maps in the Z-domain, stability of discrete-time systems

V. Digital Filters

- Concepts of FIR and IIR digital systems, design of digital filters using discrete-time fourier transform - window method, introduction to window functions, comparison of the properties of the window functions.

VI. Spectrum Estimation

- Stationary and non-stationary signals, estimating energy density spectrum of non-stationary signals using window functions, advantages and disadvantages of the window functions in terms of spectral resolution and leakage, periodogram or power density spectrum.

VII. Multi-rate Digital Signal Processing

- Advantages for multi-rate digital signal processing, decimation, interpolation, sampling rate conversion by a rational factor, applications for multi-rate signal processing in telecommunication engineering.

Lab Outline

Laboratory experiments are designed to train the students to perform signal processing concepts and digital filters designing using Matlab and DSP trainer kit.

- MATLAB: sampling and quantisation of signals, implementation and interpretation of convolution, correlation algorithms, frequency-domain analyses of discrete-time signals and systems, discrete fourier transform (DFT), design of FIR filters using window method, power spectrum estimation of signals, introduction to multirate signal processing.
- TI DSP 320TMSC6713: introduction to TI 320TMSC6713 DSP starter kit and code composer studio, implementation of mathematical equations on the DSK, import/export of data to/from DSK, digital direct synthesis.

Recommended Textbooks

1. Discrete-Time Signal Processing - Alan V. Oppenheim, Ronald W. Schafer
   (Latest Edition "3rd", ISBN-10: 0131988425 or ISBN-13: 978-0131988422)
2. Digital Signal Processing - John G. Proakis, Dimitris K Manolakis
   (Latest Edition "4th", ISBN-10: 0131873741 or ISBN-13: 978-0131873742)

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Reference Material

1. Digital Signal Processing: A Practical Approach - Emmanuel Ifeachor, Barrie Jervis
   (Latest Edition "2nd", ISBN-10: 0201596199 or ISBN-13: 978-0201596199)

2. Understanding Digital Signal Processing - Richard G. Lyons
   (Latest Edition "3rd", ISBN-10: 0137027419 or ISBN-13: 978-0137027415)

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MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO
DEPARTMENT OF TELECOMMUNICATION ENGINEERING

Probability and Stochastic Processes

Pre-requisites	Electromagnetics
Co-requisite	Communication Systems
Course Code	TL354
Semester	5th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The course aims to teach the basic theory of probability, random processes and its mathematical analysis. These tools are required to design and study communication systems.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 60: TH: CLOs, Mapping of CLOs to PLOs of Probability and Stochastic Processes

CLOs	Description	Taxonomy	PLOs
1	Define the basic concept of Probability and stochastic processes and their need in telecommunication engineering.	C1	1
2	Describe properties and classifications of probability density functions and regression analysis.	C2	2
3	Apply different probability techniques in engineering problems.	C3	3

Table 61: Assessment Methods of CLOs of Probability and Stochastic Processes

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-30%]	[Q1-70%]		C1	1
2	[Quiz-20%]	[Q2-10%]	[Q2-70%]	C2	2
3	[Quiz-70%]		[Q2-30%]	C3	3

Contents

I. Introduction

- Introduction to probability, axiomatic approach, distribution function and density function of random variables, examples of distribution and density functions, conditional and joint distribution, functions of random variables, central-limit theorem, expected value, moments, variance, mean, auto correlation, auto covariance.

II. Random Processes

- Stationary process, wide sense stationary process, transformation of stochastic processes, correlation and power spectral density (PSD) of a linear system.

III. Noise in LTI Systems

- Thermal noise, band-limited processes, introduction to linear mean square estimation (LMSE) and filtering problems.

IV. Random signal and noise through a linear system

- Noise representation, signal to noise ratio for F.M., A.M., P.M. and digital modulation schemes, shot noise, white noise, noise figure and noise temperature.

Recommended Textbooks

1. Applied Statistics and Probability for Engineers - Douglas C. Montgomery, George C. Runger
   (Latest Edition "6th", ISBN-10: 1118539710 or ISBN-13: 978-1118539712)

2. Probability and Statistics for Engineers and Scientists - Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye
   (Latest Edition "9th", ISBN-10: 9332519080 or ISBN-13: 978-9332519084)

Reference Material

1. Probability, Random Variables and Stochastic Processes - Athanasios Papoulis, S. Unnikrishna Pillai
   (Latest Edition "4th", ISBN-10: 0071226613 or ISBN-13: 978-0071226615)

2. Probability and Random Processes - W. Davenport
   (Latest Edition "1st", ISBN-10: 0070154406 or ISBN-13: 978-0070154407)

3. Information Transmission, Modulation and Noise - M. Schwartz
   (Latest Edition "4th", ISBN-10: 0071009310 or ISBN-13: 978-0071009317)

4. Modern Digital and Analog Communication Systems - B. P. Lathi, Zhi Ding
   (Latest Edition "4th", ISBN-10: 0195331451 or ISBN-13: 978-0195331455)

5. Digital and Analog Communication Systems - Leon W. Couch
   (Latest Edition "8th", ISBN-10: 0132915383 or ISBN-13: 978-0132915380)

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Numerical Analysis and Computer Applications

Pre-requisites	Object Oriented Programming
Co-requisite	Nil
Course Code	MTH336
Semester	5th
Effective	17TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

To introduce the concept of numerical computation.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 62: TH: CLOs, Mapping of CLOs to PLOs of Numerical Analysis and Computer Applications

CLOs	Description	Taxonomy	PLOs
1	Locate the root of a non-linear equations f(x) = 0, and determine iterative methods for the solution of simultaneous linear algebraic equations.	C2	1
2	Estimate interpolation, extrapolation, and determine numerical differentiation and integration.	C2	1
3	Compute numerical solution of ordinary differential equations.	C3	1

Table 63: PR: CLOs, Mapping of CLOs to PLOs of Numerical Analysis and Computer Applications

CLOs	Description	Taxonomy	PLOs
4	Perform computations of defined numerical schemes using C++ programming.	P4	5

Table 64: Assessment Methods of CLOs of Numerical Analysis and Computer Applications

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-70%]	[Q1-10%]			C2	1
2	[Quiz-40%]	[Q2-30%]	[Q1-30%]			C2	1
3	[Quiz-40%]		[Q2-60%]			C3	1
4	[Quiz-40%]			[Test-30%] [ViVa-30%]		P4	5

Contents

I. Error Analysis

  - Introduction, floating points, errors, types of errors.

II. Solution of Non-Linear Equation

  - Bisection method, regula-falsi method, newton-raphson method, fixed-point iterative method.

III. Solution of Linear Algebraic Equation

- Iterative methods: jaccobi's method, guass-seidal method.

IV. Eigen Values and Eigen Vectors

- Power method

V. Interpolation and Extrapolation

- Differences: forward, backward, central, operators and their relations, newton's forward interpolation formula, newton's backward interpolation formula, newton's divided difference formula, lagrange's interpolation formula, stirling's formula.

VI. Numerical Differentiation

- Newton's forward and backward differentiation formulae.

VII. Numerical Quadrature

- Trapezoidal rule, simpson's one-third (1/3) rule, simpson's three-eighth (3/8) rule, weddle's rule, gaussian quadrature.

VIII. Numerical Solution of Ordinary Differential Equations

- Taylor series method, Euler's and its modified methods, runge-kutta (RK) method, predictor corrector methods, miline's method, adam-bashforth method.

Recommended Textbooks

1. Numerical Methods for Engineers - Steven Chapra, Raymond Canale
   (Latest Edition "7th", ISBN-10: 007339792X or ISBN-13: 978-0073397924)

2. Applied Numerical Analysis - Curtis F. Gerald, Patrick O. Wheatley
   (Latest Edition "7th", ISBN-10: 0321133048 or ISBN-13: 978-0321133045)

Reference Material

1. Advanced Engineering Mathematics - Erwin Kreyszig
   (Latest Edition "10th", ISBN-10: 0470458364 or ISBN-13: 978-0470458365)

2. Ordinary Differential Equations with Numerical Techniques - John L. Van Iwaarden
   (Latest Edition "1st", ISBN-10: 0155675508 or ISBN-13: 978-0155675506)

3. A First Course in Numerical Analysis with C++ - Saeed Akhter Bhatti, Naeem Akhter Bhatti
   (Latest Edition "5th")

Approval:	Board of Studies of BSRS	Res. No. 01	Dated: 26-03-2018
	Board of FOST&H	Res. No. 3.1	Dated: 11-04-2018
	Academic Council	Res. No. 17(ii)	Dated: 23-04-2018

Communication Systems

Pre-requisites	Signals and Systems
Co-requisite	Nil
Course Code	TL323
Semester	5th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course will help students get background knowledge and fundamentals about electronic communication and their applications in telecommunication networks. Special focus is accorded to linear and non-linear modulation schemes in the presence of noise.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 65: TH: CLOs, Mapping of CLOs to PLOs of Communication Systems

CLOs	Description	Taxonomy	PLOs
1	Describe the fundamentals of communication systems and information theory.	C2	1
2	Apply modulation techniques both in time domain and frequency domain.	C3	2
3	Analyse the performance of digital communication schemes, in terms of signal-to-noise ratio, symbol-error-rate and bandwidth	C4	3

Table 66: PR: CLOs, Mapping of CLOs to PLOs of Communication Systems

CLOs	Description	Taxonomy	PLOs
4	Describe the basics of modulation and demodulation techniques.	C2	4
5	Practice experiments and measurements on analog and digital modulation schemes.	P3	9
6	Respond to the questions related to communication systems.	A2	10

Table 67: Tentative Assessment Methods of CLOs of Communication Systems

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-40%]	[Q1-40%]			C2	1
2	[Quiz-20%]	[Q2-40%]	[Q2-40%]			C3	2
3	[Quiz-20%]		[Q3-80%]			C4	3
4	[Quiz-100%]					C2	4
5	[Quiz-40%]			[Test-30%]	[Q1-30%]	P3	9
6				[ViVa-100%]		A2	10

Contents

   I. Introduction to Electronic Communication System

- Block diagram of a communication system, types of communication systems, modes of communication (simplex, half duplex, full duplex), transmission mediums, bandwidth, data rate, throughput, signals, baseband and passband signals, noise, attenuation, distortion, noise sources, signal-to-noise ratio (SNR), noise factor and noise figure.

II. Analogue Modulation Techniques

- Modulation, information and carrier signals, need of modulation, amplitude modulation and demodulation, AM equation, modulation index, power and spectrum of AM, single sideband (SSB), double sideband (DSB), vestigal sideband (VSB), AM bandwidth, AM circuit
- Angle (Exponential) Modulation Techniques: frequency modulation and demodulation, FM equation, modulation index, sidebands, spectra and bandwidth of FM, FM circuit, narrowband and wideband FM, pre-emphasis and de-emphasis circuits, direct and indirect FM, noise immunity and capture effect in FM, phase modulation and demodulation, PM equation, modulation index, PM circuit

III. Pulse Modulation Techniques

- Analog-to-digital conversion, pulse code modulation (sampling using nyquist theorem, uniform and non-uniform quantization, encoding), pulse code modulation companding (A-law/μ-law), PCM bandwidth, differential PCM, delta modulation
- Pulse-amplitude modulation (PAM), pulse-width modulation (PWM), pulse-position modulation (PPM)

IV. Information Theory

- Information content of a message, entropy and entropy rate, channel capacity, impact of SNR on the capacity of a channel, hartley-shanon theorem, huffmann coding.

V. Line Coding Techniques

- Signal element, data element, data rate, signal rate (baud rate), relationship between signal rate and bandwidth
- Baseline wandering, DC components, self-synchronization
- Unipolar (NRZ), polar (manchester and differential manchester), bipolar (AMI and CMI)

VI. Scrambling Techniques

- Bipolar with 8-zero substitution (B8ZS), high-density bipolar 3-zero (HDB3)

VII. Error Detection Techniques

- Vertical and horizontal redundancy checking, cyclic redundancy checking (CRC)

VIII. Multiplexing and Multiple Access Techniques

- Multiplexing principles, multiplexer (MUX), demultiplexer (DEMUX), concept of link and channel, Frequency-division multiplexing (FDM), FDM block diagram, and related Wavelength-division multiplexing (WDM)
- Time-division multiplexing (TDM), synchronous TDM, statistical TDM
- Difference between multiplexing and duplexing
- Multiple Access Techniques: FDMA, TDMA, CDMA

Lab Outline

The concepts are verified practically through design of models for communication system.

i. Differentiating analog and digital communication systems
ii. Analog modulation techniques

- Amplitude modulation using LD trainer, double sideband suppressed carrier, single sideband residual carrier, single sideband suppressed carrier, amplitude demodulation

iii. Frequency modulation and demodulation
iv. Phase modulation and demodulation
v. Pulse modulation using EV trainer
vi. Pulse code modulation (PCM), differential PCM, and delta modulation

Recommended Textbooks

1. Principles of Electronic Communication Systems - Louis E. Frenzel Jr.
   (Latest Edition "4th", ISBN-13: 978-0-07-337385-0)

2. Electronic Communications System: Fundamentals Through Advanced - Wayne Tomasi
   (Latest Edition "5th", ISBN-13: 978-0-13-049492-4)

Reference Material

1. Telecommunications - Warren Hioki
   (Latest Edition "4th", ISBN-10: 013020031X or ISBN-13: 978-0130200310)

2. Modern Digital and Analog Communication Systems - B. P. Lathi, Zhi Ding
   (Latest Edition "4th", ISBN-10: 0195331451 or ISBN-13: 978-0195331455)

3. Digital Communications - Ian A. Glover, Peter M. Grant
   (Latest Edition "3rd", ISBN-10: 0273718304 or ISBN-13: 978-0273718307)

4. Communication Systems - Simon Haykin, Michael Moher
   (Latest Edition "5th", ISBN-10: 8126521511 or ISBN-13: 978-8126521517)

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Digital Communication

Pre-requisites	Communication Systems
Co-requisite	Nil
Course Code	TL371
Semester	6th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The aim of this course is to understand the concept of digital modulation, coding techniques and the evaluation of their performance (power and bandwidth) in practical scenarios.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 68: TH: CLOs, Mapping of CLOs to PLOs of Digital Communication

CLOs	Description	Taxonomy	PLOs
1	Solve fundamental problems of digital signals.	C3	1
2	Analyze binary signals and baseband signal space.	C4	2

Table 69: PR: CLOs, Mapping of CLOs to PLOs of Digital Communication

CLOs	Description	Taxonomy	PLOs
3	Observe bit error rate graphs and constellation diagrams for digital modulation techniques.	P1	6
4	Organize tasks for the project team and questions related to Digital Communication.	A4	11

Table 70: Assessment Methods of CLOs of Digital Communication

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-40%]	[Q1-40%]			C3	1
2	[Quiz-50%]	[Q2-50%]				C4	2
3	[Quiz-40%]			[Test-30%]	[Q1-30%]	P1	6
4				[ViVa-100%]		A4	11

Contents

I. Introduction

- Review of basic concepts such as Hartley's and Shannon's law, signal transmission through linear systems, bandwidth of digital data, binary symmetric channels, binary channels, binary eraser channel, memoryless channels, detection of binary signals in white gaussian noise, maximum likely hood receiver structure, matched filter, inter-symbol interference (ISI), equalization

II. Digital Modulation Techniques

- Introduction of binary modulation schemes (FSK, PSK and ASK), FSK transmitter and receiver, bandwidth considerations of FSK, Minimum shift-keying FSK (MSK), binary phase shift keying (BPSK), BPSK transmitter and receiver, bandwidth considerations of BPSK, performance (bandwidth and power) of binary modulation schemes in AWGN channels, differential BPSK, constellation diagrams, eye diagrams
- M-ary modulation techniques (M-ary PSK, Ma-ary FSK and M-ary ASK) and their performance evaluations in AWGN channels
- Quadrature amplitude modulation (QAM), 8/16-QAM transmitter and receiver, bandwidth considerations of 8/16-QAM
- Bandwidth efficient modulation schemes (QPSK and its variants, GMSK etc.)
- Clock recovery, performance comparison of modulation schemes in band-limited channels, probability of error and bit error rate

III. Coding Techniques

- Introduction to source coding and channel coding, error control coding techniques, forward error correction coding (hamming code), linear codes, block codes, cyclic codes, convolutional codes and turbo codes, performance of these codes in AWGN channels.

Lab Outline

Following the theoretical guidelines, perform practical sessions for various modulation schemes on trainers and software. A design example to carry out performance comparisons of various modulation schemes based on error rate calculation and/or PSD plots. Demonstration of coding schemes using software tools.

Recommended Textbooks

1. Digital Communications - John Proakis, Masoud Salehi
   (Latest Edition "5th", ISBN-10: 0072957166 or ISBN-13: 978-0072957167)

2. Digital Communications: Fundamentals and Applications - Bernard Sklar
   (Latest Edition "2nd", ISBN-10: 0130847887 or ISBN-13: 978-0130847881)

Reference Material

1. Digital Communication Techniques: Signal Design and Detection - Marvin K. Simon, Sami M. Hinedi, William C. Lindsey
   (Latest Edition "1st", ISBN-10: 0132006103 or ISBN-13: 978-0132006101)

2. Digital and Analog Communication Systems - Leon W. Couch
   (Latest Edition "8th", ISBN-10: 0132915383 or ISBN-13: 978-0132915380)

3. Digital Communication Systems - Simon Haykin
   (Latest Edition "1st", ISBN-10: 0471647357 or ISBN-13: 978-0471647355)

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Microwave Engineering

Pre-requisites	Electromagnetics
Co-requisite	Nil
Course Code	TL362
Semester	6th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to teach the necessary skills in advanced theories of microwave in order to enable students conduct high level of research in the subject area.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 71: TH: CLOs, Mapping of CLOs to PLOs of Microwave Engineering

CLOs	Description	Taxonomy	PLOs
1	Explain the phenomenon of electromagnetic wave propagation through guided and unguided media including the transmission line parameters.	C2	1
2	Analyze the effect of impedance mismatch and select the appropriate matching technique / circuit using smith chart.	C4	2
3	Explain the basic components of modern electronic warfare and use solid state active and passive microwave devices.	C2	1
4	Design project on microwave systems.	C6	3

Table 72: PR: CLOs, Mapping of CLOs to PLOs of Microwave Engineering

CLOs	Description	Taxonomy	PLOs
5	Design simulation experiment and measurement on active / passive microwave devices as individual and as a team.	P7	9
6	Respond to the questions related to microwave device functions and measurements.	A2	10

Table 73: Assessment Methods of CLOs of Microwave Engineering

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-60%]				C2	1
2	[Quiz-40%]	[Q2-20%]	[Q1-40%]			C4	2
3	[Quiz-20%]		[Q2-30%]		[Q1-50%]	C2	1
4	[Quiz-20%]		[Q2-80%]			C6	3
5	[Quiz-40%]			[Test-30%]	[Q1-30%]	P7	9
6				[ViVa-100%]		A2	10

Contents

I. Introduction

- Microwave definition, microwave frequencies, and properties of microwaves.
- Review of basic electromagnetic concepts, industry and research applications of microwave engineering.

II. Transmission Lines

- General description of waves on transmission line, E-waves, H-waves, group velocity, phase velocity.
- Review of standing waves, VSWR (Voltage Standing Wave Ratio), reflections in transmission lines.
- Lumped element model, transmission line equation, impedance /admittance relationship of transmission line, wave propagation in lossy/lossless/special cases of lossless transmission lines, calculation of attenuation constant, phase constant and propagation constant.

III. Microwave Network Analysis

- Z and Y parameters analysis, ABCD and S representation of microwave networks, transmission lines, discontinuities and S-parameters, smith chart analyzing rules, mathematical construction of smith chart, using smith chart to solve problems related to impedance matching of microwave devices (matching networks problems) and find the transmission line length.

IV. Waveguides and Microwave Passive Components

- Type of waveguides, cylindrical wave-guide, elliptical wave-guides, modes in waveguide TM, TE, TEM modes of propagation
- Rectangular wave-guide, general design equations, problems on rectangular wave guide, propagation characteristic wave-guide
- Microwave filters, power combiners, power dividers, microwave couplers, isolators and mixers, applications of couplers in microwave devices.

V. Microwave Transmitters/Receivers and Microwave Active Devices

- Principles and operation of one cavity and two cavity klystrons, multicavity Klystron
- Microwave Tubes: high frequency limitations of conventional microwave tubes, bunching and velocity modulation, travelling wave tubes, backward wave oscillator, microwave solid state devices, varactor diode, PIN diode, GUNN diode and IMPATT diode

VI. Modern Technologies

- Introduction to electronic warfare, smart technologies such as smart antennas, advanced reconfigurable and flexible electronic technologies.
- Planar circuit technologies: microstrip transmission lines and MMIC's, applications of printed antennas in RADAR and beam forming systems.

Lab Outline

- Practical demonstration of wave propagation, measurement of standing wave ratio and frequency in the guided structure, understanding the phenomenon of reflection from matched/unmatched load conditions, using trainer and through simulation using numerical electromagnetic software (Microwave Office, HFSS, CST etc.).
- Practical demonstration of antennas (various types), measurement of antenna gain and reflection parameters, calculation of return loss, smith chart evaluations and S-parameter understanding using Vector Network Analyzer.

Recommended Textbooks

1. Foundations for Microwave Engineering - Robert E. Collin
   (Latest Edition "2nd", ISBN-10: 0070118116 or ISBN-13: 978-0070118119)

2. Microwave Theory and Applications - Stephen F. Adam
   (Latest Edition "2nd", ISBN-10: 013581488X or ISBN-13: 978-0135814888)

3. Microwave Engineering - David M. Pozar
   (Latest Edition "4th", ISBN-10: 0470631554 or ISBN-13: 978-0470631553)

Reference Material

1. Antenna Theory: Analysis and Design - Constantine A. Balanis
   (Latest Edition "3rd", ISBN-10: 047166782X or ISBN-13: 978-0471667827)

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Optoelectronics

Pre-requisites	Basic Electronics
Co-requisite	Nil
Course Code	TL391
Semester	6th
Effective	17TL batch and onwards
Theory Marks	50
Practical Marks	50
Credit Hours	2 + 1
Minimum Contact Hours	30 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The subject aims to give adequate knowledge and clear understanding about the fundamentals of optical communication as well as the related principles and techniques involved with it.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 74: TH: CLOs, Mapping of CLOs to PLOs of Optoelectronics

CLOs	Description	Taxonomy	PLOs
1	Discuss fundamental physical and technical knowledge about the fundamentals of optical communication and transition processes. Also apply the knowledge about the basics of of quantum levels in atoms and solids necessary to understand recombination processes.	C2	3
2	Analyze the procedures and results related to optical devices such as spectral and output characteristics of optical sources and photo-detectors.	C4	4

Table 75: PR: CLOs, Mapping of CLOs to PLOs of Optoelectronics

CLOs	Description	Taxonomy	PLOs
3	Observe, setup and design experiments and measurements on real components, and devices of optoelectronic systems individually and in a team.	P7	9
4	Respond to the questions related to communication system.	A2	10

Table 76: Assessment Methods of CLOs of Optoelectronics

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-40%]	[Q1-40%]			C2	4
2	[Quiz-20%]	[Q2-20%]	[Q2-60%]			C4	4
3	[Quiz-40%]			[Test-30%]	[Q1-30%]	P7	9
4				[ViVa-100%]		A2	10

Contents

I. Light

- Historical background, the nature of light, basic laws and properties of light, units of measuring light (radiometric and photometric units).

II. Semiconductor Light Sources

- Light sources, emission and absorption of radiation, the einstein relation, light emission in semiconductor, stimulation emission in semiconductors, lasing conditions in semiconductors, population inversion, electrical and optical bandwidth.

III. LASERs

- Laser operation and basic concept, optical feedback, pumping, population inversion, semiconductors laser diodes (SLDs), types of semiconductor laser diodes, spectral and output characteristics, threshold condition, laser losses, laser modes, classes of lasers, single mode operation, stripe geometry, efficiency of lasers, laser rate equations.

IV. Light Emitting Diodes (LEDs)

- Types of light emitting diodes (LEDs), LED power and efficiency, spectral characteristics, modulation capabilities

V. Photo Detectors

- Photo detection in semiconductors, quantum efficiency, responsivity, long wavelength cutoff, semiconductor photodiodes without internal gain, PIN photodiodes, avalanche photodiodes (APDs), photodetector noise considerations, phototransistors.

VI. Optical Transmitters and Receiver

- Intensity modulation and direct detection modulation (IM/DD), SLD drive circuits, LED drive circuit, optical receivers design, receiver noise.

Lab Outline

Basics of optoelectronics, measuring characteristics of optical sources (LED and LASER), measuring characteristics of optical detector (PN, PIN and APD), overview of optical source meter and optical power meter, field optical spectrum analyzer, experiments on optiwave's OptiSystem software.

Recommended Textbooks

1. Optical Fiber Communications: Principles and Practice - John Senior
   (Latest Edition "3rd", ISBN-10: 013032681X or ISBN-13: 978-0130326812)

2. Optical Fiber Communications - Gerd Keiser
   (Latest Edition "5th", ISBN-10: 1-25-900687-5 or ISBN-13: 978–1-25-900687-6)

Reference Material

1. Optoelectronics - Endel Uiga
   (Latest Edition "1st", ISBN-10: 0024221708 or ISBN-13: 978-0024221704)

2. Optical Networks: A Practical Perspective - Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki
   (Latest Edition "3rd", ISBN-10: 0123740924 or ISBN-13: 978-0123740922)

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Technical Report Writing Skills

Pre-requisites	Functional English
Co-requisite	Nil
Course Code	ENG320
Semester	6th
Effective	16TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

To enable students to communicate effectively in formal and informal situations

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 77: TH: CLOs, Mapping of CLOs to PLOs of Technical Report Writing Skills

CLOs	Description	Taxonomy	PLOs
1	Distinguish between formal and informal reports and use different type of reports such as progress reports, research report, recommendation report, evaluation report and feasibility report, internship reports). Besides, format proposals, elements and types of different proposals along with technical manuals and SOPs.	C2	1
2	Write the content and structure of various technical and academic research documents such as dissertations, research papers or articles, proceeding papers and research review papers.	C3	12

Table 78: Assessment Methods of CLOs of Technical Report Writting Skills

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-60%]	[Q1-20%]	C2	1
2	[Quiz-20%]		[Q2-80%]	C3	12

Contents

I. Reading

- Text analysis, critical thinking, skimming, scanning and detailed reading

II. Writing

- Academic writing/technical report writing drafting letters with different types of messages with different registers and purposes, prepare CV's and covering letters according to job requirement

III. Listening

- Listening comprehension formal and informal lectures and presentations, take notes and collect specific information

IV. Speaking

- Speaking in real life situations, conversational strategies, elements of public speaking: giving lectures and presentation on specific topics, ask questions and explain point of view in discussions (demonstrate turn taking technique)

Recommended Books

1. Axelrod & Cooper's Concise Guide to Writing - Rise B. Axelrod, Charles R. Cooper
   (6th Edition, ISBN-10: 0312668902 or ISBN-13: 978-0312668907)

2. English for Business: A Functional Approach - Joseph Chilver
   (1st Edition, ISBN-10: 1858050634 or ISBN-13: 978-1858050638)

3. Writing: Advanced - Ron White
   (1st Edition, ISBN-10: 0194534073 or ISBN-13: 978-0194534079)

4. College Writing Skills with Readings - John Langan
   (9th Edition, ISBN-10: 0078036275 or ISBN-13: 978-0078036279)

5. Patterns for College Writing: A Rhetorical Reader and Guide - Laurie G. Kirszner, Stephen R. Mandell
   (13th Edition, ISBN-10: 1457666529 or ISBN-13: 978-1457666520)

6. Mercury Reader - A Custom Publication - Janice Neuleib, Kathleen Shine Cain, Stephen Ruffus
   (1st Edition, ISBN-10: 1256182192 or ISBN-13: 978-1256182191)

7. Effective Business Communications - Herta A. Murphy, Herbert W. Hildebrandt, Jane P. Thomas
   (7th Edition, ISBN-10: 007044398X or ISBN-13: 978-0070443983)

8. Ultimate Cover Letters - Martin John Yate
   (3rd Edition, ISBN-10: 0749464054 or ISBN-13: 978-0749464059)

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Computer Communication and Networking

Pre-requisites	Communication Systems
Co-requisite	Nil
Course Code	TL334
Semester	6th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

This course aims to give students a foundation in fixed computer networks. It provides a background of how data/information is communicated from one station to any other station. The course helps students understand architecture, protocols, and services of various data communication techniques. Moreover, students will have hands on experience of using data communication equipment.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 79: TH: CLOs, Mapping of CLOs to PLOs of Computer Communication and Networking

CLOs	Description	Taxonomy	PLOs
1	Distinguish the working mechanism of basic components of a computer networks.	C2	1
2	Explain the application of layered models to networks as well as processes involved in data encapsulation and decapsulation.	C2	1
3	Determine the principles, processes, and protocols involved at OSI layer 2, 3, 4, and 7.	C3	4

Table 80: PR: CLOs, Mapping of CLOs to PLOs of Computer Communication and Networking

CLOs	Description	Taxonomy	PLOs
4	Observe the behaviour of multi-switched network using simulation software.	P1	5
5	Respond appropriately to the questions related to the subject.	A2	10

Table 81: Assessment Methods of CLOs of Computer Communication and Networking

CLOs	Quiz / Assignment / Lab Rubrics	Mid Exam	Final Exam	Lab Exam	Project / OEL/CEP	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-70%]	[Q1-10%]			C2	1
2	[Quiz-10%]	[Q2-60%]	[Q2-30%]			C2	1
3	[Quiz-20%]	[Q3-20%]	[Q3-60%]			C3	4
4	[Quiz-40%]			[Test-30%]	[Q1-30%]	P1	5
5				[ViVa-100%]		A2	10

Contents

I. Overview of Communication System

- Communication Model, Nodes, Links, Protocol, Network Edge (Client, Server)

- Network Fundamentals, Types of Networks (LAN, MAN, WAN), Network Topologies (Bus, Star, Tree, Ring, Mesh), Logical versus Physical Topology
- Network Interface Controller, Repeaters, Hubs, Bridges, Switches, Routers, Gateway
- Access Networks, Core Networks, Internet, Intranet
- Concept of Packet, Packet Forwarding/Switching, Store-and-Forward Transmission
- Transmission Delay, Propagation Delay, Queuing Delay

II. Physical Media

- Coaxial (10Base-2, 10Base-5), Coaxial Cable Connectors
- Ethernet (10Base-T, 100Base-TX, 100Base-T), Twisted-Pair Connectors
- Fiber Optic (10Base-F, 100Base-FX, 1000Base-LX, 1000Base-SX), Fiber-Optic Connectors
- Serial (RS-232, RS-422)

III. Architecture and Protocols

- Layered Models (TCP/IP, OSI), Encapsulation/Decapsulation

IV. Link Layer

- Services Provided by the Link Layer
- Error-Detection and -Correction Techniques (Parity Checks, Checksumming Methods)
- Multiple Access Links and Protocols
    - Channel Partitioning Protocols (FDM, TDM)
    - Random Access Protocols (Slotted ALOHA, Pure ALOHA, CSMA/CD, CSMA/CA)
    - Taking-Turns Protocols (Polling Protocol, Token-Passing Protocol)
- Switched Local Area Networks (Collision Domain, ICMP, ARP)
- Self-learning of Switch Table
- Properties of Link-Layer Switching
- Spanning Tree Protocol (STP)
- Virtual Local Area Networks (VLANs)

V. Ethernet Framing

- Frame Formats (Ethernet II versus IEEE 802.3)
- Media Access Control (MAC) Addressing
- Frame Forwarding and Filtering (Unicast, Broadcast, Multicast)
- Frame Processing (Source MAC, Destination MAC, Type Field, Data, FCS)

VI. IP Addressing

- IP Packet Header
- IP Addressing (Network Part, Host Part)
- Network Address, Broadcast Address, IP Address Classes (A,B,C,D,E), Subnet Mask, VLSM
- IP Addressing Limitations
- Dynamic Host Configuration Protocol (DHCP)

VII. Network Layer

- Forwarding and Routing
- Virtual Circuit and Datagram Networks
- IP Routing Table, Routing Decision (Preference, Metric)
- Static Routing (Application, Behaviour, Limitations)
- Routing Algorithms (Distance-Vector Routing Algorithm, Link-State Routing Algorithm)
- Dijkstra's Algorithm

VIII. Transport Layer Protocols

- Transmission Control Protocol (TCP), TCP Ports, TCP Header, TCP Connection Establishment/Termination, Go-Back-N (GBN), Selective Repeat (SR)
- User Datagram Protocol (UDP), UDP Datagram Format, UDP Forwarding Behaviour
- Principles of Congestion Control, TCP Congestion Control (Slow Start, Congestion Avoidance, Fast Recovery)

IX. Application Layer Protocols

- The Web and HTTP, HTTP Message Format, Cookies
- File Transfer: FTP
- Overview of How DNS Works

Lab Outline

- I. Cables, Connectors, NIC
- II. Repeaters, Hubs, Bridges, Switches, Routers, Gateway
- III. Building Basic IP Network
- IV. Configuring STP
- V. Configuring Static Routes and Default Routes
- VI. Configuring RIPv1 and RIPv2
- VII. Configuring OSPF Single Area
- VIII. Implementing DHCP

Recommended Textbooks

1. Computer Networking: A Top-Down Approach - James F. Kurose, Keith W. Ross
   (Latest Edition "6th", ISBN-10: 0132856204 or ISBN-13: 978-0132856201)

2. Computer Networks - Andrew S. Tanenbaum, David J. Wetherall
   (Latest Edition "5th" Edition, ISBN-10: 0132126958 or ISBN-13: 978-0132126953)

3. Computer Networks and Internets - Douglas E. Comer
   (Latest Edition "6th", ISBN-10: 0133587932 or ISBN-13: 978-0133587937)

Reference Material

1. Data and Computer Communications - William Stallings
   (Latest Edition "7th", ISBN-10: 0131006819 or ISBN-13: 978-0131006812)

2. Cisco CCENT/CCNA ICND1 100-101 Official Cert Guide - Wendell Odom
   (Latest Edition "1st", ISBN-10: 1587143852 or ISBN-13: 978-1587143854)

3. Cisco CCNA Routing and Switching ICND2 200-101 Official Cert Guide - Wendell Odom
   (Latest Edition "1st", ISBN-10: 1587143739 or ISBN-13: 978-1587143731)

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Fiber Optics Communication Systems

Pre-requisites	Optoelectronics
Co-requisite	Nil
Course Code	TL474
Semester	7th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

This course aims to teach students about the attributes of a theoretical framework to understand and model optical communication systems.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 82: TH: CLOs, Mapping of CLOs to PLOs of Fiber Optic Communication Systems

CLOs	Description	Taxonomy	PLOs
1	Explain the properties of optical fiber, propagation characteristics and transmission properties.	C2	1
2	Apply the knowledge to design optical fiber links and demonstrate limitations in the performance to the limitations of the components and subsystems used.	C3	2
3	Analyze the optical networks and calculate their bit error rates and other parameters.	C4	3

Table 83: PR: CLOs, Mapping of CLOs to PLOs of Fiber Optic Communication Systems

CLOs	Description	Taxonomy	PLOs
4	Prepare experiments and measurements on real components and devices of optical communication links and systems individually and in a team.	P4	3
5	Respond to the questions related to optical fiber communication systems.	A2	10

Table 84: Assessment Methods of CLOs of Fiber Optic Communication Systems

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-30%]	[Q1-30%]			C2	1
2	[Quiz-20%]	[Q2-40%]	[Q2-40%]			C3	2
3	[Quiz-20%]		[Q3-80%]			C4	3
4	[Quiz-40%]			[Test-30%]	[Q1-30%]	P4	3
5				[ViVa-100%]		A2	10

Contents

I. Introduction

- History of optical communication, elements of optical fiber communication (OFC) transmission link, evolution of fiber optic system, advantages of OFC system.

II. Optical Fiber Wave Guides

- Optical fiber waveguide, Ray theory transmission, electromagnetic mode theory for optical propagation, cylindrical fibers, single mode fiber, multimode fibers, step index fibers, graded index fibers, single mode/multimode fiber transmission characteristics.

III. Transmission Characteristics

- Attenuation, absorption losses (intrinsic and extrinsic), scattering losses, fiber bend loss, linear scattering losses (Rayleigh and Mir scattering), non-linear scattering losses (stimulated brillouin and stimulated raman scattering), pulse broadening, intra-modal and inter-modal dispersion, overall fiber dispersion, polarization, non-linear effects.

IV. Optical Fiber Cables and Connectors

- Optical fibers, fiber strength and durability, cable design, fiber-to-fiber joints, fiber splicing.

V. Optical Fiber Communication System

- Components of fiber optic networks, optical amplifiers, semiconductor optical amplifiers (SOA), erbium doped fiber amplifiers (EDFA), advanced multiplexing strategies, operational principles of wavelength division multiplexing (WDM), FDDI, SONET/SDH networks, wavelength routing networks, wavelength cross-connects, Resilient Packet Ring (RPR) IEEE 802.17.

VI. Passive Optical Networks (PONs)

- PON overview, optical line terminator (OLT), optical network unit (ONU), optical distribution network (ODN), PON evolution (TDM-PONs, WDM-PONs), splitter/couplers configurations, PON standards
- ATM PONs (APONs), Broadband PONs (BPONs), Ethernet PONs (EPONs), Gigabit PONs (GPONs)
  - physical parameters, architecture, frame format, transmission efficiency etc.

Lab Outline

Familiarization with fiber characteristics, sources, detectors, fiber attenuation measurements, fiber dispersion measurements, field measurements, optical time domain reflectometer (OTDR), splicing, transmission (WDM), use of hardware and software tools (optiwave's OptiSystem).

Recommended Textbooks

1. Optical Fiber Communications: Principles and Practice - John Senior
   (Latest Edition "3rd", ISBN-10: 013032681X or ISBN-13: 978-0130326812)

2. Optical Fiber Communications - Gerd Keiser
   (Latest Edition "5th", ISBN-10: 0073380717 or ISBN-13: 978-0073380711)

3. Fiber-Optic Communication Systems - Govind P. Agrawal
   (Latest Edition "4th", ISBN-13: 978-0470505113)

4. Optical Fiber Communication Systems - Leonid Kazovsky, Alan E. Willner, Sergio Benedetto
   (Latest Edition "1st", ISBN-10: 0890067562 or ISBN-13: 978-0890067567)

Reference Material

1. Understanding Optical Fiber Communications - A. J. Rogers
   (Latest Edition "1st", ISBN-10: 0890064784 or ISBN-13: 978-0890064788)

2. Fiber Optic Networks - Paul E. Green
   (Latest Edition "1st", ISBN-10: 0133194922 or ISBN-13: 978-0133194920)

3. Optical Networks: A Practical Perspective - Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki
   (Latest Edition "3rd", ISBN-10: 0123740924 or ISBN-13: 978-0123740922)

4. Optical Communication Networks - Biswanath Mukherjee
   (Latest Edition "1st", ISBN-10: 0070444358 or ISBN-13: 978-0070444355)

5. Multiwavelength Optical Networks: A Layered Approach - Thomas E. Stern, Krishna Bala
   (Latest Edition "1st", ISBN-10: 020130967X or ISBN-13: 978-0201309676)

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Transmission and Switching Systems

Pre-requisites	Communication Systems
Co-requisite	Nil
Course Code	TL445
Semester	7th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

To introduce various components of transmission and switching systems being used in voice/data networks as well as understand the working principles of it.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 85: TH: CLOs, Mapping of CLOs to PLOs of Transmission and Switching Systems

CLOs	Description	Taxonomy	PLOs
1	Explain the principles and working of emerging switching and high speed transmission technologies used in legacy and VoIP networks.	C2	1
2	Analyze multistage switches and traffic statistics.	C4	2
3	Design the solution of CEP related to Transmission & Switching Systems.	C5	3

Table 86: PR: CLOs, Mapping of CLOs to PLOs of Transmission and Switching Systems

CLOs	Description	Taxonomy	PLOs
4	Observe telephone switching, call routing, signaling, trunking, and charging of calls.	P1	5
5	Respond appropriately to the questions related to Transmission & Switching Systems.	A2	10

Table 87: Assessment Methods of CLOs of Transmission and Switching Systems

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-30%]	[Q1-30%]			C2	1
2	[Quiz-40%]	[Q2-30%]	[Q2-30%]			C3	2
3	[Quiz-100%]				Assignment; CEP	C5	3
4	[Quiz-20%]			[Test-30%] [ViVa-30%]	[Q1-20%]	P1	5
5				[ViVa-100%]		A2	10

Contents

I. Review of Line Coding/Scrambling/Multiplexing Techniques

- Review of Unipolar, Polar, and Bipolar Line Coding Schemes
- Multi-level Line Coding Schemes (2B1Q, 4B3T), Scrambling Techniques (HDB3, B8ZS)

- FDM, analog carrier system, synchronous TDM, data rate management techniques, digital carrier system (DS, T, and E system) and example of DS-1 framing format, statistical TDM

II. Switching Technology

- Circuit switching, packet switching, and virtual circuit switching

III. Structure of Switch

- Space-division switch (crossbar switches), multi-stage space-division switch and clos criterion, propagation delay, transmission delay, queueing delay, processing delay, time-division switch, time-space-time (TST) switch, space-time-space (STS) switch, banyan switch

IV. Public Switched Telephone Network (PSTN)

- Telephone handset, telephone base unit, pulse dialing, tone dialing, SLIC (BORSCHT), exchange hierarchy (class 5-4-3-2-1) and their functions, private branch exchange (PBX), customer premises equipment (CPE), local exchange carrier (LEC), interexchange carrier (IXC), ITU numbering plan, charging plan (single-pulse metering, multiple-pulse metering, periodic pulse metering, periodic multi-pulse metering)

V. Signaling Technique

- Classification
  - Supervisory signals or line signals, routing signals or register signals, management signals or inter-register signaling
  - In-channeling signaling (inband and outband signaling, PCM signaling)
  - Common Channel Signaling (CCS), CSS Network (LE, STP, SCP), associated CCS, quasi-associated signaling, non-associated CCS
  - Comparison between In-channeling and Common Channel Signaling
- Signaling System 7
  - Purpose and features of SS7, SS7 network architecture (SSP, STP, SCP), signaling link types (A-B-C-D-E-F), protocol architecture of SS7 (MTP, TCAP, ISUP, TUP, OMAP/DUP), SS7 signaling units (FISU, LSSU, MSU), basic call setup (IAM, ACM, ANM, REL, RLC)

VI. Traffic Analysis

- Traffic characterization (loss and delay systems), trunk, arrival rate / calling rate, holding time / service time, traffic volume, traffic intensity or average occupancy, traffic measurement unit (erlang, century call seconds)
- Traffic Statistics
  - call completion ratio (CCR), answer to seizure ratio (ASR) and factors affecting low ASR, network efficiency ratio (NER), call setup success rate (CSSR), call drop rate (CDR), call failure rate (CFR), mean holding time (MHT), mean conversation time (MCT), busy hour call attempts (BHCA), busy hour calling rate (BHCR), Grade of Service (GoS), blocking probability, call congestion, duration of congestion period
- Traffic Types
  - traffic offered (call attempts), traffic carried (call success), traffic lost (call failure)

VII. Synchronous Optical Network (SONET) / Synchronous Digital Hierarchy (SDH)

- Plesiochronous Digital Hierarchy (PDH) overview, advantages and disadvantages of PDH, SONET and SDH overview and its features, SONET signal hierarchy (STS-1 to STS-192) and the comparison of data rates for STS and STM signals, SONET components (STS multiplexer and demultiplexer, add/drop multiplexer (ADM), regenerators), comparison of SONET and existing digital signals, SONET network and layers, SONET frame format versus SDH frame format, SONET (SOH, LOH, POH), SONET virtual tributaries, SDH containers and virtual containers

VIII. Emerging Technologies

- Broadband implementation in commercial exchange and introduction to software switches (soft-switch)
- Unification of circuit and packet technologies, next generation networks (NGN), layered architecture, implementation strategies

Lab Outline

Practical demonstration and exercise of telephone switching, call routing, signaling, trunking, numbering plan and charging of calls

Recommended Textbooks

1. Digital Telephony - John C. Bellamy
   (Latest Edition "3rd", ISBN-10: 0471345717 or ISBN-13: 978-0471345718)

2. Telecommunications Switching Principles - Michael T. Hills
   (Latest Edition "1st", ISBN-10: 0262080923 or ISBN-13: 978-0262080927)

3. Data Communications and Networking - Behrouz A. Forouzan
   (Latest Edition "5th", ISBN-10: 0073376221 or ISBN-13: 978-0073376226)

4. Telecommunications Switching, Traffic and Networks - John Edward Flood
   (Latest Edition "1st", ISBN-13: 978-0130333094)

Reference Material

1. Telecommunications Transmission Handbook - Roger L. Freeman
   (Latest Edition "4th", ISBN-13: 978-0471240181)

2. Digital Transmission Systems - David R. Smith
   (Latest Edition "3rd", ISBN-13: 978-1402075872)

3. Telecom Systems, PSTN, PBX, Datacom, IP Telephony, IPTV, Wireless and Billing - Lawrence Harte, Avi Ofrane (Latest Edition "1st", ISBN-13: 978-0972805391)

4. Signaling System #7 - Travis Russell
   (Latest Edition "6th", ISBN-13: 978-0071822145)

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Wireless Communications

Pre-requisites	Antennas and Wave Propagation
Co-requisite	Nil
Course Code	TL424
Semester	7th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	50
Credit Hours	3 + 1
Minimum Contact Hours	45 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to give basic knowledge about radio and wireless communications (propagation and systems). This knowledge is needed to understand, analyze, design and develop future wireless communication systems.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 88: TH: CLOs, Mapping of CLOs to PLOs of Wireless Communications

CLOs	Description	Taxonomy	PLOs
1	Describe the wireless communication systems (evolution, paging system, cellular telephony, call setup procedure etc).	C2	1
2	Apply the fundamental concepts of channel modeling and cellular system design.	C3	4
3	Analyze and compare the performance of modulation schemes including spread spectrum systems and multicarrier systems.	C4	2

Table 89: PR: CLOs, Mapping of CLOs to PLOs of Wireless Communications

CLOs	Description	Taxonomy	PLOs
4	Perform experiments to observe and investigate the behaviour of propagation channel and modulation schemes.	P2	5

Table 90: Assessment Methods of CLOs of Wireless Communications

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Lab Exam	Project/ OEL/CEP	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-60%]				C2	1
2	[Quiz-40%]	[Q2-20%]	[Q1-40%]			C3	4
3	[Quiz-20%]		[Q2-30%]		[Q1-50%]	C4	2
4	[Quiz-40%]			[Test-30%] [ViVa-30%]		P2	5

Contents

I. Introduction

- Introduction to wireless communication systems, classification of wireless systems, wireless propagation mechanisms (free space, sky waves and space waves etc.), frequency classifications, radio frequency management.

II. Link Performance

- wireless channel and impairments, path loss, path geometry, propagation models, free-space models, frii's equation, two-ray models, diffraction models, fading, small scale fading (due to delay spread and due to doppler spread), large scale fading, rayleigh and rician fading, average duration of fade, level crossing rate, curved earth model, mitigation of fading using equalization, link budget.

III. Introduction to Cellular Communication System

- History, evolution of cellular system, six basic components in every cellular system, frequency re-use concept, co-channel interference, channel assignment methods, handover and roaming, multiple access techniques (FDMA, TDMA and CDMA etc.), power control, cell splitting, cell breathing, sectoring.

IV. Spread Spectrum Systems

- Introduction to spread spectrum methods, direct sequence spread spectrum, frequency hopping spread spectrum, slow and fast FHSS, pseudo noise codes, m-sequences, walsh hadamard codes, correlation properties of spreading codes, orthogonal frequency division multiplexing.

V. Legacy Systems

- Introduction to GSM, system architecture, frame structure, channel types, GSM link level, GSM handover and roaming, IS-95 (CDMA-based), GPRS/EDGE systems, UMTS, UTRAN, HSPA, long-term evolution (LTE), LTE-A and beyond.

VI. Other Wireless Communication Systems

- Diversity techniques (SISO and MIMO systems), cooperative communications, WiMAX, Bluetooth v4/v5, UWB systems, WLAN (IEEE 802.11n)

Lab Outline

Simulation of propagation characteristics of a radio signal in free space, simulation of AWGN channel, simulation of rayleigh and rician fading channel, simulation of flat and frequency selective fading, simulation of BER performance of various digital modulation schemes (M-PSK, M-QAM) for the AWGN channel and rayleigh fading channel, simulation of frequency hopping spread spectrum communication, simulation of direct sequence spread spectrum, simulation of orthogonal frequency division multiplexing, design of orthogonal and quasi-orthogonal codes of CDMA systems.

Recommended Textbooks

1. Wireless Communications: Principles and Practice - Theodore S. Rappaport
   (Latest Edition "2nd", ISBN-10: 0130422320 or ISBN-13: 007-6092011736)

2. Modern Wireless Communications - Simon O. Haykin, Michael Moher
   (Latest Edition "5th", ISBN-10: 0130224723 or ISBN-13: 978-0130224729)

Reference Material

1. The Mobile Radio Propagation Channel - J. D. Parsons
   (Latest Edition "2nd", ISBN-10: 047198857X or ISBN-13: 978-0471988571)

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Queueing Theory

Pre-requisites	Probability and Stochastic Processes
Co-requisite	Nil
Course Code	TL431
Semester	7th
Effective	16TL batch and onwards
Theory Marks	50
Practical Marks	50
Credit Hours	2 + 1
Minimum Contact Hours	30 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to provide an overview of elementary concepts of queuing networks, which are essential to the design, analysis and optimization of telecommunication networks. The course starts with review of probability theory and stochastic processes, which are needed to understand Markovian processes and chains. Simple case studies along with exercises and examples will be adopted to help understand the applications of queuing theory. Moreover, the knowledge obtained through this course will build analytical skills to solve problems related to queuing networks. Queuing theory is the subject of intense research and the experience developed through this course will help students do research in the field of queuing theory.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 91: TH: CLOs, Mapping of CLOs to PLOs of Queueing Theory

CLOs	Description	Taxonomy	PLOs
1	Explain fundamental concepts of queueing theory.	C2	1
2	Analyze simple and complex queues using Markovian processes and chains.	C4	3

Table 92: PR: CLOs, Mapping of CLOs to PLOs of Queuing Theory

CLOs	Description	Taxonomy	PLOs
3	Perform experiments to observe and investigate the behaviour of simple to complex queuing systems.	P4	4
4	Respond appropriately to the questions related to the subject.	A2	10

Table 93: Tentative Assessment Methods of CLOs of Queuing Theory

CLOs	Quiz / Assignment / Lab Rubrics	Mid Exam	Final Exam	Lab Exam	Project / OEL/CEP	Learning Levels	PLOs
1	[Quiz1-20%]	[Q1-80%]				C2	1
2	[Assignment-50%]	[Q2-50%]				C4	3
3	[Lab-40%]			[Test-30%]	[Q1-30%]	P4	4
4				[ViVa-100%]		A2	10

Contents

   I. Review of probability theory and stochastic processes

     - Conditional probabilities on events, independent events and conditionally independent events, law of total probability, Bayes' theorem

II. Queueing Theory

- Introduction to queueing and its examples
- Single-Server Network
    - average arrival rate, mean inter-arrival time, mean service time, average service rate, service order
- Performance metrics
    - response time or sojourn time, waiting time or delay, number of jobs in the system, number of jobs in queue
- Classification of queuing networks
    - open networks and closed networks
    - utilization and throughput
- Little's law for open and closed systems
- Discrete-Time Markov Chains (DTMC)
    - Definition and example, transition probabilities, finite-state DTMCs, stationary equations, examples of solving stationary equations, ergodic DTMC,
    - Infinite-state DTMCs, solving stationary equations in infinite-state DTMCs
- Continuous-Time Markov Chains (CTMC)
    - Definition, example, balance equation, limit distribution, M/M/1 and PASTA, M/M/k, M/M/∞

Lab Outline

The laboratory course will start with the introduction to discrete-event system simulation and what are the steps required in formulating a simulation study along with the examples of simple queuing systems. Later, performance evaluation of simple to complex queuing systems will be conducted through various software tools.

Resources

1. Octave-Forge - Extra packages for GNU Octave http://octave.sourceforge.net/queueing/
2. OMNeT++ Discrete Event Simulator - https://omnetpp.org/
3. SimEvents with MATLAB and Simulink - http://www.mathworks.com/discovery/queuing-theory.html

Recommended Textbooks

1. Stochastic Processes - Sheldon M. Ross
   (Latest Edition "2nd", ISBN-13: 978-0471120629)

2. Performance Modeling and Design of Computer Systems - Mor Harchol-Balter
   (Latest Edition "1st" Edition, ISBN-13: 978-1-107-02750-3)

3. Queuing Systems Volume I: Theory - Leonard Kleinrock
   (Latest Edition, ISBN-10: 0471491101 or ISBN-13: 978-0471491101)

4. Fundamentals of Queuing Theory - Donald Gross, John F. Shortle, James M. Thompson
   (Latest Edition "4th", ISBN-10: 047179127X or ISBN-13: 978-0471791270)

5. Queuing Modelling Fundamentals: With Applications in Communication Networks - Ng Chee-Hock, Soong Boon-Hee
   (Latest Edition "2nd", ISBN-10: 0470519576 or ISBN-13: 978-0470519578)

6. Queuing Theory and Telecommunications: Networks and Applications - Giovanni Giambene
   (Latest Edition "2nd", ISBN-10: 1461440831 or ISBN-13: 978-1461440833)

Reference Material

1. TCP/IP Illustrated: The Protocols, Volume 1 - Kevin R. Fall, W. Richard Stevens
   (Latest Edition "2nd", ISBN-13: 978-0321336316 or ISBN-10: 0321336313)

2. TCP/IP Illustrated: The Implementation, Volume 2 - Gary R. Wright, W. Richard Stevens
   (Latest Edition "1st", ISBN-13: 978-0201633542 or ISBN-10: 020163354X)

3. Teletraffic Engineering Handbook - Villy B. Iversen
   ITU-D SG 2/16 and ITC (Draft 2001-06-20)

Approval:	Board of Studies of Telecom. Engg:	Res. No. 20.3	Dated: 03-10-2017
	Board of Faculty of EEC Engineering	Res. No. 12.4	Dated: 16-10-2017
	Academic Council	Res. No. 93.3	Dated: 17-09-2018

Satellite and Radar Communication

Pre-requisites	Antennas and Wave Propagation
Co-requisite	Nil
Course Code	TL413
Semester	8th
Effective	16TL batch and onwards
Theory Marks	100
Practical Marks	0
Credit Hours	3 + 0
Minimum Contact Hours	45 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The course aims to equip students with fundamentals and basics of satellite and radar communication, such as orbits and launching methods, propagation and polarization methods, on board processing, link budget calculations, understandings of multiple access and modulations techniques, navigational and mobile services offered by such systems. The course also presents the latest development and practices in the satellite communication industry along with emphasis on the basics of RADAR communication system.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 94: TH: CLOs, Mapping of CLOs to PLOs of Satellite and Radar Communication

CLOs	Description	Taxonomy	PLOs
1	Explain the principles, concepts and operation of satellite and radar communication systems.	C2	1
2	Describe the concepts of signal propagation affects, link design, rain fading and link availability and perform interference calculations.	C2	2
3	Analyze the design requirements and the performance of satellite and radar communication systems.	C4	2

Table 95: Assessment Methods of CLOs of Satellite and Radar Communication

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-60%]		C2	1
2	[Quiz-20%]	[Q2-40%]	[Q2-40%]	C2	2
3	[Quiz-40%]		[Q2-60%]	C4	2

Contents

I. Principle of Satellite Communication

- Introduction and historical background, need of satellite communication, uplink and downlink frequencies, international regulation and frequency coordination, satellite frequency allocation and band spectrum, general and technical characteristics of satellite communication signal.

II. Orbits and Launching Methods

- Introduction to orbits and Kepler's laws for planetary motion, orbital perturbations, GEO-stationary orbit, and antenna look angles, earth eclipse of satellite, launches and launch vehicles.

III. Radio Wave Propagation

- Introduction of wave propagation theory, polarization of satellite signals, atmospheric losses, ionospheric effects, rain attenuation and depolarization and other impairments.

IV. The Space and Earth Segments

- Introduction of satellite segments, satellite on board processing, satellite subsystems, introduction and types of earth stations.

V. The Space Links

- Introduction, equivalent isotropic radiated power (EIRP), transmission losses, link power budget calculations, carrier-to-noise ratio (C/N) and carrier to interference ratio (C/I).

VI. Satellite Accessing Techniques

- Introduction of access techniques, pre-assigned and demand assigned FDMA, pre-assigned and demand assigned TDMA, satellite-switched TDMA, code-division multiple access (CDMA).

VII. Satellite Systems and Services

- Introduction of satellite systems, global positioning system (GPS), very small aperture terminals (VSATs), direct broadcast satellite (DBS) services, mobile satellite services, metrological satellite services, remote sensing services.

VIII. RADAR

- RADAR concept, RADAR block diagram and operation, RADAR distance equation, nautical mile, RADAR received power equation
- Pulse wave RADAR, PRT, PRF, duty cycle, block diagram analysis of pulse RADAR
- Continuous wave RADAR, doppler effect, RADAR velocity equation
- Phased array RADAR, ultrawideband (UWB) RADAR, RADAR applications

Recommended Textbooks

1. Satellite Communications - Dennis Roddy
   (Latest Edition "4th", ISBN-10: 0071462988 or ISBN-13: 978-0071462983)
2. Satellite Communication Systems - M. Richharia
   (Latest Edition "2nd", ISBN-10: 0071342087 or ISBN-13: 063-9785308706)

Reference Material

1. Handbook on Satellite Communications - International Telecommunications Union
   (Latest Edition "3rd", ISBN-10: 0471221899 or ISBN-13: 978-0471221890)
2. Satellite Communications Fundamentals - Jules E. Kadish, Thomas W. R. East
   (Latest Edition "1st", ISBN-10: 1580531369 or ISBN-13: 978-1580531368)
3. Satellite Communications - Timothy Pratt, Charles W. Bostian, Jeremy E. Allnutt
   (Latest Edition "2nd", ISBN-10: 047137007X or ISBN-13: 978-0471370079)
4. Introduction to RADAR Systems - Merrill Skolnik
   (Latest Edition "3rd", ISBN-10: 0072881380 or ISBN-13: 978-0072881387)
5. RADAR Engineering - G. S. N. Raju
   (Latest Edition "1st", ISBN-10: 8190694219 or ISBN-13: 978-8190694216)

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	Academic Council	Res. No. 93.3	Dated: 17-09-2018

Network Protocols and Architecture

Pre-requisites	Computer Communication and Networking
Co-requisite	Nil
Course Code	TL456
Semester	8th
Effective	19TL batch and onwards
Theory Marks	50
Practical Marks	50
Credit Hours	2 + 1
Minimum Contact Hours	30 + 45
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination
Assessment (Practical)	40% sessional, 60% final lab examination

Course Objectives

The course aims to highlight advanced concepts and configuration techniques used in the network of switches and routers.

Course Learning Outcomes

Upon completion of this course, students will be able to,

Table 96: TH: CLOs, Mapping of CLOs to PLOs of Network Protocols and Architecture

CLOs	Description	Taxonomy	PLOs
1	Explain link aggregation solutions, VLAN principles, link layer protocols for serial links, IP security architectures, IPv6 networks and routing technologies.	C2	1
2	Analyze VLANs and ACLs to suit application requirements.	C4	4

Table 97: PR: CLOs, Mapping of CLOs to PLOs of Network Protocols and Architecture

CLOs	Description	Taxonomy	PLOs
3	Perform link aggregation solutions, IP security, NAT and VLANs to suit application requirements.	P4	5

Table 98: Tentative Assessment Methods of CLOs of Network Protocols and Architecture

CLOs	Quiz / Assignment / Lab Rubrics	Mid Exam	Final Exam	Lab Exam	Project / OEL/CEP	Learning Levels	PLOs
1	[Quiz-20%]	[Q1-50%]	[Q1-30%]			C2	1
2		[Q2-50%]	[Q2-50%]			C4	4
3	[Lab-30%]			[Test-30%] [ViVa-20%]	[Q1-20%]	P4	5

Contents

   I. Advanced Enterprise Solutions and Link Aggregation

     - Use of link aggregation and various forms of link aggregation

  II. VLAN Principles

     - Application of VLAN tagging, port link types and characteristics

     - Port based VLANs

 III. GARP and GVRP

- Characteristics of GARP and GVRP, GARP messages and GVRP registration modes

IV. VLAN Routing

- Purpose of VLAN routing
- VLAN routing for layer 2 and layer 3 switches

V. Principle and Configuration of HDLC and PPP

- DCE, DTE, HDLC protocol
- PPP protocol, components of PPP, PPP frame, LCP negotiation
- PAP authentication on the PPP link, CHAP authentication on the PPP link

VI. Frame Relay Principles

- Function of DLCI, LMI negotiation process, static and dynamic mapping
- PPPoE connection establishment process and sessions

VII. MPLS Principles

- Fundamentals of Labels, Label Stack and Label Distribution Protocol (LDP)
- Basic MPLS architecture (Control and Forwarding Plane), Label Edge Router (LER) and Label Switched Router (LSR), MPLS Packet Structure
- Label Switched Path (LSP) and Forwarding Equivalence Class (FEC)
- MPLS Support for Virtual Networks, MPLS VPN Basics

VIII. Network Address Translation

- General behavior of NAT, different forms of NAT

IX. Access Control Lists

- Applications of ACL in the enterprise networks
- Decision making behavior of ACLs
- Establishing AAA and schemes of AAA security architecture

X. Securing Traffic with IPSec VPN

- Basic principles of IPSec security architecture
- IPSec peering between two devices

XI. Supporting Dynamic Routing with GRE

- Principle behavior of GRE, GRE over IPSec

XII. Implementing IPv6 Networks and Routing Technologies

- Characteristics of IPv6, address format and addressing types
- IPv6 stateless address auto-configuration
- Characteristics and operation of RIPng and OSPFv3

XIII. Simple Network Management Protocol

- SNMP architecture and messaging behavior
- Function of the Management Information Base (MIB)

Lab Outline

I. Manually set the line rate on an interface, manual mode link aggregation, link aggregation using LACP mode

II. Assign port interfaces to become access and trunk ports, VLAN tagging, GVRP configuration, VLAN routing and configuration of sub-interfaces, VLAN routing over an Ethernet Trunk link

III. HDLC and PPP Configuration, configuration of frame relay interfaces, establishment of RIP in a hub and spoke network, configuration of frame relay interfaces when using the OSPF point-to-multipoint network type

IV. Establishment of basic and advanced ACL to implement enhanced filtering

V. Translation of addresses between networks (NAT)

VI. Establishing local AAA solutions and securing traffic with IPSec VPN

VII. Supporting dynamic routing with GRE, and configuration of IPv6 network

Laboratory Resources

1. Huawei's Simulator Platform eNSP (V100R002C00B500)

Recommended Textbooks

1. HCNA Networking Study Guide - Huawei Technologies Co., Ltd.
   (Latest Edition "1st", ISBN-10: 9811015538 or ISBN-13: 978-9811015533)

2. CCNA Routing and Switching Complete Study Guide: Exam 100-105, Exam 200-105, Exam 200-125 - Todd Lammle
   (Latest Edition "2nd", ISBN-10: 1119288282 or ISBN-13: 978-1119288282)

Reference Material

1. Computer Networking: A Top-Down Approach - James F. Kurose and Keith W. Ross
   (Latest Edition "6th", ISBN-10: 0-13-285620-4 or ISBN-13: 978-0-13-285620-1)

2. Data Communications and Networking - Behrouz A. Forouzan
   (Latest Edition "5th", ISBN-10: 0073376221 or ISBN-13: 978-0073376226)

Approval:	Board of Studies of Telecom. Engg:	Res. No. 27.1	Dated: 23-05-2022
	Board of Faculty of EEC Engineering	Res. No. 19.7	Dated: 15-06-2022
	Academic Council	Res. No. 6(iii)	Dated: 29-07-2022

Emerging Wireless Technologies and RF Planning

Pre-requisites	Wireless Communications
Co-requisite	Nil
Course Code	TL484
Semester	8th
Effective	16TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The course aims to introduce the basic concepts behinds the design and planning of mobile networks such as 2G/3G systems and beyond.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 99: TH: CLOs, Mapping of CLOs to PLOs of Emerging Wireless Technologies and RF Planning

CLOs	Description	Taxonomy	PLOs
1	Discuss the fundamentals of emerging wireless communication systems and process of radio network planning.	C2	1
2	Analyze the traffic modelling, blocking and dropping.	C4	4
3	Demonstrate the link budget, coverage probability and frequency reuse planning.	C3	2
4	Examine the design principles and deployment scenarios of 2G, 3G and beyond systems.	C4	3

Table 100: Assessment Methods of CLOs of Emerging Wireless Technologies and RF Planning

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-30%]	[Q1-70%]		C2	1
2	[Quiz-30%]	[Q2-70%]		C4	4
3	[Quiz-30%]	[Q3-30%]	[Q1-40%]	C3	2
4	[Quiz-30%]		[Q2-70%]	C4	3

Contents

I. Capacity Planning

- Detailed network design and analysis - capacity design, traffic modeling (Erlang model), reverse/forward link capacity and link capacity equation, network architecture, site surveys and audits, cell site configurations

II. Link Budgets

- Noise figure in link budget, S/N ratio for a mobile user, receiver sensitivity, confidence cell, shadow margin and handoff gain, fade margin, interference, forward/reverse link range, link budget factors (MAPL calculations)

III. Coverage Planning

- Coverage design, average path loss models (Hata, Cost 231 etc.), Link budget factors (MAPL calculations), cell site gains and losses, drive testing, identifying antenna types, antenna configurations, coverage goals, equipment characteristics, base station design, spreadsheet based planning and growth planning

IV. 2G Network Planning: Case Study GSM

- Review of GSM system and architecture, reverse and forward links, frequency planning (frequency reuse, frequency allocation, frequency conflicts, handoffs, power control)

V. 3G Network Planning: Case Study WCDMA/CDMA2000

- Fundamentals of CDMA2000 standard, radio configurations, wireless architecture, reverse and forward links, logical and physical channels
- PN Planning (frequency allocation, pilot increment and search window size, PN offset reuse patterns, PN offset planning, pilot searching process, aliasing)
- Handoff Planning (soft handoffs, deploying second carrier, hard handoff, interference mitigation, hard handoff triggers, pilot beacon)

VI. Emerging Wireless Networks

- WLAN/WPAN/WMAN (IEEE 802.15, 802.16, IEEE 802.11ac, 802.11ah for IoT, 802.11ai, 802.11ax)
- 4G/5G (OFDMA, SC-FDMA, SOFDMA, BDMA, FBMC, IEEE 802.11ad, 802.11af)
- 5G cellular network architecture

Recommended Textbooks

1. Mobile Cellular Telecommunications: Analog and Digital Systems - William C. Y. Lee
   (Latest Edition "2nd", ISBN-10: 0070380899 or ISBN-13: 978-0070380899)

2. Radio Interface System Planning for GSM/GPRS/UMTS - Jukka Lempiäinen, Matti Manninen
   (Latest Edition "2nd", ISBN-10: 1441949143 or ISBN-13: 978-1441949141)

3. Radio Network Planning and Optimisation for UMTS - Jaana Laiho, Achim Wacker, Tomas Novosad
   (Latest Edition "2nd", ISBN-10: 0470015756 or ISBN-13: 978-0470015759)

Reference Material

1. CDMA RF System Engineering - Samuel C. Yang
   (Latest Edition "1st", ISBN-10: 0890069913 or ISBN-13: 978-0890069912)

2. CDMA Network planning - Qualcomm (Student Notes)

3. Fundamentals of LTE - Arunabha Ghosh, Jun Zhang, Jeffrey G. Andrews, Rias Muhamed
   (Latest Edition "1st", ISBN-10: 0137033117 or ISBN-13: 978-0137033119)

4. Emerging Wireless LANs, Wireless PANs, and Wireless MANs: IEEE 802.11, IEEE 802.15, 802.16 Wireless Standard Family - Yang Xiao, Yi Pan
   (Latest Edition "1st", ISBN-10: 0471720690 or ISBN-13: 978-0471720690)

5. RF Engineering for Wireless Networks: Hardware, Antennas, and Propagation - Daniel M. Dobkin
   (Latest Edition "1st", ISBN-10: 0750678739 or ISBN-13: 978-0750678735)

6. Cellular Mobile Radio Systems: Designing Systems for Capacity Optimization - Husni Hammuda
   (Latest Edition "1st", ISBN-10: 0471956414 or ISBN-13: 978-0471956419)

7. Designing a Wireless Network: Understanding How Wireless Communication Works - Jeffrey Wheat, Randy Hiser, Jackie Tucker, Alicia Neely, Andy McCullough
   (Latest Edition "1st", ISBN-10: 1928994458 or ISBN-13: 978-1928994459)

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	Board of Faculty of EEC Engineering	Res. No. 12.4	Dated: 16-10-2017
	Academic Council	Res. No. 93.3	Dated: 17-09-2018

Telecom Policies and Standards

Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL461
Semester	8th
Effective	16TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The course aims to familiarize student with ICT and its economic and socio-cultural impact at international/local level as well as understand the telecom environment/landscape at international, regional and national level. Moreover, to understand the role of various government entities and other stakeholders, including telecom organizations/entities regulating and providing telecom services in Pakistan.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 101: TH: CLOs, Mapping of CLOs to PLOs of Telecom Policies and Standards

CLOs	Description	Taxonomy	PLOs
1	Explain the role of independent regulations, policy objectives, and the challenges posed by emerging ICT/Telecom technologies in the development of Telecommunication Policy in Pakistan, in relation to the legal/regulatory regime.	C2	1
2	Apply the acquired skills in a professional manner to provide Quality of Service, customer care, and competitive behavior.	C3	2
3	Analyze the current Telecommunication policies and standards worldwide given by ITU(T), IEEE and International Organization of Standards (ISO).	C4	12

Table 102: Assessment Methods of CLOs of Telecom Policies and Standards

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-60%]		C2	1
2	[Quiz-20%]	[Q2-40%]	[Q1-40%]	C3	2
3	[Quiz-20%]		[Q2-80%]	C4	12

Contents

I. Introduction

- Basic concepts and definitions concerning ICT along with types of ICT and its measuring parameters
- Selected regulatory terminologies

II. Pakistan Telecom. Background/Historical Perspective

- Covering telecom sector's background, from the days of T&T to the current competitive scenario prevailing in the local telecom market
- Introduction to and functioning of telecom regulatory stakeholders in Pakistan: stakeholders, like the GoP (MoIT), pakistan telecom authority (PTA), frequency allocation board (FAB), telecom operators/service providers, telecom consumers, etc.

III. Telecom Deregulation and Liberalization (A Conceptual Framework)

- Familiarization with Telecom liberalization, privatization, de-regulation, competition etc. as per international best practices.

IV. Regulating for Effective Competition

- Conceptual frame work of telecom regulation as international best practices, prevailing regulatory environment in the country; competition amongst various segments of services in Pakistan and future prospects etc.
- Process of legislation in Pakistan and introduction to telecom policies, act, rules and regulations: process of enactment of legislation/laws, presentation/discussion on telecom reorganization act of 1996, introduction to various telecom rules and major regulations issued by PTA and analysis of their usefulness/utility

V. Introduction to Telecom Standards and Protocols

- Familiarization with international/regional telecom organizations/bodies: functioning of various agencies/bodies (international and regional) such as World Bank, WTO, ITU, APT and SAARC etc.
- Acquaintance with telecom standard organizations like ITU(T), IEEE and international organization of standards (ISO) etc.

Recommended Textbooks

1. Section 1 (Chapters 1,2,4,7), Section 4 (Chapters 15,16), Section 6 (Chapters 24,26,27,28), Section 7 (Chapter 31) of "The APC ICT Policy Handbook (Second edition) | Association for Progressive Communications", apc.org, 2016. [Online]. Available: https://www.apc.org/en/pubs/books/apc-ict-policy-handbook-second-edition. [Accessed: 13-Oct-2016].

2. Chapters 1,2 of "10th Anniversary Telecommunications Regulation Handbook", infodev.org, 2016. [Online]. Available: http://www.infodev.org/articles/10th-anniversary-telecommunications-regulation-handbook. [Accessed: 13-Oct-2016].

3. An Introduction to International Telecommunications Law - Charles H. Kennedy, M. Veronica Pastor (Latest Edition "1st", ISBN-10: 0890068356 or ISBN-13: 978-0890068359)

Reference Material

1. Secondary Reading: International Telecom. Union (ITU) relevant publications at www.itu.int ; International Organization for Standardization (ISO) at www.iso.org ; Institute of Electrical & Electronics Engineering (IEEE) at www.ieee.org

2. An Introduction to International Telecommunications Law - Charles H. Kennedy, M. Veronica Pastor (Latest Edition "1st", ISBN-10: 0890068356 or ISBN-13: 978-0890068359)

3. International Telecommunications Handbook - Robert M. Frieden
(Latest Edition "1st", ISBN-10: 0890065683 or ISBN-13: 978-0890065686)

4. Material on various topics issued by the instructor

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	Board of Faculty of EEC Engineering	Res. No. 12.4	Dated: 16-10-2017
	Academic Council	Res. No. 93.3	Dated: 17-09-2018

Entrepreneurship

Pre-requisites	Nil
Co-requisite	Nil
Course Code	ENT401
Semester	8th
Effective	19TL batch and onwards
Theory Marks	50
Practical Marks	0
Credit Hours	2 + 0
Minimum Contact Hours	30 + 0
Assessment (Theory)	20% sessional work, 20% mid-semester, 60% final examination

Course Objectives

The course aims to identify entrepreneurship in theory and its economic contribution, positive or negative, in practice. In particular, the course considers whether the policy intervention can encourage entrepreneurship activity and if so, how this may best be achieved.

Course Learning Outcomes

Upon completion of this course, students will be able to achieve:

Table 103: TH: CLOs, Mapping of CLOs to PLOs of Entrepreneurship

CLOs	Description	Taxonomy	PLOs
1	Develop advanced knowledge on how to assess business opportunities and an in-depth understanding of what typically characterize successes and failures.	C3	6
2	Develop advanced knowledge about key processes necessary to bring new products and services to market and key challenges faced by the entrepreneur at different stages.	C3	7
3	Assess the commercial viability of new technologies, business opportunities and existing companies.	C6	12
4	Organize and execute a project or new venture with the goal of bringing new products and service to the market.	P4	11

Table 104: Assessment Methods of CLOs of Entrepreneurship

CLOs	Sessional Quizzes and Assignments	Mid Exam	Final Exam	Learning Levels	PLOs
1	[Quiz-40%]	[Q1-60%]		C3	6
2	[Quiz-40%]	[Q2-20%]	[Q1-40%]	C3	7
3	[Quiz-20%]	[Q3-20%]	[Q2-60%]	C6	12
4			[Q3-100%]	P4	11

Contents

I. Foundations of Entrepreneurship

- Concept of Entrepreneurship and Entrepreneur
- Different forms of Entrepreneurship

II. Making the Possible Real

- Core of Entrepreneurship
- Entrepreneur and Entrepreneurship
- Characteristics of an Entrepreneur

- Essential skills for Entrepreneur
- Cognitive foundations of Entrepreneurship
- Entrepreneurial revolution

III. Entrepreneurship

- An evolving concept
- Understanding Entrepreneurial opportunities and industry analysis
- Developing corporate Entrepreneurship
- Innovation and the Entrepreneurship
- Minority Entrepreneurs
- Total quality management in Entrepreneurship
- Women Entrepreneurship

Recommended Textbooks

1. Entrepreneurship in Theory and Practice: Paradoxes in Play - Suna Lowe Nielsen, Kim Klyver, Majbritt Rostgaard Evald, Torben Bager
   (Latest Edition "2nd", ISBN-10: 1785364472 or ISBN-13: 978-1785364471)

2. Entrepreneurship: A Process Perspective - Robert A. Baron, Scott A. Shane
   (Latest Edition "2nd", ISBN-10: 0324365586 or ISBN-13: 978-0324365580)

3. Entrepreneurship - Donald F. Kuratko, Richard M. Hodgetts
   (Latest Edition "7th", ISBN-10: 0324323417 or ISBN-13: 978-0324323412)

Reference Material

1. Entrepreneurship: An Evidence-Based Guide - Robert A. Baron
   (Latest Edition "1st", ISBN-10: 1781000395 or ISBN-13: 978-1781000397)

2. Fundamentals of Entrepreneurship - H. Nandan
   (Latest Edition "3rd", ISBN-10: 8120347501 or ISBN-13: 978-8120347502)

Approval:	Board of Studies of MUISTD	Res. No. 1.04	Dated: 17-03-2014
	Advanced Studies and Research Board	Res. No. 128.05	Dated: 29-04-2014
	Board of Faculty of EEC Engineering	Res. No. 12.4	Dated: 16-10-2017
	Academic Council	Res. No. 93.3	Dated: 17-09-2018

MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO
DEPARTMENT OF TELECOMMUNICATION ENGINEERING

Thesis/Project

Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL498, TL499
Semester	7th & 8th
Practical Marks	200
Credit Hours	0 + 6

Final Year Project

Table 105: Assessment Method and Marks Distribution of Final Year Project

CLOs	7th Semester		8th Semester	
	Achievement	Marks	Achievement	Marks
PLO1	50%	15	50%	15
PLO2	70%	10	30%	05
PLO3	40%	10	60%	15
PLO4	50%	10	50%	10
PLO5	50%	10	50%	10
PLO6	50%	05	50%	05
PLO7	50%	05	50%	05
PLO8	50%	10	50%	10
PLO9	50%	05	50%	05
PLO10	50%	10	50%	10
PLO11	50%	05	50%	05
PLO12	50%	05	50%	05

Table 106: List of Examiners and their Marks Distribution for Final Year Project

Semester	CHs	Marks	Supervisor	Internal	External	Chairman
7th	3	100	25	25	25	25
8th	3	100	25	25	25	25