

# **UNIVERSITY OF MUMBAI**



## **Bachelor of Engineering**

**Electronics & Telecommunication Engineering**  
**(Second Year – Sem. III & IV), Revised course**  
**(REV- 2012) from Academic Year 2012 -13.**

**Under**

**FACULTY OF TECHNOLOGY**

(As per Semester Based Credit and Grading System)

## **From Dean's Desk:**

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

**Dr. S. K. Ukarande**  
**Dean,**  
**Faculty of Technology,**  
**Member - Management Council, Senate, Academic Council**  
**University of Mumbai, Mumbai**

## Preamble:

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. An engineering program must ensure that its graduates understand the basic concepts of science and mathematics, have gone through one engineering field in dept of appreciate and use its methodologies of analyses and design, and have acquired skills for life-long learning.

An engineering program must therefore have a mission statement which is in conformity with program objectives and program outcomes that are expected of the educational process. The outcomes of a program must be measureable and must be assessed regularly through proper feedback for improvement of the programme. There must be a quality assurance process in place within the Institute to make use of the feedback for improvement of the programme. The curriculum must be constantly refined and updated to ensure that the defined objectives and outcomes are achieved. Students must be encouraged to comment on the objectives and outcomes and the role played by the individual courses in achieving them. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electronics and Telecommunication Engineering University of Mumbai, happy to state here that, Program Educational Objectives were finalized in a meeting where more than 20 members from different Institutes were attended, who were either Heads or their representatives of Electronics and Telecommunication Engineering Department. The Program Educational Objectives finalized for undergraduate program in Electronics and Telecommunication Engineering are listed below;

- To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
- To prepare students to demonstrate an ability to identify, formulate and solve electronics and telecommunication engineering problems.
- To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
- To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
- To develop the ability among students to synthesize data and technical concepts from applications to product design.
- To provide opportunity for students to work as part of teams on multidisciplinary projects.
- To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

In addition to above more program educational objectives of their own may be added by affiliated Institutes.

In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum

to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

**Dr. Udhav Bhosle**  
**Chairman, Board of Studies in Electronics and Telecommunication Engineering**

**Programme Structure B.E. (Electronics & Telecommunication)**  
**S.E. (Electronics & Telecommunication) Sem IV**

Sub Code	Subject Name	Teaching Scheme(Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETS401	* Applied Mathematics IV	04	--	01	04	--	01	05
ETC402	Analog Electronics II	04	--	--	04	--	--	04
ETC403	Microprocessors and Peripherals	04	--	--	04	--	--	04
ETC404	Wave Theory and Propagation	04	--	--	04	--	-	04
ETC 405	Signals and Systems	03	--	01	03	-	01	04
ETC406	Control Systems	04	--	--	04	--	-	04
ETL401	Analog Electronics II Laboratory	--	02	--	--	01	--	01
ETL402	Microprocessors and Peripherals Laboratory	--	02	--	--	01	--	01
ETL403	Software Simulation Laboratory	--	02	--	--	01	--	01
<b>Total</b>		<b>23</b>	<b>06</b>	<b>02</b>	<b>23</b>	<b>03</b>	<b>02</b>	<b>28</b>

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETS401	*Applied Mathematics IV	20	20	20	80	25	--	--	125
ETC402	Analog Electronics II	20	20	20	80	--	--	--	100
ETC403	Microprocessors and Peripherals	20	20	20	80	--	--	--	100
ETC404	Wave Theory and Propagation	20	20	20	80	--	--	--	100
ETC 405	Signals and Systems	20	20	20	80	25	--	--	125
ETC406	Control Systems	20	20	20	80	--	--	--	100
ETL401	Analog Electronics II Laboratory	--	--	--	--	25	25	--	50
ETL402	Microprocessors and Peripherals Laboratory	--	--	--	--	25	25	--	50
ETL403	Software Simulation Laboratory	--	--	--	--	25	25	--	50
<b>Total</b>		<b>--</b>	<b>--</b>	<b>120</b>	<b>480</b>	<b>125</b>	<b>75</b>	<b>--</b>	<b>800</b>

\* Indicate common subject for Electronics, Electronics & Telecommunication, Instrumentation, Biomedical and Electrical Engineering

Subject Code	Subject Name	Teaching Scheme(Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
<b>ETS 401</b>	Applied Mathematics IV	04	--	01	04	--	01	05

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test 2							
<b>ETS 401</b>	Applied Mathematics IV	20	20	20	80	25	--	--	125	

#### Course pre-requisite:

FE C 101 : Applied Mathematics I  
 FE C 201 : Applied Mathematics II  
 SE S 301 : Applied Mathematics III

#### Course objectives:

This course will present the method of calculus of variations (CoV), basic concepts of vector spaces, matrix theory, concept of ROC and residue theory with applications.

- To provide students with a sound foundation in mathematics and prepare them for graduate studies in Electronics and Telecommunication Engineering
- To provide students with mathematics fundamental necessary to formulate, solve and analyze engineering problems.
- To provide opportunity for students to work as part of teams on multi disciplinary projects.

#### Expected outcomes:

- Students will able to apply method of calculus of variations to specific systems, demonstrate ability to manipulate matrices and compute eigenvalues and eigenvectors, Identify and classify zeros, singular points, residues and their applications.
- Students will demonstrate an ability to identify formulate and solve Telecommunication Engineering problem using applied mathematics.
- Students who can participate and succeed in competitive exams like GATE, GRE.

Module No.	Unit No.	Topics	Hrs.
<b>1.0</b>		<b>Calculus of variation</b>	<b>10</b>
	<b>1.1</b>	Euler Langrange equation, solution of Euler's Langrange equation (only results for different cases for function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables	
	<b>1.2</b>	Isoperimetric problems, several dependent variables	
	<b>1.3</b>	<b>Functions involving higher order derivatives:</b> Rayleigh-Ritz method	
<b>2.0</b>		<b>Linear algebra: vector spaces</b>	<b>12</b>
	<b>2.1</b>	<b>Vectors in n-dimensional vector space:</b> Properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	<b>2.2</b>	Metric spaces, vector spaces over real field, properties of vector spaces over real field, subspaces.	
	<b>2.3</b>	Norms and normed vector spaces	
	<b>2.4</b>	Inner products and inner product spaces	
	<b>2.5</b>	The Cauchy-Schwarz inequality, orthogonal Subspaces, Gram-Schmidt process	
<b>3.0</b>		<b>Linear Algebra: Matrix Theory</b>	<b>15</b>
	<b>3.1</b>	Characteristic equation, Eigenvalues and Eigenvectors, properties of Eigenvalues and Eigenvectors	
	<b>3.2</b>	Cayley-Hamilton theorem, examples based on verification of Cayley-Hamilton theorem	
	<b>3.3</b>	Similarity of matrices, Diagonalisation of matrix	
	<b>3.4</b>	Functions of square matrix, derogatory and non-derogatory matrices	
	<b>3.5</b>	Quadratic forms over real field, reduction of quadratic form to a diagonal canonical form, rank, index, signature of quadratic form, Sylvester's law of inertia, value-class of a quadratic form of definite, semi-definite and indefinite	
	<b>3.6</b>	Singular Value Decomposition	
<b>4.0</b>		<b>Complex variables: Integration</b>	<b>15</b>
	<b>4.1</b>	<b>Complex Integration:</b> Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula	
	<b>4.2</b>	Taylor's and Laurent's series	
	<b>4.3</b>	Zeros, singularities, poles of $f(z)$ , residues, Cauchy's Residue theorem	
	<b>4.4</b>	Applications of Residue theorem to evaluate real Integrals of different types	
		<b>Total</b>	<b>52</b>

**Text books:**

- 1) A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune
- 2) Mathematical Methods in science and Engineering, A Datta (2012)
- 3) Higher Engg. Mathematics by Dr. B.S. Grewal, Khanna Publication

**Reference Books:**

- 1) Todd K.Moon and Wynn C. Stirling, Mathematical Methods and algorithms for Signal Processing, Pearson Education.
- 2) Kreyszig E., Advanced Engineering Mathematics, 9<sup>th</sup> edition, John Wiley, 2006.
- 3) Linear Algebra- Hoffman & Kunze (Indian editions) 2002
- 4) Linear Algebra- Anton & Torres (2012) 9<sup>th</sup> Indian Edition.
- 5) Complex Analysis – Schaum Series.

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

**End Semester Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
- 3: Question No.1 will be compulsory and based on entire syllabus.
- 4: Remaining question (Q.2 to Q.6) will be selected from all the modules.

**Term Work/Tutorial:**

At least 08 assignments covering entire syllabus must be given during the **Class Wise Tutorial**. The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **Credit and Grading System** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.



Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW	Tutorial	Total
ETC 402	Analog Electronics II	4	--	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETC 402	Analog Electronics II	20	20	20	80	-	-	--	100

**Course Pre-requisite:**

**ETC : 302 – Analog Electronics I**

**Course Objective:**

- To deliver the core concepts and reinforce the analytical skills learned in Analog Electronics I
- To motivate students to use MOS devices for designing and analyzing electronic Circuits which will help them to understand the fundamentals of VLSI design.

**Expected Outcomes:**

After completion of the course students will be able to

- Analyze and design multistage electronic Circuits.
- Differentiate between discrete and integrated biasing techniques.
- Differentiate between small signal and large signal Amplifiers.

Module No.	Unit No.	Topics	Hrs.
1.0		<b>Frequency Response of Amplifiers</b>	14
	1.1	<b>High Frequency Model:</b> High frequency hybrid-pi equivalent Circuits of BJT and MOSFET, Miller effect and Miller capacitance, gain bandwidth product	
	1.1	<b>Single Stage Amplifiers :</b> Effect of capacitors (coupling, bypass, load) on frequency response of single stage BJT (CE, CC, CB configurations) , MOSFET (CS, CG, CD configuration) amplifiers, low and high frequency response of BJT (CE, CB, CC) and MOSFET (CS, CG, CD) amplifiers	
	1.2	<b>Multistage Amplifier:</b> Low and high frequency response and mid – frequency analysis of multistage (CE-CE, CS-CS), cascode (CE-CB, CS-CG) Amplifiers, Darlington pair, design of two stage amplifiers	
2.0		<b>Differential Amplifiers</b>	10
	2.1	<b>BJT Differential Amplifiers:</b> Terminology and qualitative description, DC transfer characteristics, small signal analysis, differential and common mode gain, CMRR, differential and common mode input impedance	
	2.2	<b>MOSFET Differential Amplifiers:</b> DC transfer characteristics, small signal analysis, differential and common mode gain, CMRR, differential and common mode input impedance	
3.0		<b>Integrated Circuits Biasing Techniques</b>	08
	3.1	<b>Current Mirror:</b> Two transistor (BJT, MOSFET) current source, current relationship, output resistance.	
	3.2	<b>Improved Current Source:</b> Three transistor (BJT, MOSFET) current source	
	3.3	<b>Special Current Source:</b> Cascode (BJT, MOSFET) current source, Wilson and Widlar current sources	
4.0		<b>Power Amplifiers</b>	8
	4.1	<b>Power Devices:</b> Power BJTs, power MOSFETs, heat sinks	
	4.2	<b>Classification:</b> Class A, Class B, Class AB and Class C operation, and performance parameters	
	4.3	<b>Transformer and Transformerless Amplifiers:</b> Transformer coupled Class A Amplifier, Class AB output stage with diode biasing, $V_{BE}$ multiplier biasing, input buffer transistors, Darlington configuration	
5.0		<b>Fundamentals of Operational Amplifier</b>	08
	5.1	<b>Fundamentals of Op-amp:</b> characteristics of op-amp, high frequency effects on op-amp gain and phase, slew rate limitation,	
	5.2	<b>Applications of Op-amps:</b> Inverting and non-inverting amplifier, adder, subtractor, integrator, differentiator, active filters (first order low and high pass)	
6.0		<b>DC Regulated Power Supply</b>	04
	6.1	<b>Series and Shunt Regulator:</b> Regulator performance parameters, Zener shunt regulator, transistorized series and shunt regulator	
		<b>Total</b>	<b>52</b>

**Text Books:**

1. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill, 2<sup>nd</sup> Edition
2. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar, Microelectronic Circuits Theory and Applications, Fifth Edition, International Version, OXFORD International Students Sixth Edition

**Recommended Books:**

1. S. Salivahanan, N. Suresh Kumar, "*Electronic Devices and Circuits*", Tata McGraw Hill, 3<sup>rd</sup> Edition
2. Jacob Millman, Christos C Halkias, and Satyabratatajit, "*Millman's Electronic Devices and Circuits*", McGrawHill, 3<sup>rd</sup> Edition
3. Muhammad H. Rashid, "*Microelectronics Circuits Analysis and Design*", Cengage Learning, 2<sup>nd</sup> Edition
4. Jacob Milliman and Arvin Grabel, "Microelectronics" Tata McGrawHill, 2<sup>nd</sup> Edition
5. Anil K. Maini and Varsha Agrawal, "*Electronic Devices and Circuits*", Wiley Publications

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

**End Semester Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
- 3: Question No.1 will be compulsory and based on entire syllabus.
- 4: Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC 403	Microprocessors and Peripherals	4	--	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Avg. Of Test 1 and Test 2						
ETC403	Microprocessor and Peripherals	20	20	20	80	-	-	-	100	

**Course pre-requisite:**

ETC 303 : Digital Electronics

**Course objectives:**

- To develop background knowledge and core expertise in microprocessor.
- To study the concepts and basic architecture of 8085, 8086, 80286, 80386, 80486 Pentium processor and Co-processor 8087.
- To know the importance of different peripheral devices and their interfacing to 8086.
- To know the design aspects of basic microprocessor.
- To write assembly language programs in microprocessor for various applications.

**Course outcomes:**

Students will learn

- The architecture and software aspects of microprocessor 8086
- Assembly language program in 8086 for various applications.
- Co-processor configurations.
- Various interfacing techniques with 8086 for various applications.
- Basic concepts of advanced microprocessors.

Module No.	Unit No.	Topics	Hrs.
<b>1.0</b>		<b>Architecture of 8085 and 8086 Microprocessor</b>	<b>08</b>
	<b>1.1</b>	8085 Architecture and pin configuration.	
	<b>1.2</b>	8086 Architecture and organization, pin configuration.	
	<b>1.3</b>	Minimum and Maximum modes of 8086.	
	<b>1.4</b>	Read and Write bus cycle of 8086.	
<b>2.0</b>		<b>Instruction set and programming of 8086</b>	<b>10</b>
	<b>2.1</b>	8086 Addressing modes.	
	<b>2.2</b>	8086 Instruction encoding formats and instruction set.	
	<b>2.3</b>	Assembler directives.	
	<b>2.4</b>	8086 programming and debugging of assembly language program.	
<b>3.0</b>		<b>Peripherals interfacing with 8086 and applications.</b>	<b>10</b>
	<b>3.1</b>	8086-Interrupt structure.	
	<b>3.2</b>	Programmable interrupt controller 8259A.	
	<b>3.3</b>	Programmable peripheral Interface 8255.	
	<b>3.4</b>	Programmable interval Timer 8254.	
	<b>3.5</b>	DMA controller 8257	
	<b>3.6</b>	Interfacing 8259A, 8255, 8254, 8257 with 8086 and their applications	
<b>4.0</b>		<b>ADC, DAC interfacing with 8086 and its application</b>	<b>08</b>
	<b>4.1</b>	Analog to Digital Converter (ADC) 0809	
	<b>4.2</b>	Digital to Analog Converter (DAC) 0808	
	<b>4.3</b>	Interfacing ADC 0809, DAC 0808 with 8086 and their applications.	
	<b>4.4</b>	8086 based data Acquisition system.	
<b>5.0</b>		<b>8086 Microprocessor interfacing</b>	<b>10</b>
	<b>5.1</b>	8087 Math coprocessor, its data types and interfacing with 8086.	
	<b>5.2</b>	Memory interfacing with 8086 microprocessor	
<b>6.0</b>		<b>Advanced Microprocessors</b>	<b>06</b>
	<b>6.1</b>	Basic architectures of 80286, 80386, 80486 and Pentium processor.	
		<b>Total</b>	<b>52</b>

**Text Books:**

1. Gaonkar R.S.: "Microprocessor Architecture Programming and Applications with the 8085" Penram International Pub, 5<sup>th</sup> Edition.
2. John Uffenbeck: "8086/8088 family: "Design, Programming and Interfacing", Prentice Hall, 2<sup>nd</sup> Edition
3. B. B. Brey: "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro Processor", Pearson Pub, 8<sup>th</sup> Edition

**Reference Books:**

1. Hall D.V: "Microprocessor and Interfacing Programming and Hardware", Tata McGraw Hill, 2<sup>nd</sup> Edition.
2. A. K. Ray and K. M. Burchandi: "Advanced Microprocessor and Peripherals, Architecture Programming and Interfacing", Tata McGrawHill, 3<sup>rd</sup> Edition
3. Don Anderson, Tom Shanley: "Pentium Processor System Architecture", MindShare Inc., 2<sup>nd</sup> Edition
4. National Semiconductor: Data Acquisition Linear Devices Data Book
5. Intel Peripheral Devices: Data Book.

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered for final Internal Assessment.

**End Semester Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
- 3: Question No.1 will be compulsory and based on entire syllabus.
- 4: Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC 404	Wave Theory and Propagation	4	--	--	4	--	-	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Avg. Of Test 1 and Test 2						
ETC 404	Wave Theory and Propagation	20	20	20	80	--	-	-	100	

### Course Pre-requisite

Vector Algebra, Vector Integral

### Course Objective:

- To understand basic laws of electrostatics and magnetostatics in vector form.
- To understand the propagation of wave in different media like dielectric and conducting media by solving wave equation and find parameters of media.
- To calculate energy transported by means of electromagnetic waves from one point to another and to study polarization of waves.
- To solve electromagnetic problems using different numerical methods.
- To extend the students' understanding about the propagation of the waves by different types such as ground waves and space waves.
- To study the factors affecting the wave during its propagation.
- To understand sky wave propagation; related parameters such as MUF, skip distance and critical frequency.

### Expected Outcomes:

- Ability to find nature of electric or magnetic field produced due to different charge distributions.
- Ability to understand working of different equipments based on electromagnetic used in day to day life.
- Knowledge of behavior of EM waves and travelling of waves in free space as well as media.
- Able to find conditions for loss of signal.
- Able to apply numerical methods for designing antennas.
- An ability to select proper parameters for propagation of the waves by considering the factors affecting.
- Any ability to identify and solve problems related to the propagation of waves.
- To understand the basics of wave propagation required for the study of antennas.

Module No.	Unit No.	Topics	Hrs.
<b>1.0</b>		<b>Basic Laws of electromagnetic &amp; Maxwell's equations</b>	<b>13</b>
	1.1	<b>Fundamental laws of electromagnetic fields:</b> Coulomb's law, Gauss's law, Bio-Savart's law, Ampere's law, Poisson's and Laplace equations	
	1.2	<b>Boundary conditions:</b> Static electric and magnetic fields	
	1.3	<b>Maxwell's equations:</b> Integral and differential form for static and time varying fields and its interpretations	
	1.4	<b>Applications of electromagnetic fields:</b> Ink-jet printer, CRO, electromagnetic pump	
<b>2.0</b>		<b>Uniform plane wave equation and power balance</b>	<b>08</b>
	2.1	<b>Wave equation:</b> Derivation and its solution in Cartesian co-ordinates	
	2.2	<b>Solution of wave equations:</b> Partially conducting media, perfect dielectrics and good conductors, concept of skin dept	
	2.3	<b>Electromagnetic Power:</b> Poynting Vector and Power Flow in free space and in dielectric, conducting media	
<b>3.0</b>		<b>Plane Wave Propagation</b>	<b>06</b>
	3.1	<b>Polarization of wave;</b> Elliptical. Linear and Circular	
	3.2	<b>Propagation in different mediums:</b> Behavior of waves for normal and oblique incidence in dielectrics and conducting media, propagation in dispersive media	
<b>4.0</b>		<b>Computational Electromagnetics</b>	<b>08</b>
	4.1	<b>Finite Difference Method (FDM):</b> Neumann type and mixed boundary conditions, Iterative solution of finite difference equations, solutions using band matrix method	
	4.2	<b>Finite Element Method (FEM):</b> Triangular mesh configuration, Finite element discretization, Element governing equations, Assembling all equations and solving resulting equations	
	4.3	<b>Method of Moment (MOM):</b> Field calculations of conducting wire, parallel conducting wires and complicated geometries	
<b>5.0</b>		<b>Radio Wave Propagation</b>	<b>10</b>
	5.1	<b>Types of wave propagation:</b> Ground, space and surface wave propagation, tilt and surface waves, impact of imperfect earth and earth's behavior at different frequencies	
	5.2	<b>Space wave propagation:</b> Effect of imperfection of earth, curvature of earth, effect of interference zone, shadowing effect of hills and building, atmospheric absorption, Super-refraction, scattering phenomena, troposphere propagation and fading	
<b>6.0</b>		<b>Sky Wave Propagation</b>	<b>07</b>
	6.1	<b>Reflection and Refraction of waves:</b> Ionosphere and Earth magnetic field effect	
	6.2	<b>Measures of Ionosphere Propagation:</b> Critical frequency, Angle of incidence, Maximum unstable frequency, Skip distance, Virtual height, Variations in ionosphere and Attenuation and fading of waves in ionosphere	
		<b>Total</b>	<b>52</b>



**Text Books:**

1. J.A. Administer, "*Electromagnetic*", McGraw Hill Companies, 2<sup>nd</sup> Edition, 2006
2. Bhag Guru and Huseyin Hiziroglu, "*Electromagnetic field theory fundamentals*", Cambridge University Press, 2<sup>nd</sup> Edition, 2010.
3. J.D. Kraus, R.J. Marhefka, A.S. Khan "*Antennas & Wave Propagation*", McGraw Hill Publications, 4<sup>th</sup> Edition, 2011

**Reference Books**

1. R.K. Shevgaonkar, *Electromagnetic Waves*, TATA McGraw Hill Companies, 3<sup>rd</sup> Edition, 2009
2. R.L. Yadava, *Antenna & Wave Propagation*, PHI Publications, 1<sup>st</sup> Edition, 2011
3. Edward C. Jordan, Keth G. Balmin, *Electromagnetic Waves & Radiating Systems*, Pearson Publications, 2<sup>nd</sup> Edition, 2006
4. Matthew N.D. SADIKU, *Principles of Electromagnetics*, Oxford International Student 4<sup>th</sup> Edition, 2007
5. W.H. Hayt, J.A. Buck, *Engineering Electromagnetics*, McGraw Hill Publications, 7<sup>th</sup> Edition, 2006.

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered for final Internal Assessment.

**End Semester Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
- 3: Question No.1 will be compulsory and based on entire syllabus.
- 4: Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC 405	Signals and Systems	04	--	01	04	--	01	05

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Avg. Of Test 1 and Test 2						
ETC 405	Signals and Systems	20	20	20	80	25	--	--	125	

**Course pre-requisite :**

ETS : 301 - Applied Mathematics III  
 ETC : 304 - Circuits and Transmission Lines

**Course objectives:**

- To introduce students to the idea of signal and system analysis and characterization in time and frequency domain.
- To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.

**Course outcomes:**

- Students will be able to understand significance of signals and systems in the time and frequency domains
- Students will be able to interpret and analyze signal and report results.
- Students will be able to evaluate the time and frequency response of continuous and discrete time, system which is useful in understanding behavior of Electronics circuits and communication systems.

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Module No.	Unit No.	Topics	Hrs.
1.0		<b>Overview of signals and systems</b>	<b>06</b>
	1.1	<b>Introduction:</b> Signals, systems, examples of systems for controls and communication, sampling theorem, sampling of continuous time signals, elementary signals, exponential, sine, step, impulse, ramp, rectangular, triangular and operations on signals	
	1.2	<b>Classification of signals:</b> Continuous and discrete time, deterministic and non deterministic, periodic and aperiodic, symmetric (even) and asymmetric (odd), energy and power, causal and anti-causal signals.	
2.0		<b>Time domain analysis of Continuous Time and Discrete Time systems</b>	<b>12</b>
	2.1	<b>Classification of systems:</b> Static and dynamic, time variant and time invariant, linear and nonlinear, causal and noncausal, stable and unstable systems.	
	2.2	<b>Linear Time Invariant (LTI) systems:</b> Representation of systems using differential /difference equation, Impulse, step and exponential response, system stability, examples on applications of LTI systems, convolution, impulse response of interconnected systems, auto-correlation, cross correlation, properties of correlation, analogy between correlation and convolution, total response of a system	
3.0		<b>Laplace Transform</b>	<b>06</b>
3.0	3.1	<b>Overview of Laplace Transform:</b> Laplace Transform and properties, relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform.	
	3.2	<b>Analysis of continuous time LTI systems using Laplace Transform:</b> Transfer Function, causality and stability of systems, solution of differential equation using Laplace Transform.	
4.0		<b>z – Transform</b>	<b>08</b>
	4.1	z-Transform of finite and infinite duration sequences, relation between discrete time Fourier Transform and z-Transform, properties, Inverse z-Transform, one sided z-Transform.	
	4.2	<b>Analysis of discrete time LTI systems using z-Transform:</b> Transfer Function, causality and stability of systems, frequency response, relation between Laplace Transform and z-Transform.	
5.0		<b>Fourier series of continuous and discrete time signals</b>	<b>10</b>
	5.1	<b>Review of Fourier series:</b> trigonometric and exponential Fourier series representation of signals, magnitude and phase spectra, power spectral density and bandwidth. Gibbs phenomenon.	
	5.2	<b>Properties of Fourier Series:</b> Linearity, time shifting, time reversal, frequency shifting, time scaling, differentiation, symmetry. Parseval's relation. Examples based on properties, analogy between Continuous Time Fourier Series (CTFS) and Discrete Time Fourier Series (DTFS).	
6.0		<b>Continuous Time Fourier Transform (CTFT) and Discrete Time Fourier Transform (DTFT)</b>	<b>10</b>
	6.1	<b>Fourier Transform:</b> Fourier Transform and Inverse Fourier Transform on periodic and non-periodic signals, limitations of Fourier Transform and need for Laplace and z-Transform	
	6.2	<b>Properties of Fourier Transform:</b> Linearity, time shifting, time reversal, frequency shifting, time and frequency scaling, modulation, convolution in time domain, differentiation in time domain, differentiation in frequency domain, symmetry. Parseval's relation. Energy, power spectral density and bandwidth. Definition and problems on DTFT	
		<b>Total</b>	<b>52</b>

### Text books

1. Nagoor Kani, Signals and Systems, Tata McGraw Hill, Third Edition, 2011.
2. B.P. Lathi, Principles of Linear Systems and Signals, Oxford, Second Edition, 2010.
3. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

### Reference books

- 1) Hwei. P Hsu, Signals and Systems, Tata McGraw Hill, Third edition, 2010
- 2) V. Krishnaveni and A.Rajeshwari, Signals and Systems, Wiley-India, First Edition 2012.
- 3) Narayana Iyer, Signals and Systems, Cenage Learning, First Edition 2011.
- 4) Michael J Roberts, Fundamentals of Signals and systems, Tata McGraw Hill, special Indian Economy edition, 2009.
- 5) Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Signals and Systems, Pearson Education, Fourth Edition 2009.
- 6) Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.

#### **Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

#### **End Semester Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
- 3: Question No.1 will be compulsory and based on entire syllabus.
- 4: Remaining question (Q.2 to Q.6) will be selected from all the modules.

#### **Term Work:**

At least 08 assignments covering entire syllabus must be given during the “**Class Wise Tutorial**”. The assignments should be students’ centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme Hrs.			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC 405	Control Systems	04	-	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Avg. Of Test 1 and Test 2						
ETC 405	Control Systems	20	20	20	80	--	--	--	100	

**Course pre-requisite:**

Dynamics; Differential Equations; Laplace Transforms.

**Course objectives:**

Objectives of this course are:

- To teach the fundamental concepts of Control systems and mathematical modeling of the system.
- To study the concept of time response and frequency response of the system.
- To teach the basics of stability analysis of the system

**Course outcomes:**

The outcomes of this course are:

- Students will be able to derive the mathematical model of different type of the systems.
- Students will understand the basic concepts of control system.
- Students will understand the analysis of systems in time and frequency domain.
- Students will be able to apply the control theory to design the conventional controllers widely used in the industries.

Module No.	Unit No.	Topics	Hrs.
1.0		<b>Introduction to Control System Analysis</b>	08
	1.1	<b>Introduction:</b> Open loop and closed loop systems, feedback and feed forward control structure, examples of control systems.	
	1.2	<b>Modeling:</b> Types of models, impulse response model, state variable model, transfer function model	
	1.3	<b>Dynamic Response:</b> Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types	
2.0		<b>Mathematical Modeling of Systems</b>	08
	2.1	<b>Transfer Function models of various systems:</b> Models of mechanical systems, models of electrical systems, block diagram reduction, signal flow graph, and the Mason's gain rule	
3.0		<b>State Variable Models</b>	12
	3.1	<b>State Variable Models of Various Systems:</b> State variable models of mechanical systems, state variable models of electrical systems	
	3.2	<b>State Transition Equation:</b> Concept of state transition matrix, properties of state transition matrix, solution of homogeneous systems, solution of non-homogeneous systems	
	3.3	<b>Controllability and Observability:</b> Concept of controllability, controllability analysis of LTI systems, concept of observability, observability analysis of LTI systems	
4.0		<b>Stability Analysis In Time Domain</b>	08
	4.1	<b>Concepts of Stability:</b> Concept of absolute, relative and robust stability, routh stability criterion	
	4.2	<b>Root Locus Analysis:</b> Root-locus concepts, general rules for constructing root-locus, root-locus analysis of control systems, design of lag and lead compensators	
5.0		<b>Stability Analysis In Frequency Domain</b>	08
	5.1	<b>Introduction:</b> Frequency domain specifications, response peak and peak resonating frequency, relationship between time and frequency domain specification of system, stability margins	
	5.2	<b>Bode plot:</b> Magnitude and phase plot; Method of plotting Bode plot; Stability margins on the Bode plots; Stability analysis using Bode plot.	
	5.3	<b>Nyquist Criterion:</b> Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	
6.0		<b>Optimal and Adaptive Control Systems</b>	08
	6.1	<b>Optimal control:</b> Performance measure for optimal control problems, the principle of optimality, concept of dynamic programming, fundamental of a single Function, Functions involving several independent Functions, constrained minimization of Functions	
	6.2	<b>Adaptive Control Systems:</b> Model reference adaptive control approach for controller design, Neuro-Fuzzy adaptive control (only concept)	
		<b>Total</b>	<b>52</b>

**Text books:**

1. Nagrath, M.Gopal, "Control System Engineering", Tata McGraw Hill.
2. K.Ogata, "Modern Control Engineering, Pearson Education", III<sup>rd</sup> edition.
3. Benjamin C.Kuo, "Automatic Control Systems, Pearson education", VII<sup>th</sup> edition.

**Reference Books:**

1. Madam Gopal, Control Systems Principles and Design, Tata McGraw hill, 7th edition, 1997.
2. Norman, Control System Engineering, John Wiley & sons, 3rd edition.
3. Curtis Johnson, Process Control Instrumentation Technology, Pearson education fourth edition.
4. Dhanesh N. Manik, "Control Systems", Cengage Learning, 1<sup>st</sup> edition, 2012.
5. Sastry S. S., "Adaptive Control", PHI.

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

**End Semester Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
- 3: Question No.1 will be compulsory and based on entire syllabus.
- 4: Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW	Tutorial	Total
ETL 401	Analog Electronics II Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETL 401	Analog Electronics II Laboratory	--	--	--	--	25	25	--	50

**Term Work:**

At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades converted into marks as per **Credit and Grading** System manual should be added and averaged. Based on this final term work grading and term work assessment should be done.

**The Practical and Oral examination will be based on entire syllabus.**



Subject Code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL402	Microprocessors and Peripherals Laboratory	--	02	--	--	01	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Avg. Of Test 1 and Test 2						
ETL402	Microprocessors and Peripherals Laboratory	--	--	--	--	25	25	--	50	

**Term Work:**

At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per '**credit and grading**' System manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

**The Practical and Oral examination will be based on entire syllabus.**

Subject Code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL 403	Software Simulation Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Avg. Of Test 1 and Test 2						
ETL 403	Software Simulation Laboratory	--	--	--	--	25	25	-	50	

## Objectives

Students will demonstrate

- an ability to design a system and process as per needs/specifications.
- an ability to visualize and work on laboratory and multi disciplinary task.
- skills to use modern Engineering tools, software's and equipments to analyze problems.

### Term Work:

At least 10 simulation based experiments from Analog Electronics, Digital Electronics, Circuits and Transmission, Microprocessor, Signals and Systems and Wave Theory and Propagation should be set to have well predefined inference and conclusion. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades converted into marks as per Credit and Grading System manual should be added and averaged. Based on this final term work grading and term work assessment should be done. It is advisable to use required application software for simulation based experiments. Use of open source software should be encouraged.

**Practical and oral examination will be based on simulation experiments.**