Name of Institute: Indus Institute of Technology and Engineering (IITE)
Name of Faculty: Divyangna Gandhi

Course code: EC0620
Course name: Optical Communication

Pre-requisites: Basics of electromagnetic waves, Mode theory of waveguide.
Basics of Communication

Credit points: 04
Offered Semester: 6th

Course Coordinator (weeks 15)
Full Name: Divyangna Gandhi
Department with sitting location: 2nd Floor, Bhanwar Building, EC Lab 5(Digital and
Networking Lab), IITE - IU
Telephone: 3202
Email: Divyangnagandhi.ec@indusuni.ac.in
Consultation times: 4:00PM to 4:45PM

Course Lecturer (weeks 15)
Full Name: Divyangna Gandhi
Department with sitting location: 2nd Floor, Bhanwar Building, EC Lab 5(Digital and
Networking Lab), IITE - IU
Telephone: 3202
Email: Divyangnagandhi.ec@indusuni.ac.in
Consultation times: 4:00PM to 4:45PM

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives
By participating in and understanding all facets of this course a student will:

To comprehend the basic elements of optical fiber transmission link, fiber modes and structure configurations.
To visualize the significance of the different kind of losses, signal distortion in optical wave guides, signal degradation factors
To analyze the performance of both digital and analogue optical fiber systems
Estimate the losses and analyze the propagation characteristics of an optical signal in different types of fibers

To understand the basic operating principles of light sources and detectors

To compare the various optical source materials, LED structures, quantum efficiency as well as structures and figure of merit of Laser diodes.

To analyze the system performance of optical transmitters and receivers

To understand the basic operating principles of amplifiers.

To be familiar with different optical components like optical couplers, filters, optical mux/demux waveguide grating, optical add drop multiplexer (OADM), optical cirulators, attenuators, optical cross connects.

To analyze and integrate fiber optical network components in variety of networking schemes, SONET/ SDH and operational principles WDM.

To design a simple optical communication link and solve the main issues in designing optical communication system.

Course Outcomes (CO)

1. Define the basic elements of optical fiber transmission link and principle of OC
2. Explain the basic operating principle of light source and detector and summarize the various optical source materials
3. Calculate the losses and examine the performance of digital and analog optical communication systems
4. Illustrate the fiber optical network components in variety of networking schemes like SONET/ SDH
5. Compare different types of amplifiers and receiver noises
6. Design a simple optical communication link and solve the main issues in designing optical communication system

Course Outline

Basic foundation of fiber optic communication,
Attenuation and power penalty in a link
LED LASER and Optical receiver
SOA, EDFA and Raman Amplifiers
Optical components
DWDM systems, SONET/ SDH

Method of delivery

(Online lectures, self-study material, Active Learning Techniques)

Study time

(3 Hour's theory and 2 Hour's Lab per week)

PO / CO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
1	√											
2	√						√					
3		√		√								
4		√	√	√	√		√					
5		√					√					
6		√			√							

CO-PO Mapping (PO: Program Outcomes)

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

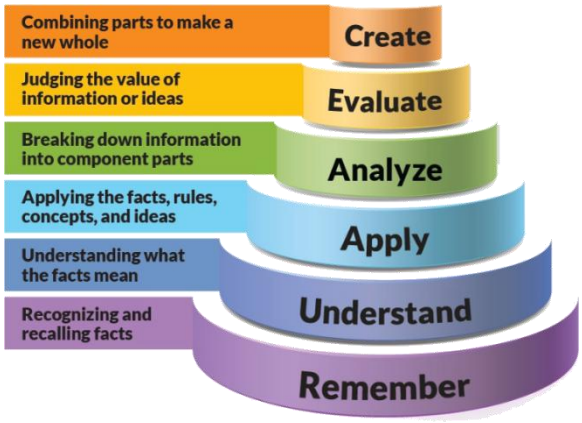


Figure 1: Blooms Taxonomy

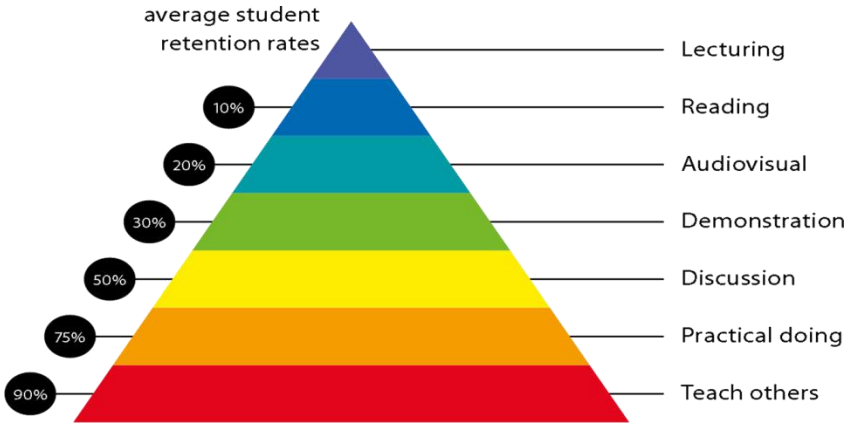


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of	**2 Information literacy, gathering & processing**

sources and technologies. Acknowledge the work and ideas of others.	
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Lecture/tutorial times

Example:

Lecture	**Monday**	**12.20 – 01.20PM**	**Room LH 22**
Lecture	Tuesday	**02.00 – 03.00PM**	**Room LH 22**
Lecture	**Thursday**	**11:10 – 12.10AM**	**Room LH 22**
Lab	Friday	**09:00 to 11:00**	**EC Lab 5**

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

Text books	Optical Fiber Communications by Gerd Keiser, 5th Edition (Mc Graw Hill)
	Optical Fiber Communication by John M. Senior (PHI/Pearson)
Reference Books	Fiber Optics and Optoelectronics by R P Khare ,2004
	Fiber optic Communication Systems by G. Agrawal (John Wiley and sons)
	Fiber optical communication Technology by Djafar Mymbaev & Lowell L, Scheiner. (Pearson)

Additional Materials

NPTEL- Lecture
http://www.nptel.ac.in/downloads/117101054/
http://nptel.ac.in/courses/117101002/
www.nptel.iitm.ac.in/foc

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Example:

Midterm Exam	40%	Objective (1-6)
Presentation	5%	Objectives (2-5)
Attendance	5%	
Assignment	10%	Objectives (2-5)
Final exam (*closed book*)	40%	Objectives (1-6)

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective

components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

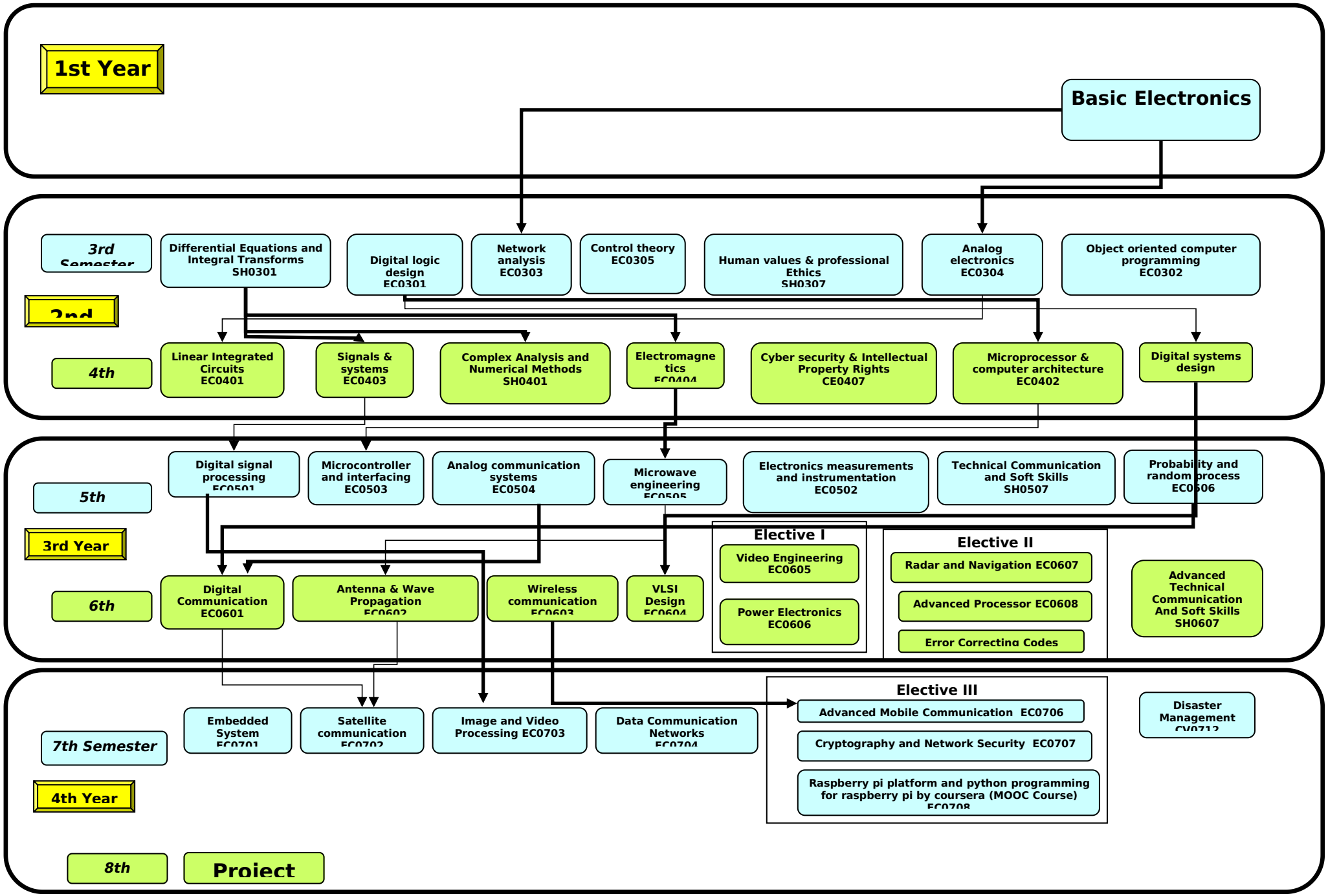
Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

Course schedule

	Week 15	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	To aware students with theoretical and practical syllabus, assessment scheme for theory (CIE, End sem exam), practical (CIE, End sem exam) and all the details about subject activities has to be carry out throughout the semester Introduction to Optical Fiber Communication	1	BB,PPT
	Weeks 2	Optical Fiber Waveguide and Structures	1,2	BB,PPT
	Week 3	Optical laws, Transmission Characteristics of Optical Fibers	1,2,3,4	BB,PPT
	Week 4	Problems		BB,PPT
	Week 5	Optical Source: LED	1,5,6	BB,PPT
	Week 6	Optical Source: LASER	1,5,6	BB,PPT
	Week 7	Power Launching and coupling	5,6	BB,PPT
	Week 8	Optical Detectors	1,2,7	BB,PPT
	Week 9	Problems		BB,PPT
	Week 10	Optical Receiver	1,2,8	BB,PPT

	Week 11	Optical Amplifiers	1,2,8	BB,PPT
	Week 12	Problems		BB,PPT
	Week 13	Optical components	8	BB,PPT
	Week 14	WDM and Optical Networks	8,9	BB,PPT
	Week 15	Free Space Optical Communication	8,9	BB,PPT


1st Year
Basic Electronics
3rd Semester
Differential Equations and Integral Transforms SH0301
Digital logic design EC0301
Network analysis EC0303
Control theory EC0305
Human values & professional Ethics SH0307
Analog electronics EC0304
Object oriented computer programming EC0302
2nd
4th
Linear Integrated Circuits EC0401
Signals & systems EC0403
Complex Analysis and Numerical Methods SH0401
Electromagnetics EC0404
Cyber security & Intellectual Property Rights CE0407
Microprocessor & computer architecture EC0402
Digital systems design
5th
Digital signal processing EC0501
Microcontroller and interfacing EC0503
Analog communication systems EC0504
Microwave engineering EC0505
Electronics measurements and instrumentation EC0502
Technical Communication and Soft Skills SH0507
Probability and random process EC0506
3rd Year
6th
Digital Communication EC0601
Antenna & Wave Propagation EC0602
Wireless communication EC0603
VLSI Design EC0604
Elective I
Video Engineering EC0605
Power Electronics EC0606
Elective II
Radar and Navigation EC0607
Advanced Processor EC0608
Error Correcting Codes
Advanced Technical Communication And Soft Skills SH0607
7th Semester
Embedded System EC0701
Satellite communication EC0702
Image and Video Processing EC0703
Data Communication Networks EC0704
Elective III
Advanced Mobile Communication EC0706
Cryptography and Network Security EC0707
Raspberry pi platform and python programming for raspberry pi by coursera (MOOC Course) EC0708
Disaster Management CV0712
4th Year
8th
Project

Name of Institute: **Institute of Technology & Engineering**
Name of Faculty: **Dr. Vrushank Shah**

Course code EC0623
Course name: Image Processing

Pre-requisites: Signals & Systems & Digital Signal Processing
Credit points: 4
Offered Semester: 6th

Course coordinator (weeks 01 - 14)

Full name: Dr. Vrushank Shah
Department with siting location: Electronics & Communication Engineering
Telephone: 9898331721
Email: vrushankshah.ec@indusuni.ac.in
Consultation times: 09.00 AM – 10.00 AM (Working Saturdays)

Course lecturer (weeks 01 - 14)

Full name: Dr. Vrushank Shah
Department with siting location: Electronics & Communication Engineering
Telephone: 9898331721
Email: vrushankshah.ec@indusuni.ac.in
Consultation times: 09.00 AM – 10.00 AM (Working Saturdays)

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives
By participating in and understanding all facets of this course a student will:

1. Describe and explain basic principles of digital image processing.
2. Design and implement algorithms that perform basic image processing (e.g.noise removal and image enhancement).
3. Design and implement algorithms for advanced image analysis (e.g.image compression, image segmentation).
4. Assess the performance of image processing algorithms and systems.

Course Outcomes (CO)

1. Understand image formation and the role human visual system plays in perception of gray and color image data. Get broad exposure to and understanding of various applications of image processing in industry, medicine, and defense.
2. Learn the signal processing algorithms and techniques in image enhancement and image restoration.

3. Acquire an appreciation for the image processing issues and techniques and be able to apply these techniques to real world problems. Filter given image using frequency domain filtering technique.
4. Select the right image restoration technique to remove degradation from given image & Understand the various kind of noise present in the image and how to restore the noisy image
5. Be able to conduct independent study and analysis of image processing problems and techniques.

Course Outline

CONTENTS
UNIT-I
[5 hours]
Introduction Introduction to Digital Image Processing & Applications, Sampling, Quantization, Basic Relationship Between Pixels. Imaging Geometry. Image interpolation.
UNIT-II
[8hours]
Image enhancement and filtering in spatial domain: Intensity transformation functions: Contrast stretching, Thresholding, Image negative, Log transformation, Power - low transformation, Intensity level slicing and Bit - plane slicing. Image histogram, Histogram equalization process. Fundamentals of spatial filtering, Correlation and convolution, Spatial filtering mask for low pass filtering (smoothing) and high pass filtering (sharpening).
UNIT-III
[16 hours]
Image filtering in the frequency domain: Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering, 2D- DFT, 2D-FFT, 2D-DCT,Fundamentals of 2D-wavelet transform, Image pyramids, sub-band coding**.** **Image restoration:** Reasons for image degradation, Model of image degradation/restoration process, Noise probability density functions, Image restoration using spatial filtering (Mean filters, Order statistic filters and adaptive filters), Inverse Filtering, MMSE (Wiener) Filtering. **Colour Image Processing:** Colour Fundamentals, Colour Models, Pseudo – colour image processing.
UNIT-IV
[16 hours]
Image Compression: Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding, JPEG Compression standard, Wavelet based image compression. **Image Segmentation:** Edge based segmentation, Region based segmentation, Region split and merge techniques, Region growing by pixel aggregation, optimal thresholding. **Morphological Image Processing:** Basic morphological operations, Erosion, dilation, opening, closing,

Structuring elements, Hit - Or - Miss transform, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons , Reconstruction by erosion and dilation
TEXT BOOKS :
1. Digital Image Processing by Rafael C Gonzalez & Richard E Woods, 3rd Edition 2. Digital Image Processing by William K Pratt
REFERENCE BOOKS:
1. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill Publication. 2. Digital Image Processing, S Sridhar, Oxford University Press.
WEB RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc16_ec14
2. **https://nptel.ac.in/syllabus/117105079/**

Method of delivery

1. Chalk and talk
2. PowerPoint Presentations
3. Self-study material
4. NPTEL notes

Study time

3 hours per week Lectures and 2 Hours practical per week

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	√											
CO 2	√				√							
CO 3	√	√	√		√							
CO 4	√	√	√	√	√	√	√					√
CO 5	√	√	√	√	√	√	√					√

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

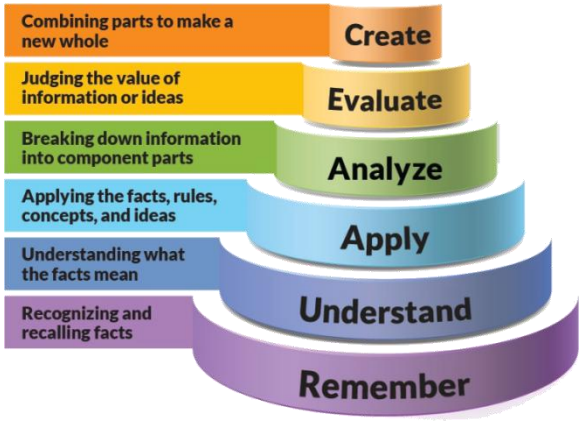


Figure 1: Blooms Taxonomy

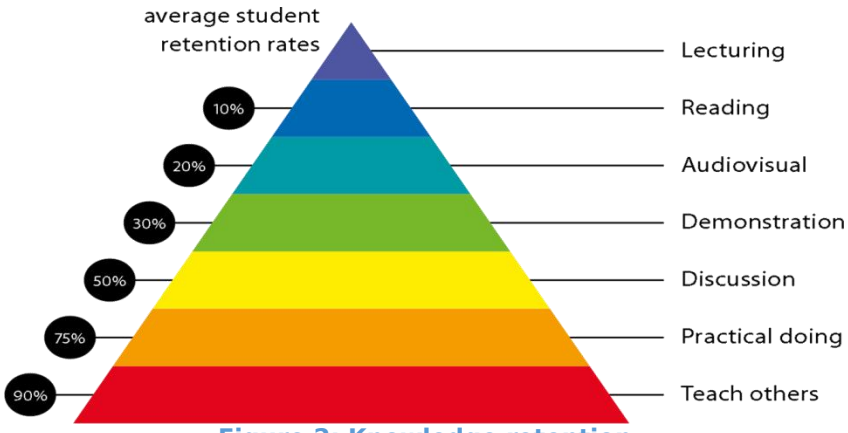


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**

Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

1.	To write and execute image processing programs using point processing method ⁀Obtain Negative image ⁀Obtain Flip image ⁀Thresholding ⁀Contrast stretching
2.	To write and execute programs for image arithmetic & logical operations operations ⁀Addition of two images

	⁀Subtract one image from other image ⁀Calculate mean value of Image ⁀Different Brightness by changing mean value ⁀AND operation between two images ⁀OR operation between two images ⁀Calculate intersection of two images ⁀Water Marking using EX-OR operation ⁀NOT operation (Negative image)
3.	To write a program for histogram calculation and equalization
4.	To write a program for Bit plane slicing & Spatial resolution
5.	To understand various image noise models and to write programs for image restoration ⁀Remove Salt and Pepper Noise ⁀Minimize Gaussian noise ⁀Median filter and Weiner filter
6.	Write and execute programs to remove noise using spatial filters
7.	To write a program for JPEG compression
8.	Write and execute programs for image frequency domain filtering ⁀Apply FFT on given image ⁀Perform low pass and high pass filtering in frequency domain ⁀Apply IFFT to reconstruct image
9.	Write a program for edge detection using different edge detection mask
10	Write and execute program for image morphological operations erosion and dilation.
11	To write and execute program for wavelet transform on given image and perform inverse wavelet transform to reconstruct image.

Lecture/tutorial times

(Give lecture times in the format below)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Details of referencing system to be used in written work

1. Text Books and Reference Books
2. Online Resources

Text books

Mention in syllabus

Additional Materials

1. https://onlinecourses.nptel.ac.in/noc16_ec14
2. **https://nptel.ac.in/syllabus/117105079/**

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end

semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of 10 % of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

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Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

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Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	**Introduction** Introduction to Digital Image Processing & Applications, Sampling, Quantization, Basic	CO1	Chalk and talk PowerPoint Presentations
	Weeks 2	Relationship Between Pixels. Imaging Geometry. Image interpolation Intensity transformation functions	CO1	Chalk and talk PowerPoint Presentations
	Week 3	Contrast stretching, Thresholding, Image negative, Log transformation, Power - low transformation, Intensity level slicing and Bit - plane slicing. Image histogram, Histogram equalization process.	*CO1 CO2*	Chalk and talk PowerPoint Presentations
	Week 4	Fundamentals of spatial filtering, Correlation and convolution, Spatial filtering mask for low pass filtering (smoothing)	CO2	Chalk and talk PowerPoint Presentations
	Week 5	high pass filtering (sharpening). **Image filtering in the frequency domain:** Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering	C03	Chalk and talk PowerPoint Presentations
	Week 6	2D- DFT, 2D-FFT, 2D-DCT,Fundamentals of 2D-wavelet transform, Image pyramids, sub-band coding**.**	*C03*	Chalk and talk PowerPoint Presentations

	Week 7	**Image restoration:** Reasons for image degradation, Model of image degradation/restoration process, Noise probability density functions,	C04	Chalk and talk PowerPoint Presentations
	Week 8	Image restoration using spatial filtering (Mean filters, Order statistic filters and adaptive filters), Inverse Filtering, MMSE (Wiener) Filtering.		Chalk and talk PowerPoint Presentations
	Week 9	**Colour Image Processing:** Colour Fundamentals, Colour Models, Pseudo – colour image processing.	*CO4CO5*	Chalk and talk PowerPoint Presentations
	Week 10	**Image Compression:** Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding,	CO5	Chalk and talk PowerPoint Presentations
	Week 11	JPEG Compression standard, Wavelet based image compression **Image Segmentation:** Edge based segmentation, Region based segmentation, Region split and merge techniques,	CO4 C05	Chalk and talk PowerPoint Presentations
	Week 12	Region growing by pixel aggregation, optimal thresholding. **Morphological Image Processing:** Basic morphological operations, Erosion, dilation, opening, closing, Structuring elements,	C05	Chalk and talk PowerPoint Presentations
	Week 13	Hit -Or - Miss transform, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons ,	C05	Chalk and talk PowerPoint Presentations
	Week 14	Reconstruction by erosion and dilation Revision		

Name of Institute: **Institute of Technology & Engineering**
Name of Faculty: **Dr. Vrushank Shah**

Course code EC0621
Course name: Image Processing

Pre-requisites: Signals & Systems & Digital Signal Processing
Credit points: 4
Offered Semester: 6th

Course coordinator (weeks 01 - 14)

Full name: Dr. Vrushank Shah
Department with siting location: Electronics & Communication Engineering
Telephone: 9898331721
Email: vrushankshah.ec@indusuni.ac.in
Consultation times: 09.00 AM – 10.00 AM (Working Saturdays)

Course lecturer (weeks 01 - 14)

Full name: Dr. Vrushank Shah
Department with siting location: Electronics & Communication Engineering
Telephone: 9898331721
Email: vrushankshah.ec@indusuni.ac.in
Consultation times: 09.00 AM – 10.00 AM (Working Saturdays)

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives
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1. Describe and explain basic principles of digital image processing.
2. Design and implement algorithms that perform basic image processing (e.g.noise removal and image enhancement).
3. Design and implement algorithms for advanced image analysis (e.g.image compression, image segmentation).
4. Assess the performance of image processing algorithms and systems.

Course Outcomes (CO)

1. Understand image formation and the role human visual system plays in perception of gray and color image data. Get broad exposure to and understanding of various applications of image processing in industry, medicine, and defense.
2. Learn the signal processing algorithms and techniques in image enhancement and image restoration.

3. Acquire an appreciation for the image processing issues and techniques and be able to apply these techniques to real world problems. Filter given image using frequency domain filtering technique.
4. Select the right image restoration technique to remove degradation from given image & Understand the various kind of noise present in the image and how to restore the noisy image
5. Be able to conduct independent study and analysis of image processing problems and techniques.

Course Outline

CONTENTS
UNIT-I
[5 hours]
Introduction Introduction to Digital Image Processing & Applications, Sampling, Quantization, Basic Relationship Between Pixels. Imaging Geometry. Image interpolation.
UNIT-II
[8hours]
Image enhancement and filtering in spatial domain: Intensity transformation functions: Contrast stretching, Thresholding, Image negative, Log transformation, Power - low transformation, Intensity level slicing and Bit - plane slicing. Image histogram, Histogram equalization process. Fundamentals of spatial filtering, Correlation and convolution, Spatial filtering mask for low pass filtering (smoothing) and high pass filtering (sharpening).
UNIT-III
[16 hours]
Image filtering in the frequency domain: Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering, 2D- DFT, 2D-FFT, 2D-DCT,Fundamentals of 2D-wavelet transform, Image pyramids, sub-band coding**.** **Image restoration:** Reasons for image degradation, Model of image degradation/restoration process, Noise probability density functions, Image restoration using spatial filtering (Mean filters, Order statistic filters and adaptive filters), Inverse Filtering, MMSE (Wiener) Filtering. **Colour Image Processing:** Colour Fundamentals, Colour Models, Pseudo – colour image processing.
UNIT-IV
[16 hours]
Image Compression: Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding, JPEG Compression standard, Wavelet based image compression. **Image Segmentation:** Edge based segmentation, Region based segmentation, Region split and merge techniques, Region growing by pixel aggregation, optimal thresholding. **Morphological Image Processing:** Basic morphological operations, Erosion, dilation, opening, closing,

Structuring elements, Hit - Or - Miss transform, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons , Reconstruction by erosion and dilation
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1. Digital Image Processing by Rafael C Gonzalez & Richard E Woods, 3rd Edition 2. Digital Image Processing by William K Pratt
REFERENCE BOOKS:
1. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill Publication. 2. Digital Image Processing, S Sridhar, Oxford University Press.
WEB RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc16_ec14
2. **https://nptel.ac.in/syllabus/117105079/**

Method of delivery

1. Chalk and talk
2. PowerPoint Presentations
3. Self-study material
4. NPTEL notes

Study time

3 hours per week Lectures and 2 Hours practical per week

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	√											
CO 2	√				√							
CO 3	√	√	√		√							
CO 4	√	√	√	√	√	√	√					√
CO 5	√	√	√	√	√	√	√					√

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

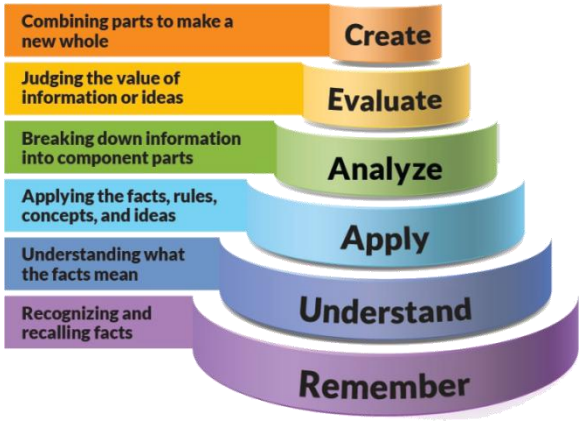

Figure 1: Blooms Taxonomy

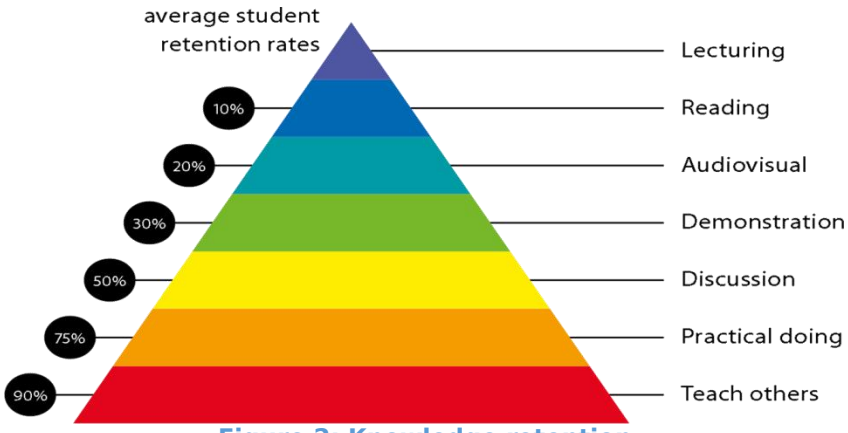

Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**

Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

1.	To write and execute image processing programs using point processing method ⁀Obtain Negative image ⁀Obtain Flip image ⁀Thresholding ⁀Contrast stretching
2.	To write and execute programs for image arithmetic & logical operations operations ⁀Addition of two images

	⁀Subtract one image from other image ⁀Calculate mean value of Image ⁀Different Brightness by changing mean value ⁀AND operation between two images ⁀OR operation between two images ⁀Calculate intersection of two images ⁀Water Marking using EX-OR operation ⁀NOT operation (Negative image)
3.	To write a program for histogram calculation and equalization
4.	To write a program for Bit plane slicing & Spatial resolution
5.	To understand various image noise models and to write programs for image restoration ⁀Remove Salt and Pepper Noise ⁀Minimize Gaussian noise ⁀Median filter and Weiner filter
6.	Write and execute programs to remove noise using spatial filters
7.	To write a program for JPEG compression
8.	Write and execute programs for image frequency domain filtering ⁀Apply FFT on given image ⁀Perform low pass and high pass filtering in frequency domain ⁀Apply IFFT to reconstruct image
9.	Write a program for edge detection using different edge detection mask
10	Write and execute program for image morphological operations erosion and dilation.
11	To write and execute program for wavelet transform on given image and perform inverse wavelet transform to reconstruct image.

Lecture/tutorial times

(Give lecture times in the format below)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Details of referencing system to be used in written work

1. Text Books and Reference Books
2. Online Resources

Text books

Mention in syllabus

Additional Materials

1. https://onlinecourses.nptel.ac.in/noc16_ec14
2. **https://nptel.ac.in/syllabus/117105079/**

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end

semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of 10 % of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

.

Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	**Introduction** Introduction to Digital Image Processing & Applications, Sampling, Quantization, Basic	CO1	Chalk and talk PowerPoint Presentations
	Weeks 2	Relationship Between Pixels. Imaging Geometry. Image interpolation Intensity transformation functions	CO1	Chalk and talk PowerPoint Presentations
	Week 3	Contrast stretching, Thresholding, Image negative, Log transformation, Power - low transformation, Intensity level slicing and Bit - plane slicing. Image histogram, Histogram equalization process.	*CO1 CO2*	Chalk and talk PowerPoint Presentations
	Week 4	Fundamentals of spatial filtering, Correlation and convolution, Spatial filtering mask for low pass filtering (smoothing)	CO2	Chalk and talk PowerPoint Presentations
	Week 5	high pass filtering (sharpening). **Image filtering in the frequency domain:** Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering	C03	Chalk and talk PowerPoint Presentations
	Week 6	2D- DFT, 2D-FFT, 2D-DCT,Fundamentals of 2D-wavelet transform, Image pyramids, sub-band coding**.**	*C03*	Chalk and talk PowerPoint Presentations

	Week 7	**Image restoration:** Reasons for image degradation, Model of image degradation/restoration process, Noise probability density functions,	C04	Chalk and talk PowerPoint Presentations
	Week 8	Image restoration using spatial filtering (Mean filters, Order statistic filters and adaptive filters), Inverse Filtering, MMSE (Wiener) Filtering.		Chalk and talk PowerPoint Presentations
	Week 9	**Colour Image Processing:** Colour Fundamentals, Colour Models, Pseudo – colour image processing.	*CO4CO5*	Chalk and talk PowerPoint Presentations
	Week 10	**Image Compression:** Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding,	CO5	Chalk and talk PowerPoint Presentations
	Week 11	JPEG Compression standard, Wavelet based image compression **Image Segmentation:** Edge based segmentation, Region based segmentation, Region split and merge techniques,	CO4 C05	Chalk and talk PowerPoint Presentations
	Week 12	Region growing by pixel aggregation, optimal thresholding. **Morphological Image Processing:** Basic morphological operations, Erosion, dilation, opening, closing, Structuring elements,	C05	Chalk and talk PowerPoint Presentations
	Week 13	Hit -Or - Miss transform, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons ,	C05	Chalk and talk PowerPoint Presentations
	Week 14	Reconstruction by erosion and dilation Revision		

Name of Institute: Indus Institute of Technology and Engineering.
Name of Faculty: Prof. Zalak Patel

Course code: EC0618
Course name: Digital Communication

Pre-requisites: Basic idea of Signals and Systems, and probability theory
Credit points: 4
Offered Semester: 6th

Course Coordinator (weeks 01 - 14)
Full Name: Prof. Zalak Patel
Department with siting location: EC Lab-4, 2nd floor Bhanwar building
Telephone: 3203 (Extn. No)
Email: zalakpatel.ec@indusuni.ac.in
Consultation times: Monday (8:30 to 10:30) Tuesday (14:00 to 15:00) Wednesday (8:30 to 10:30), Thursday (13:00 to 15:00), Friday (8:30 to 11:30) and all working Saturday.

Course Lecturer (weeks 01 - 14)
Full Name: Prof. Zalak Patel
Department with siting location: EC Lab-4, 2nd floor Bhanwar building
Telephone: 3203 (Extn. No)
Email: zalakpatel.ec@indusuni.ac.in
Consultation times: Monday (8:30 to 10:30) Tuesday (14:00 to 15:00) Wednesday (8:30 to 10:30), Thursday (13:00 to 15:00), Friday (8:30 to 11:30) and all working Saturday.

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

1. The objectives of this course are to introduce the basic principles that underlie the analysis and successful design of a digital communication system.
2. Emphasis is placed on understanding system design goals and to optimize the tradeoff among basic system parameters such as signal-to-noise ratio, bandwidth, etc.
3. To analyze error performance of a digital communication system in presence of noise and other interferences.

Course Outcomes (CO)

By participating in and understanding all facets of this Course a student will be able to:

1. Student will understand the advantages of digital systems over analog counterparts and calculate the mean and variance of some common continuous and discrete distributions
2. Identify and explain the techniques used for waveform coding viz. Pulse Amplitude Modulation (PAM) and Pulse Code Modulation (PCM).
3. Identify various types of error introduced in the processes viz. sampling, quantizing, and Describe Inter Symbol Interference (ISI), adaptive equalization techniques.
4. Describe different digital modulation schemes, and compare advantages/ Disadvantages of each as applied to baseband signal.
5. Identify the presence of error bits signal, and calculate unknown phase of noise in the received signal.

Course Outline

Introduction of digital communication
Probability & random Process
Information Theory
Error control coding
Baseband modulation
Digital Modulation & demodulation

Method of delivery

3 lectures per week. (Black board ,Chalk , PPT)
2 hours of lab per week
Understanding of design techniques using simulations.
Self-study material
NPTEL notes

Study time

3 hours per week Lectures and 2 Hours practical per week

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	√	√	√	√	√							
CO 2	√	√	√	√	√							√
CO 3	√	√	√	√	√							√
CO 4	√	√	√	√	√	√	√	√				√
CO 5	√	√	√	√	√	√	√					√

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

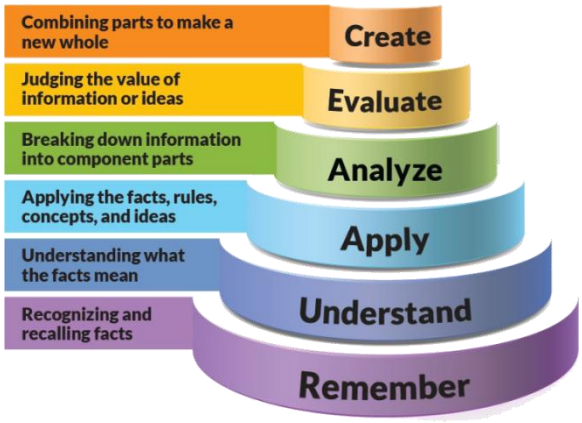

Figure 1: Blooms Taxonomy

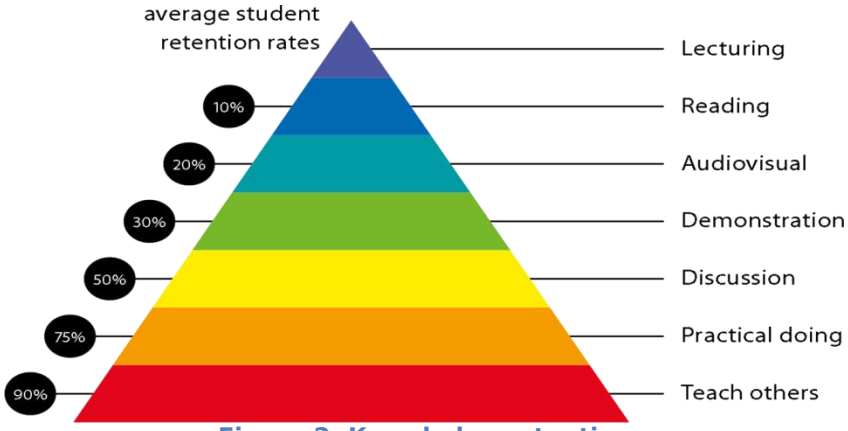

Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

Practical work in this course starts with the sampling, Lines codes & digital modulation techniques. At the end of this course student will be able design the different basic block of communication as minor project with laboratory practical.

Lecture/tutorial times

(Give lecture times in the format below)

Sr. No.	Pedagogy	Day	Time	Place
1	Lecture	Monday	10:00 to11:00 AM	Online
2	Lecture	Wednesday	12:20 to 1:20 PM	
3	Lecture	Thursday	12:20 to 1:20 PM	
4	Practical	Tuesday	11:00 to 1:00 PM	

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. Digital Communications by Simon Haykin, Wiley India.
2. Digital and analog communication system by B.P.Lathi, Zhi Ding (International 4th Edition), OXFORD university press.
3. Digital communication-Theory, Techniques and Applications by R. N. Mutagi, 2nd edition, OXFORD university press.

Additional Materials

NPTEL Course: Digital Communication
Link: https://nptel.ac.in/courses/117101051/

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

1. **Theory CIE 60 marks:**
   - **a**. Attendance 10 Marks
   - **b**. Midsem exam 40 Marks

c. Quiz/Presentation 10 Marks

2. Practical CIE 60 marks:

a. Attendance 10 Marks
b. Experiment Performance 30 Marks
c. File work + Skill Test 20 Marks

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -20% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

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plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

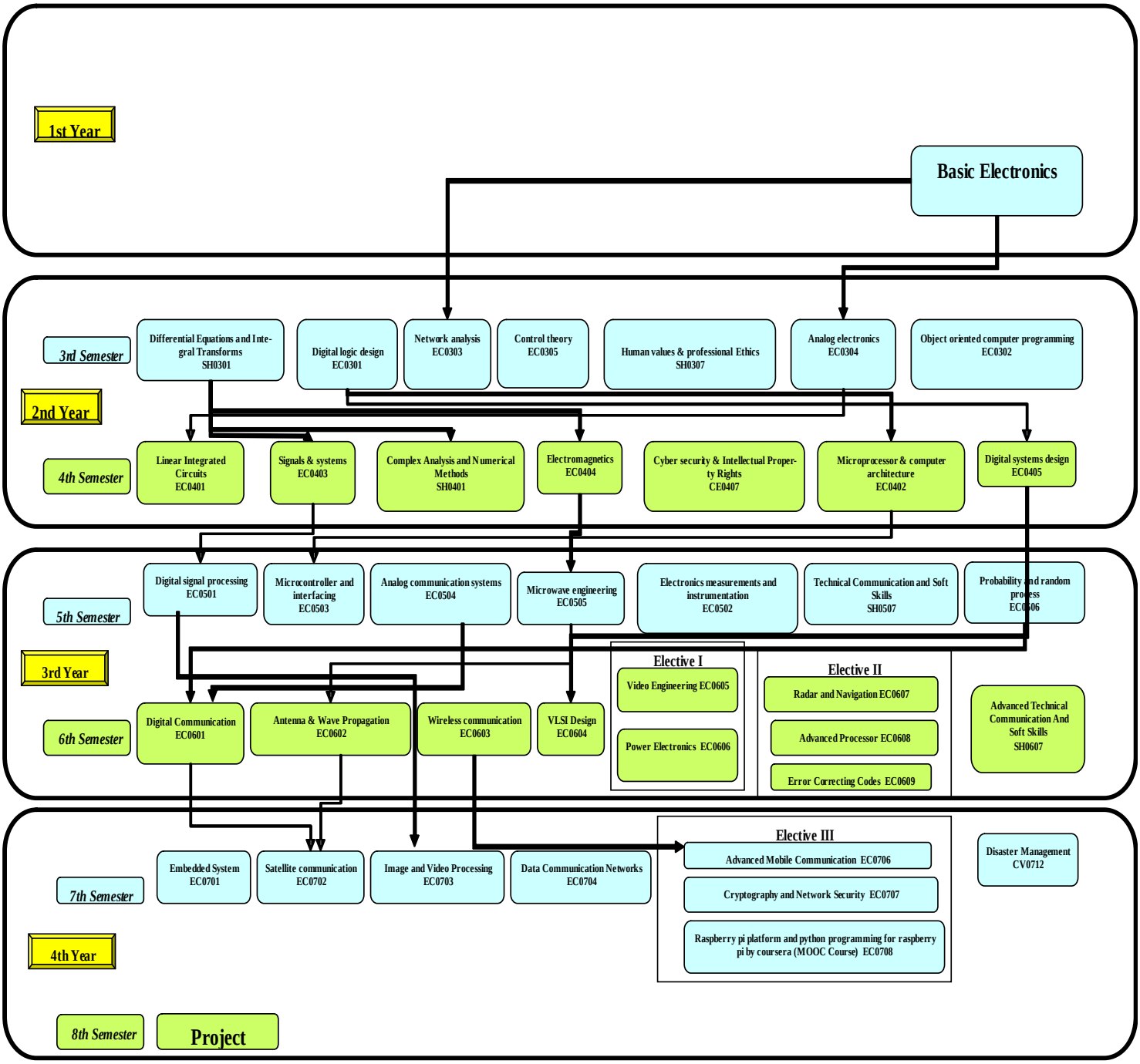
Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment).

Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Week 1	Introduction to Digital Communication Systems Communication System Model, Typical Digital communication System, Advantage of Digital communication , PAM Signals, Digital multiplexing ,line coding,Digitizing	1-2	BB,Chalk,PPT
	Week 2	Analog signals - sampling,Quntization,Encoding, Alising, Nyquist first and second criterion for zero ISI, PCM, DPCM,	1-2	BB,Chalk,PPT
	Week 3	ADPCM, Uniform and Non-uniform Quantization, Quantization Error in PCM,Delta	2-3-4-5	BB,Chalk,PPT
	Week 4	Modulation, Adaptive Delta Modulations ,SNR Calculation, Non-uniform Quantization	3-4-5	BB,Chalk,PPT
	Week 5	Digital Modulation Techniques : QAM, BPSK, QPSK, DPSK, MSK, M-ary-FSK, M-ary-PSK,	4-5	BB,Chalk,PPT
	Week 6	BFSK of various digital modulation techniques and scrambling	4-5	BB,Chalk,PPT
	Week 7	Digital Demodulation Techniques: Coherent and non-coherent detection of ASK, FSK	4-5	BB,Chalk,PPT

	Week 8	PSK, QPSK,DPSK. Noise Figure, Signal to noise Ratio, performance of communication system with channel noise.	4-5	BB,Chalk,PPT
	Week 9	Probability and random process Information, Probability, Random Variables, Mean and variance, Conditional Probability of independent events, Relation between probability and probability Density , Releigh Probability Density ,	1	BB,Chalk,PPT
	Week 10	CDF, PDF, Random Variables, correlation between Random Variables, Linear mean square Estimation, Central limit theorem, Error function	1	BB,Chalk,PPT
	Week 11	Complementary error function Discrete and Continuous Variable, Gaussian PDF, Threshold Detection, Statistical Average,Chebyshev In Equality, Autocorrection.	5	BB,Chalk,PPT
	Week 12	Information Theory : Introduction, Concept & Measure of information, statistics of discrete channel, Error Free Communication Over a noisy channel	1-4-5	BB,Chalk,PPT
	Week 13	Shannon Theorem, The channel capacity of a Discrete Memory less Channel, Optimum System, The channel capacity of a Continuous Channel, Source Coding	1-4-5	BB,Chalk,PPT
	Week 14	Error Control Coding: Introduction, Linear block code, cyclic code, convolution code,	2-4-5	BB,Chalk,PPT
	Week 15	Burst Error Correcting and detecting code	2-4-5	


1st Year
Basic Electronics
3rd Semester
Differential Equations and Integral Transforms SH0301
Digital logic design EC0301
Network analysis EC0303
Control theory EC0305
Human values & professional Ethics SH0307
Analog electronics EC0304
Object oriented computer programming EC0302
2nd Year
4th Semester
Linear Integrated Circuits EC0401
Signals & systems EC0403
Complex Analysis and Numerical Methods SH0401
Electromagnetics EC0404
Cyber security & Intellectual Property Rights CE0407
Microprocessor & computer architecture EC0402
Digital systems design EC0405
5th Semester
Digital signal processing EC0501
Microcontroller and interfacing EC0503
Analog communication systems EC0504
Microwave engineering EC0505
Electronics measurements and instrumentation EC0502
Technical Communication and Soft Skills SH0507
Probability and random process EC0506
3rd Year
Elective I
Video Engineering EC0605
Power Electronics EC0606
Elective II
Radar and Navigation EC0607
Advanced Processor EC0608
Error Correcting Codes EC0609
6th Semester
Digital Communication EC0601
Antenna & Wave Propagation EC0602
Wireless communication EC0603
VLSI Design EC0604
Advanced Technical Communication And Soft Skills SH0607
Elective III
Advanced Mobile Communication EC0706
Cryptography and Network Security EC0707
Raspberry pi platform and python programming for raspberry pi by coursera (MOOC Course) EC0708
7th Semester
Embedded System EC0701
Satellite communication EC0702
Image and Video Processing EC0703
Data Communication Networks EC0704
Disaster Management CV0712
4th Year
8th Semester
Project

Name of Institute: Indus Institute of Technology and Engineering.
Name of Faculty: Prof. Ankur Changela

Course code: EC0616
Course name: VLSI Design
Pre-requisites: Digital Logic Design (EC0301)
Credit points: 5
Offered Semester: 6th

Course Coordinator (weeks 01 - 12)
Full Name: Prof. Ankur Changela
Department with siting location: EC/ECLab-2
Telephone: 3114 (Extn. No)
Email: ankurchangela.ec@indusuni.ac.in
Consultation times: Monday to Friday (4:00 to 5:00 PM) and working Saturday

Course Lecturer (weeks 01 - 12)
Full name: Prof. Ankur Changela
Department with siting location: EC/ECLab-2
Telephone: 3114 (Extn. No)
Email: ankurchangela.ec@indusuni.ac.in
Consultation times: Monday to Friday (4:00 to 5:00 PM) and working Saturday

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

1. The main objective of the course is to bring out circuit and system level views on VLSI design on the same platform.
2. In this course, student will learn the basic device (MOSFET) used to implement the VLSI design and then deals with complex digital circuits keeping in mind the current trend in technology.
3. After completion of the course, student will be able to understand design perspective, from basic specifications to system level blocks.

Course Outcomes (CO)

By participating in and understanding all facets of this Course a student will be able to:

1. Calculate the R-C delay using Elmore's delay method.
2. Analyze and optimize the delay of the critical data path using logical effort technique.
3. Design complex logic gates using different logic styles like CMOS, Pass Transistor Logic, and Transmission Gate etc.

4. Design and implement the combinational circuits and sequential circuits at transistor level.
5. Test the different design for stuck at faults and learn the different methods for testing.

Course Outline

- RC delay model,
- Schematic design,
- Logical effort technique,
- Combinational circuit design, and
- Sequential design.

Method of delivery

- 3 lectures per week.
- 2 hours tutorial per week
- 2 hours of lab per week
- Understanding of design techniques using simulations.

Study time

7 hours per week.

CO-PO Mapping (PO: Program Outcomes)

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

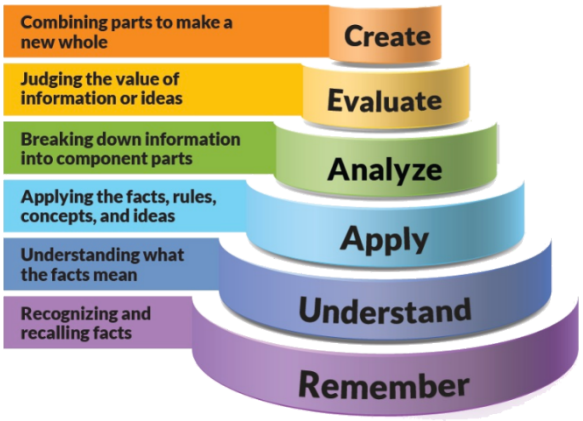


Figure 1: Blooms Taxonomy

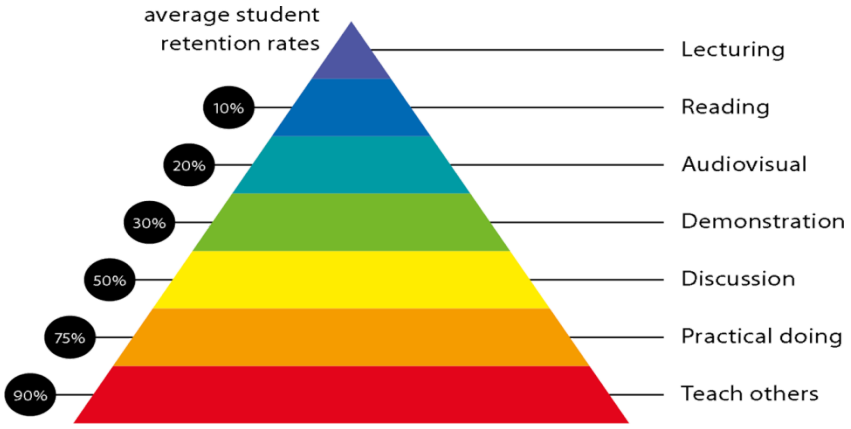


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in	**5 Written communication** **6 Oral communication** **7 Teamwork**

different settings. Recognize how culture can shape communication.	
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

Practical work in this course starts with the design of basic gates using different logic families. Student will learn to characterize their design by measuring the four parameters: 1. Power, 2. Area, 3. Delay, and 4. Power Delay Product. At the end of this course student will be able design the system blocks at transistor level.

Lecture/tutorial times

(Give lecture times in the format below)

Example:

Lecture Monday 9:00 – 9:55 AM Room LH 21
Lecture Wednesday 11:00 – 11:55 AM Room LH 21
Lecture Friday 9:55 – 10:50 AM Room LH 21
Tutorial Thursday 9:00 – 10:50 AM Room ECLab2 (A1)
Tutorial Friday 11:00 – 12:55 PM Room ECLab2 (A2)
Practical Wednesday 2:25 to 4:20 PM Room ECLab6 (A1)
Practical Tuesday 11:00 – 12:55 PM Room ECLab6 (A2)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. Neil H. E. Weste, David Money Harris “CMOS VLSI Design: A circuit and Systems Perspective” Pearson, 3rd edition.

2. Jan M. Rabaey “Digital integrated circuits: a design perspective” Prentice-Hall 2nd edition.

Additional Materials

NPTEL Course: CMOS Digital VLSI Design.
Link: https://onlinecourses.nptel.ac.in/noc19_ee25/course

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Example:
Tutorial 1 (5 Marks)
Tutorial 2 (5 Marks)
Tutorial 3 (5 Marks)
Tutorial 4 (5 Marks)
Mid-semester (20 Marks)
Quiz-1 (10 Marks)
Quiz-2 (10 Marks)

SUPPLEMENTARY ASSESSMENT

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available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

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Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

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Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment).

Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Introduction, MOSFET I/V Characteristics, Channel length modulation	1-2	-

	Weeks 2	MOSFET C/V Characteristics Second Order Effects	1-2	-
	Week 3	CMOS inverter DC Characteristics Beta Ratio Effects Noise Margins Pass Transistor DC Characteristics Tristate Inverter Switch level RC delay model	1-3	Tutorial-1
	Week 4	RC Delay Model Linear Delay Model Logical Effort	2-3	Tutorial-2
	Week 5	Parasitic Delay Delay in a Logic Gate Delay in Multistage Logic Networks Choosing the Best Number of Stages	2-4	Tutorial-3
	Week 6	Limitations of Logical Effort Dynamic Power Static Power	3-4	Tutorial-4
	Week 7	**Combinational Circuit Design** Pass-Transistor Circuits Static CMOS	4	
	Week 8	Ratioed Circuits Pass-Transistor Circuits	4	
	Week 9	Sequencing Static Circuits Max-Delay Constraints Min-Delay Constraints	3-4	
	Week 10	Time Borrowing Clock Skew Circuit Design of Latches and Flipflops	4	
	Week 11	Fault Models Design for Testability	5	
	Week 12	Ad-hoc testing Scan chain based testing BIST IDDQ testing	5