COMMUNICATION ENGLISH
ENSH 204

Lecture : 3 **Year : II**
Tutorial : 0 **Part : I**
Practical : 1

Course Objectives:
The general objective of this course is to focus on English as a communication tool. Specifically, it emphasizes using English for professional communication for engineering works. It aims to increase English language ability to use appropriate research formats and methodology, develop concept papers, prepare research proposals and abstracts, set research questions, write a literature review, determine a research gap, link ideas, write technical proposals, prepare formal and informal reports and engage in project works, seminars/conferences.

1 Technical Communication (2 hours)

1.1 Definition, nature and scope of technical communication
1.2 Professional ethics in communication (Ethical issues, plagiarism and copyright concerns, honesty, transparency and clarity)

2 Writing Skills (8 hours)

2.1 Principles of effective technical writing (Clarity, conciseness and coherence)
2.2 Grammar (Pronoun and its antecedent, subject-verb agreement, non-finite verbs), sentence construction (Simple, compound, complex, and mixed sentences), error analysis and punctuation
2.3 Bias-free language guideline, reducing bias

3 Technical Writing (15 hours)

3.1 Technical proposals (Purpose, types, structure, key considerations and examples)
3.2 Research proposals and reports (Title page, table of contents, summary and abstract)
3.3 Technical reports (Progress, feasibility and case study)
3.4 Manuscript for journal (Structure, key considerations and examples)
3.5 Citation and referencing (In-text citation, direct quote citations, indent citation, indirect citation, citing from books and journals, citing multiple authors in a single text, citing multiple texts from the same author, using numerical, pagination, preparing a reference page

4 Business Correspondence (10 hours)

- 4.1 Writing formal letters (Applications, inquiries, complaints and orders)
- 4.2 E-mails (Structure, etiquette, and tone)
- 4.3 Notice, minutes and memos
- 4.4 Resume and cover letter
- 4.5 Press release/communique
- 4.6 Calling tender and responding to it

5 Listening and Oral Communication (4 hours)

- 5.1 Active listening (Barriers and strategies)
- 5.2 Effective speaking skills (Clarity, tone and pace)
- 5.3 Oral presentation skills (Structuring a presentation and handling questions)
- 5.4 Group discussions (Strategies and active participation)
- 5.5 Public speaking and speech delivery techniques

6 Use of Visual Aids in Communication (6 hours)

- 6.1 Tables
- 6.2 Graphs
- 6.3 Charts
- 6.4 Diagrams

Practical (15 hours)

1. Listening skill test
2. Visual skill test
3. Reading skill test
4. Oral communication test
5. Presentation skill test
6. Research proposals and project proposals
7. Team-based technical writing and presentations
8. Presentation on the prescribed texts
    - 8.1 "Which is More Important When Designing a Building: Beauty or Function?" from Unlock: Reading and Writing Skills by Chris Sowton
    - 8.2 On Being Modern-minded (Bertrand Russell)
    - 8.3 A Fable of Tomorrow" from The Silent Spring by Rachel Carson
    - 8.4 Religion and Science (From The World as I See It- Albert Einstein)
    - 8.5 "The Tamarisk Hunter" from Metatropolis by Paolo Bacigalupi
    - 8.6 Artificial Intelligence from The Art of Doing Science and Engineering by Richard W. Hamming
    - 8.7 Guglielmo Marconi and the History of Radio. Part II (Gerald A. Isted)
    - 8.8 Human-Centered Design (From The Design of Everyday Things- Don Norman)
    - 8.9 "The Paper Managerie" from The Paper Managerie and Other Stories by Ken Liu

8.10 “The Algorithm Will Save Us” from The New Voices of Fantasy by Sam J. Miller
8.11 “The Phantom Heart” by Laurence Yep
8.12 “Everyday Use” by Alice Walker

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	2	5
2	8	10
3	15	20
4	10	10
5	4	10
6	6	5
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Markel, M. and Selber, S. A. (2018). Technical communication (12th edition). Bedford/St. Martin's.
2. Ingre, D. (2017). Engineering communication: A practical guide to workplace communications for engineers (2nd edition). Cengage Learning.
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8. Farhathullah, T. M. (2002). Communication skills for technical students. Orient Longman.
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10. Ligawa. H. (2021). Communication skills notes. Siaya Institute of Technology.
11. Katz, M. J. (2009). From research to manuscript: A guide to scientific writing (2nd edition). Springer.
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13. Hofmann, A. H. (2014). Scientific writing and communication: Papers, proposals, and presentations (2nd edition). Oxford University Press.

ENGINEERING MATHEMATICS III
ENSH 201

Lecture : 3 **Year : II**
Tutorial : 2 **Part : I**
Practical : 0

Course Objectives:
The objective of this course is to equip students with understanding and practical application of Fourier series, Fourier transform, function of complex variable, partial differential equations and obtaining mathematical models and Z- transform.

1 Fourier Series and Fourier Transform (12 hours)

1.1 Review of periodic, odd and even functions
1.2 Fourier series of a function over an interval of length 2ℓ and 2π; Euler's formula, Dirichlet's condition for uniform convergence of Fourier series, Fourier series of discontinuous functions
1.3 Half range Fourier sine and cosine series
1.4 Complex form of Fourier series; frequency and amplitude of a function
1.5 Fourier integral theorem, Fourier sine and cosine integrals, complex form of Fourier integral
1.6 Fourier transform, Fourier sine transform, Fourier cosine transform and their inversion formulas
1.7 Fourier transform of the derivative of a function
1.8 Relation between Fourier and Laplace transform

2 Functions of Complex Variable (12 hours)

2.1 Intuitive idea of limit, continuity and differentiability of functions of complex variable
2.2 Analytic functions, the Cauchy Reimann equations both in Cartesian and polar form, construction of analytic functions
2.3 Harmonic functions, the orthogonal system
2.4 Application of analytic functions in flow problems
2.5 Transformation (Mapping), conformal mapping, translation, rotation and magnification; inversion, bilinear transformation
2.6 Complex integration, simply and multiply connected regions, Cauchy's integral theorem and formula
2.7 Series of complex terms, power series, circle of convergence and radius of convergence, Taylor's and Laurent's series
2.8 Zeros, singularities, poles; residue at poles, Cauchy's residue theorem and evaluation real and improper integrals

3 Partial Differential Equations (5 hours)

3.1 Definition and formation of partial differential equations
3.2 Partial differential equations solvable by direct integration
3.3 Linear partial differential equation of the first order, Lagrange's linear equations and their solution
3.4 Nonlinear partial differential equation of first order; equations of the form $f(p,q) = 0$, $z = px + qy + f(p,q)$, $f(z,p,q) = 0$, $f_1(x,p) = f_2(y,q)$
3.5 Charpit's method of solving nonlinear partial differential equations of first order

4 Modelling through Partial Differential Equation (10 hours)

4.1 Second order partial differential equation and classification
4.2 One-dimensional wave equation
4.3 One-dimensional heat equation
4.4 Two-dimensional heat equation, Laplace equation in Cartesian form
4.5 Mass balance equation; equation of continuity in fluid dynamics, Navier-Stoke's equation
4.6 Momentum balance equation; Euler's equation of motion for inviscid fluid flow

5 Z- transform and its Applications (6 hours)

5.1 Representation of a sequence and basic operations
5.2 Definition and existence of Z-transform, Z-transform of standard sequences
5.3 Properties of Z-transform; linearity, change of scale, shifting properties, initial and final value theorems
5.4 Differentiations of Z-transform
5.5 Inverse Z-transform; partial fraction and residue methods
5.6 Convolution of sequences, convolution of Z- transform
5.7 Difference equations, application of Z-transform to solve difference equations and to find the sum of series

Tutorial (30 hours)

1. Problems related to find period and identify odd and even functions
2. Exercises on Fourier series representation over intervals 2l and generalization into 2π
3. Exercises related to Fourier series for discontinuous functions
4. Exercises related to half range Fourier series
5. Exercises related to complex form of Fourier series
6. Exercises related to Fourier integral, Fourier sine and cosine integral
7. Exercises related to Fourier transform, Fourier sine and cosine transform and inversion
8. Exercises related to Fourier transform of derivatives and boundary value problems.

9. Exercises on application of C-R equations and construction of analytic functions
10. Exercises on application of analytic functions to flow problems
11. Exercises on mapping covering example of each mapping
12. Exercises on application of Cauchy integral theorem and formula
13. Exercises related to expansion of a function in Taylor and Laurent series
14. Exercises related to complex integration by using Cauchy's residue theorem
15. Exercises on solution of partial differential equation by direct integration
16. Exercises related to Lagrange's equation and PDE's as mentioned in 3.4
17. Exercises related to solution of one dimensional wave equation, one dimensional heat equation, two dimensional equation
18. Exercises related to Z-transform, application of properties
19. Exercises related to inverse Z-transform
20. Exercises related to solve difference equations by Z-transform
21. Exercises related to find sum of series by Z- transform

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	**Hours**	**Marks distribution***
1	12	18
2	12	18
3	5	6
4	10	10
5	6	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Jeffery A. (2002). Advanced Engineering Mathematics (2nd edition). San Diego: Harcourt Academic Press.
2. O'Neill, P.V. (2011). Advanced Engineering Mathematics (7th edition). India: Thompsons, USA/Baba Baghanath Printers.
3. Kreyszig, A. (2020). Advanced engineering Mathematics (10th edition). USA: Wiley Publications.
4. Sastry S.S. (2014). Engineering Mathematics vol I and II (4th edition). India: PHI Learning Pvt. Ltd.
5. Wylie C., Barrett L. (1988). Advanced Engineering Mathematics (5th edition). McGraw Hill.
6. Dutta, D. (2006). A text book of Engineering Mathematics Vol I and II (2nd edition). India: New Age International Publishers.
7. Ogata, K. (2015). Discrete Time Control System (2nd edition). Pearson Publications.
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MICROPROCESSORS
ENEX 201

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 3

Course Objectives:
The objective of this course is to familiarize students with assembly language programming, hardware and applications of microprocessors. The course provides students with a comprehensive understanding of microprocessor architecture, programming, and interfacing techniques, with a focus on the Intel 8085 and 8086 microprocessors. Students will gain theoretical and practical knowledge of microprocessor-based systems, covering essential topics such as computer organization, instruction sets, memory and I/O interfacing, interrupt mechanisms, and advanced architectural concepts.

1 Introduction (4 hours)

1.1 Introduction to microprocessors
1.2 History of microprocessors
1.3 Basic block diagram of a digital computer
1.4 Microcomputer and microcontroller
1.5 Bus organization of computer system
1.6 Stored program concept (Von Neumann's architecture)
1.7 Processing cycle of a stored program computer

2 Intel 8085 Microprocessor (12 hours)

2.1 Features of 8085
2.2 Internal architecture of 8085
2.3 Pin configurations of 8085
2.4 Instruction format and data format
2.5 Addressing modes of 8085
2.6 Instruction set of 8085
2.7 Various programs in 8085
  2.7.1 Simple programs with arithmetic and logical operations
  2.7.2 Conditions and loops
  2.7.3 Array and table processing
  2.7.4 Decimal - BCD conversion
  2.7.5 Multiplication and division
2.8 Instruction cycle, machine cycle and T-cycle
2.9 Timing diagrams of bus operations

3 Intel 8086 Microprocessor (14 hours)

- 3.1 Features of 8086
- 3.2 Internal architecture of 8086
  - 3.2.1 BIU and components
  - 3.2.2 EU and components
  - 3.2.3 EU and BIU operations
- 3.3 Segment and offset address
- 3.4 Pin configurations of 8086
- 3.5 Addressing modes of 8086
- 3.6 Assembly language programming
- 3.7 High level versus low level programming
- 3.8 Assembly language syntax
  - 3.8.1 Comments
  - 3.8.2 Reserved words
  - 3.8.3 Identifiers
  - 3.8.4 Statements
  - 3.8.5 Directives
  - 3.8.6 Operators
  - 3.8.7 Instructions
- 3.9 EXE and COM programs
- 3.10 Assembling, linking and execution
- 3.11 One pass and two pass assemblers
- 3.12 Interrupt services: INT 21H and INT 10H
- 3.13 Various programs in 8086
  - 3.13.1 Simple programs for arithmetic, logical, string and input/output
  - 3.13.2 Conditions and loops
  - 3.13.3 Array and string processing
  - 3.13.4 ASCII and decimal numbers operation
  - 3.13.5 Displaying numbers in decimal, binary and hexadecimal formats

4 Microprocessor System (7 hours)

- 4.1 Memory classifications and hierarchy
- 4.2 Interfacing I/O devices and memory with 8085
  - 4.2.1 Address decoding
  - 4.2.2 Unique and non-unique address decoding
  - 4.2.3 I/O mapped I/O and memory mapped I/O
  - 4.2.4 I/O address decoding with NAND and block decoders
  - 4.2.5 Memory address decoding
- 4.3 Parallel Interface
  - 4.3.1 Modes: Simple, wait, single handshaking and double handshaking
  - 4.3.2 Introduction to programmable peripheral interface (PPI)

4.4 Serial Interface
  4.4.1 Synchronous and asynchronous transmission
  4.4.2 Serial interface standards: RS232, USB
  4.4.3 Introduction to USART

5 Interrupt Operations **(5 hours)**

5.1 Interrupt and its importance
5.2 Polling vs interrupt
5.3 Types of interrupts
5.4 Interrupts in 8085 and interrupt instructions
5.5 Interrupt service routine
5.6 Interrupt processing in 8085
5.7 Using programmable interrupt controllers (PIC)
5.8 Interrupt in 8086 and interrupt vector table
5.9 Interrupt processing in 8086

6 Advanced Topics **(3 hours)**

6.1 Harvard architecture
6.2 Accumulator based and register based architecture
6.3 Hardwired and microprogrammed control unit
6.4 RISC and CISC
6.5 Introduction to multiprocessing/multitasking
6.6 Digital signal processor

Tutorial **(15 hours)**

1. Assembly language programming with 8085
2. Assembly language programming with 8086
3. Input/output and memory address decoding

Problems are solved, and students are assisted by the teacher to solve additional programming problems during tutorial classes.

Assignment

Appropriate assignment problems should be given to students after the completion of each chapter.

Practical **(45 hours)**

1. Familiarization to programming kit and program entry/execution in kit
2. 8085 assembly language programming with data transfer instructions
3. 8085 assembly language programming with arithmetic instructions
4. 8085 assembly language programming with logical instructions
5. 8085 assembly language programming with branching and stack instructions
6. Miscellaneous and practical programming with 8085 such as multiplication/division

7. Familiarization with DEBUG and entry/executing programs
8. 8086 assembly language programming with simple programs and assemble link and execute programs
9. 8086 assembly language programming for input and output using INT 21H service
10. 8086 assembly language programming for display using INT 10H service
11. 8086 assembly language programs for various conditions and I/O operations
12. Lab test

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	4	6
2	12	15
3	14	18
4	7	12
5	5	6
6	3	3
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Gaonkar, R. S. (2002). Microprocessor Architecture, Programming and Applications with the 8085. United Kingdom: Prentice Hall.
2. Abel, P. (2000). IBM PC Assembly Language and Programming (5th edition). United Kingdom: Prentice Hall.
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THEORY OF COMPUTATION
ENCT 203

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 0

Course Objectives:
The objective of this course is to introduce students to the foundational concepts of theory of automata, formal languages, computational models and computational complexity.

1 Introduction to Formal Language, Logic and Proof (7 hours)

1.1 Brief review of set theory, function and relation
1.2 Propositional logic, expressing statements in propositional logic, rules of inference and proofs in propositional logic, introduction to predicate logic
1.3 Proofs, principle of mathematical induction, diagonalization principle, pigeonhole principle
1.4 Alphabet and language
1.5 Operations on languages: Union, concatenation, Kleene star

2 Finite Automata and Regular Language (10 hours)

2.1 Introduction to finite automata, finite state machine
2.2 Deterministic finite automata (DFA), representation of DFA, language of DFA, design of DFA
2.3 Non deterministic finite automata (NFA), equivalence of DFA and NFA
2.4 Finite automata with epsilon transition (ε - NFA), equivalence of NFA and ε –NFA, equivalence of DFA and ε – NFA
2.5 Regular expressions and regular languages
2.6 Equivalence of regular expression and finite automata
2.7 Closure properties of regular languages
2.8 Pumping lemma for regular languages
2.9 Decision algorithm for regular language

3 Context Free Grammar and Pushdown Automata (10 hours)

3.1 Introduction to context free grammar (CFG), component of CFG, context free language (CFL)
3.2 Types of derivations, parse tree and its construction, ambiguity
3.3 Simplification of CFG, normal forms, Chomsky normal form (CNF), Greibach normal form (GNF), Backus-Naur form (BNF)
3.4 Closure properties of context free languages

3.5 Pumping Lemma for context free languages
3.6 Decision algorithm for context free language
3.7 Introduction to push down automata (PDA), representation of PDA, operations of PDA, move of a PDA, instantaneous description for PDA
3.8 Language of PDA, equivalence of CFL and PDA, conversion of CFG to PDA
3.9 Context sensitive grammar

4 Turing Machine (10 hours)

4.1 Introduction to turing machine (TM), representation of TM, move of a TM, instantaneous description for TM
4.2 Computing with turing machine
4.3 Variants of turing machine
4.4 Unrestricted grammar, Chomsky hierarchy of grammar
4.5 Recursive function theory

5 Decidability and Computational Complexity (5 hours)

5.1 Church turing thesis
5.2 Universal turing machine, encoding of turing machine
5.3 Undecidable problem about turing machines, halting problems and its implications
5.4 Computational complexity, time and space complexity of a turing machine
5.5 Complexity classes class P, class NP, NP-complete problems

6 Automata Theory and Compiler (3 hours)

6.1 Basic concept of compiler, role of lexical analyzer, lexical analysis with deterministic finite automata
6.2 Parser and context free grammar, top down parsing, bottom up parsing, IR parsing

Tutorial (15 hours)

1. Set operations and proof using mathematical induction
2. Proof using rules of inference in propositional logic
3. Design of DFA, conversion of NFA to DFA, proof using pumping lemma for regular language
4. Writing grammar for context free language, design of PDA, proof using pumping Lemma for context free language
5. Design of turing machine for a language
6. Problem related to compiler design

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks Distribution*
1	7	9
2	10	13
3	10	13
4	10	14
5	5	6
6	3	5
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

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2. Sipser, M. (2006). Introduction to the Theory of Computation. United Kingdom: Thomson Course Technology.
3. Rosen, K. (2006). Discrete Mathematics and Its Applications. United Kingdom: McGraw-Hill Education.
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FOUNDATION OF DATA SCIENCE
ENCT 202

Lecture : 3 | **Year : II**
Tutorial : 1 | **Part : I**
Practical : 3

Course Objectives:
The objective of this course is to introduce the core concepts, tools, and methodologies of data science, focusing on the tools and techniques needed to analyze and interpret data effectively. Using data science tools, students will cover the entire data science process, from data acquisition, data manipulation, visualization, probability, statistics, and machine learning, with applications in business and engineering.

1 Introduction to Data Science (3 hours)

1.1 Overview of data science
1.2 Jargons of data science
1.3 Modern data ecosystem
1.4 Data science lifecycle
1.5 Trends, markets and applications of data science
1.6 Tools and technologies in data science
1.7 Data scientist and their roles

2 Mathematics for Data Science (10 hours)

2.1 Introduction to linear algebra for data science
2.2 Vectors, matrices and matrix factorization
2.3 Gradient descent for optimization
2.4 Introduction to probability and random variable
2.5 Probability distributions: Normal, Bernoulli, Binomial, Poisson
2.6 Descriptive and inferential statistics
2.7 Central limit theorem and sample distribution concepts
2.8 Normal approximation; hypothesis testing procedures: Tests about the mean of a normal population
2.9 The t-test, Z-tests for differences between two populations means, the two-sample t-test, confidence interval for mean of normal population
2.10 ANOVA

3 Data Understanding and Preprocessing (10 hours)

3.1 Types of data: Structured, unstructured, semi-structured
3.2 Data preprocessing requirements
3.3 Data sources and collection methods

3.4 Data cleaning and preparation
3.5 Data wrangling and associated tools
3.6 Data enrichment, validation and publishing
3.7 Data transformation and normalization
3.8 Dimensionality reduction linear factor model, principal component analysis (PCA)

4 Data Analysis (8 hours)

4.1 Data analytics: Descriptive, diagnostic, predictive and prescriptive analytics
4.2 Exploratory data analysis using descriptive statistics
4.3 Data visualization
4.4 Data visualization techniques
4.5 Principles of effective data visualization
4.6 Feature engineering and other aspects of data manipulation

5 Regression and Predictive Modeling (5 hours)

5.1 Empirical models, simple linear regression, MLE and least square estimator
5.2 Multiple linear regression, matrix approach to multiple linear regression, polynomial regression models, categorical regressors, indicator variables, selection of variables and model building
5.3 Logistic regression

6 Modeling and Validation Processes (6 hours)

6.1 Introduction to machine learning
6.2 Introduction to supervised, unsupervised and reinforcement learning
6.3 Modeling process, training /validating model, cross validation methods, predicting new observations interpretation
6.4 Measures for model performance and evaluation: Classification accuracy, confusion matrix, sensitivity, specificity, precision, recall, F-score, ROC curve, clustering performance measures, other measures

7 Ethics and Recent Trends (3 hours)

7.1 Ethical considerations in data science
7.2 Data privacy regulations
7.3 Responsible data usage
7.4 The five Cs
7.5 Future trends

Tutorial (15 hours)

1. Solution of data problems using linear algebra, vectors and matrices
2. Solution of the problems related probability and statistics to understand application in data science

3. Identification of the data types and performing data cleaning, transformation, wrangling, and dimensionality reduction Including EDA and feature engineering
4. Solution of the problem related to linear and logistic regression
5. Understanding machine learning basics by model training, cross-validation, and performance evaluation

Practical **(45 hours)**

1. Get acquainted with data science tools and perform statistical analysis
2. Hypothesis tests (e.g., t-tests, Z-tests) on sample datasets to compare population means
3. Simulate and apply the central limit theorem (CLT) to demonstrate how sample distributions converge to a normal distribution
4. Perform data wrangling and ETL processes on a dataset, followed by exploratory data analysis (EDA)
5. Utilize tools to create effective data visualizations (e.g., line charts, bar charts, heat maps, box plots) to derive key insights from the dataset
6. Implement feature extraction and selection techniques, including experimenting with encoding methods like one-hot encoding and creating new features based on domain expertise
7. Develop a simple linear regression model, extend it to multiple linear regression with several variables, and visualize both the regression line and residual plots
8. Apply logistic regression and evaluate the model using metrics such as accuracy, precision, recall, and the ROC curve
9. Apply K-means clustering and assess cluster quality using evaluation metrics like the silhouette score

By the end of the practical, students are required to submit a project where they develop a prototype to solve a real-world problem.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	3	6
2	10	12
3	10	12
4	8	9
5	5	6
6	6	9
7	3	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Ozdemir, S. (2016). Principles of Data Science. Germany: Packt Publishing.
2. Maheshwari A. (2018). Data Science for Dummies, Wiley.
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COMPUTER GRAPHICS AND VISUALIZATION
ENCT 201

Lecture : 3	**Year : II**
Tutorial : 1	**Part : I**
Practical : 3	

Course Objectives:
The objective of this course is to provide basic principles and their applications to computer graphics and visualization. After completion of this course, students will be able to understand geometric transformations and their applications, two-dimensional and three-dimensional object modeling techniques, rendering techniques, animation and get an overview of the latest trends in computer graphics.

1 Introduction and Application (4 hours)

- 1.1 History of computer graphics
- 1.2 Overview of graphic systems
  - 1.2.1 Video display devices: Raster-scan displays, random-scan displays, flat panel displays, three-dimensional viewing devices
  - 1.2.2 Graphics software and tools: Coordinate representations, graphics functions, software standards, PHIGS workstations, DirectX, OpenGL, WebGL, Maya, Blender, Unity
- 1.3 Graphics pipeline
  - 1.3.1 Two-dimensional (2D) viewing pipeline
  - 1.3.2 Three-dimensional (3D) viewing pipeline
- 1.4 Applications in various fields like medicine, engineering, art, uses in augmented and virtual realism

2 Raster Graphics and Algorithms (9 hours)

- 2.1 Rasterizing a point
- 2.2 Rasterizing a straight line: DDA line algorithm, Bresenham’s line algorithm
- 2.3 Rasterizing a circle and an ellipse: Mid-point circle and ellipse algorithm
- 2.4 Scan-line polygon fill algorithm
- 2.5 Scan-line fill of curved boundary areas
- 2.6 Boundary-fill algorithm
- 2.7 Flood-fill algorithm
- 2.8 Point clipping

2.9 Line clipping
    2.9.1 Cohen-Sutherland line clipping
    2.9.2 Liang-Barsky line clipping
2.10 Polygon clipping: Weiler-Atherton polygon clipping
2.11 Text clipping

3 2D and 3D Coordinate Systems and Viewing Transformations (9 hours)

3.1 2D transformation: Translation, rotation, scaling, reflection, shear
3.2 2D composite transformation
3.3 Window-to-viewport coordinate transformation
3.4 3D display methods
    3.4.1 Parallel projection
    3.4.2 Perspective projection
3.5 3D transformation: Translation, rotation, scaling, reflection, shear
3.6 3D composite transformation
3.7 Projection and viewing transformation

4 Curve Modeling and Surface Modelling (4 hours)

4.1 Introduction to parametric cubic curves, splines, Bezier curves
4.2 Surface modeling (Polygon surface, vertex table, edge table, polygon table, surface normal and spatial orientation of surfaces)

5 Visible Surface Determination (4 hours)

5.1 Image space and object space techniques
5.2 Back face detection, Z-Buffer, A-Buffer, Scan-Line method

6 Illumination and Surface Rendering Methods (4 hours)

6.1 Algorithms to simulate ambient, diffuse and specular reflections
6.2 Constant, Gouraud, Phong and Fast Phong shading models

7 Computer Animation and Visualization (5 hours)

7.1 Computer animation functions
7.2 Raster animations
7.3 Key-frame systems
7.4 Motion specifications
    7.4.1 Direct-motion specifications
    7.4.2 Goal-directed systems
    7.4.3 Kinematics and dynamics

8 Latest Trends in Computer Graphics (6 hours)

8.1 Interactive visualization
8.2 Distributed scene rendering
8.3 Augmented reality (AR), virtual reality (VR) and mixed reality (MR)
8.4 Game development and real-time graphics
8.5 Applications of AR, VR and gaming

Tutorial (15 hours)

1. Computations regarding raster graphics system- frame buffer size, color manipulation techniques, aspect ratio, refresh rate, resolution
2. Implementation of studied algorithms to determine points for digitizing lines, circles, and ellipses
3. Computational problems related to different clipping algorithms
4. Solution of problems related to 2D and 3D transformations and matrix compositions, including fixed-point scaling, pivot-point rotation, and reflection across an arbitrary line, among others
5. Transformation of object descriptions from the window coordinate system to the viewport coordinate system and solving problems related to parallel and perspective projection
6. Calculation of the points required to construct different curves studied using the specified set of control points and the desired number of line segments
7. Calculation of the surface normal of polygons and evaluating visibility using various visible surface determination techniques
8. Calculation of average intensity at a point on a polygon using Gouraud shading

Assignment

Appropriate assignment problems are given to students after the completion of each chapter.

Practical (45 hours)

1. DDA line algorithm
2. Bresenham's line algorithm
3. Mid-point circle algorithm
4. Mid-point ellipse algorithm
5. Lab on 2-D transformations
6. Lab on 3-D transformations
7. Program for viewing and shading the 3D object
8. Clipping hidden surface removal
9. Implement the discrete techniques
10. Basic drawing techniques in OpenGL
11. A simple computer animation
12. A simple AR/VR scene or application using a framework (e.g., Unity, ARKit, Unreal Engine)

By the end of the practical, students required to develop a prototype project to demonstrate their understanding of computer graphics concepts. Students will work in teams and are encouraged to explore new programming languages or platforms (e.g., Unity, Unreal Engine, WebGL) to complete their project.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks Distribution*
1	4	5
2	9	13
3	9	13
4	4	5
5	4	5
6	4	5
7	5	7
8	6	7
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Hearn D., Baker, M. P. (1997). Computer Graphics C version (2nd edition), Prentice Hall.
2. Theoharis, T., Papaioannou, G., Platis, N., Patrikalakis, N. M. (2008). Graph ics and Visualization: Principles & Algorithms. United States: CRC Press.
3. Foley, J. D. (1995). Computer Graphics: Principles and Practice in C (2nd edition). Germany: Addison-Wesley.