Far Western University
Faculty of Education
Bachelors in computer science education

Course Title: Database Management System
Course No.: CS. Ed. 243
Level: B.Ed.
Fourth Semester

Nature of the Course: Theory and Practical
Credits: 3
Total Periods: 48+16
Practical: 2 hours per period

1. Course Description

The purpose of this course is to introduce the fundamental concepts of database management system, including aspects of data models, database languages, and database design and its applicability in educational filed, data modeling using ER diagram, relational model, SQL, relational algebra, normalization, transaction processing, concurrency control and database recovery . At the end of this course, a student will be able to understand and apply the fundamental concepts required for the use and design of database management systems for different organizations.

2. Course Objectives

Throughout this course, students will

- be able to understand the physical and logical aspect of database,
- be able to develop and design database schemas with necessary data integrity constraints,
- become knowledgeable in the creation, altering, and manipulation of tables, indexes, and views using relational algebra and SQL,
- become proficient at casting queries in SQL,
- be able to write database application programs with an understanding of transaction management, concurrency control, and crash recovery.

3. Specific Objectives and Contents

Specific Objectives	**Contents**
• Define terms related to database management systems. • Understand the purpose of database management system. • Explain the concept of data abstraction and data independence. • Describe different data models and their usefulness. • Compare and contrast between DDL and DML. • Explain and database user's database systems structure.	**Unit I: Introduction to Database System (6)** 1.1. Data, Data Hierarchy, Database, Database Management System. 1.2. Application Areas of Database System 1.3. Views of Data: Data Abstraction, Database Schema and Instance, Data Independence, Data Models: (Hierarchical, Network, Entity Relationship, Relational, and object oriented data model). 1.4. Database Languages: DDL and DML 1.5. Database Users (Naive, Sophisticated, Specialized and Application), DBA and Responsibilities of DBA 1.6. Database System Structure, Database Application Architecture (Centralized, Client/Server)

• Explain use and importance of ER model. • Use ER diagrams to design databases. • Define concepts used in EER modeling • Explain concept behind Relational model. • Describe conversion of ER diagrams into Relational model.	**Unit II: Entity Relationship Data Modeling (7)** 2.1. ER Model and ER Diagrams, Components of ER Model, Types of Attributes. 2.2. Degree of Relationship, Constraints on ER Model (Mapping Cardinalities and Participation Constraints), Keys and Types of Keys(primary, foreign, super and candidate), Weak Entity Sets, and inheritance. 2.3. Extended ER Modelling: Super class, Subclass, Specialization and Generalization, Constraints on Specialization/Generalization, Aggregation. 2.4. Relational Model: Introduction, Structure of Relational Databases, Schema Diagram, Mapping ER Model to Relational Database.
• Implement basic operations of relational algebra. • Discuss and use additional relational algebra operations and extended relational algebra operations. • Understand and use database modification through relational algebra. • Apply the concept behind NULL values and three-valued logic.	**Unit III: Relational Algebra and Relational Calculus (7)** 3.1. Introduction of Relational Algebra (RA), Fundamental Operation of RA: Select Project, Set Union, Set Difference, Cartesian product and Rename Operations. 3.2. Additional Relational Algebra Operations: Set Intersection, Natural Join, Division and Assignment Operation, Aggregate Functions (sum, count, avg, min, max). 3.3. Database Modification: Insert, Delete and Update Operation 3.4. Null Values.
• Explain structure of SQL queries. • Describe sting operations. • Understand concept behind join operations and nested queries. • Discuss and Use aggregate functions and sub queries. • Apply database modification statements. • Explain and use DDL statements. .	**Unit IV: Structured Query Language (9)** 4.1. Introduction: Basic Structure of SQL Query, SELECT, FROM and WHERE clause, Using single and Multiple Relations 4.2. Strings Operations (Pattern Matching), Ordering the Display of Tuples, Join Operations: Join Types and Join Conditions. 4.3. Nested Queries: Set membership Test, Set Comparison and Test for Empty Relations. 4.4. Aggregate Functions (min, max, avg, sum, count), Aggregation with Grouping: Group by Clause and Having Clause 4.5. Database Modifications: Insert, Delete and Update Operations 4.6. Data Definition Language: Domain Types in SQL, Create, Alter and Drop statements

• Understand importance of integrity constraints. • List and discuss different types of integrity constraints. • Use Integrity constraints for maintaining for achieving correctness of data. • Compare and contrast between assertions and triggers	**Unit V:Integrity Constraints (4)** 5.1. Concept and Importance of Integrity Constraints, Data Integrity. 5.2. Domain Constraints: Not Null Constraints, Unique Constraints, Primary key Constraints, Check Constraints. 5.3. Referential Integrity. 5.4. Introduction to Assertions and Triggers.
• Understand and exemplify functional dependencies. • Conceptualize the closure sets of FD. • Discuss and exemplify conversion of unnormalized relations into normalized forms. • Explain why normalization is needed?	**Unit VI: Relational Database Design (5)** 6.1. Introduction 6.2. Functional Dependencies (FDs), Types of FD's, FD Inference Rules (Armstrong's Axioms). 6.3. Closure of Set of FD's, Closure of Set of Attributes. 6.4. Normalization: Purpose and Concept of Normalization, Forms of Normalization: 1-NF, 2-NF, 3-NF, BCNF
• Illustrate the concept of transaction. • Discuss serial and serializable schedules. • Understand the problems behind concurrent execution of transactions • Describe and exemplify concurrency control techniques	**Unit VII: Transaction Management (6)** 7.1 Transaction Concept, Read/Write operation. 7.2 Properties of Transactions, Transaction State Diagram. 7.3 Concurrent Executions, Schedules (Serial, Non-serial and Conflict), Serializability (Conflict and View) Testing for Conflict Serializability. 7.4 Concurrency Control: Overview of Concurrency Control, Locking Techniques, Lock-Based Protocols, Timestamp-Based Protocols.
• Demonstrate the reason of database failure. • Illustrate different recovery techniques.	**Unit VIII: Database Recovery Techniques (4)** 8.1 Recovery Concept, Reasons of database failure 8.2 Recovery Techniques: Log Based Recovery (Differed Update and Immediate Update) and Shadow Paging

4. Methodology and Techniques

Modes of instruction*:* Lecture, seminar, exercise course, guided personal study, tutorial, independent study, project work, Assignments in different topics, group discussion, reflective writing.

Types of learning activities

Attending lectures, performing specific assignments, writing papers, independent and private study, reading books, journals and papers, providing constructive feedback, group study and

peer discussion.

5. Evaluation Scheme

5.1 Internal Evaluation 40%

Internal Evaluation will be conducted by course teacher based on following activities.

a) **Attendance and Participation in class activities**: **5+5=10marks**

b) **Assignment I: Reflective Notes and Class presentation: 5+5=10marks**

(Reflective notes on2to4 questions given by teacher at the end of every unit and presentation on any two questions among them)

c) **Assignment II**: **One Term paper/Essay/Project and Interview: 5+5=10marks**

(Logical essay /term paper /project on the topics chosen by students and approved by the teacher and interview)

d) **Mid-term exam**: **10marks**

5.2 External Evaluation (Final Examination) 40%

Types of questions	**Total questions to be asked**	**Number of questions to be answered and marks allocated**	**Total marks**
Group A: Multiple choice items	8 questions	8×1	8
Group B: Short answer questions	6 with 2 'or' questions	6×4	24
Group C: Long answer questions	1 with 1 'or' question	1×8	8

5.3 Practical Evaluation (20%)

Office of the Controller of Examination will conduct final practical examination at the end of final examination.

After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the following evaluation criteria. There will be an internal examiner to assist the external examiner. Three hours' time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Evaluation System:

Practical	Weightage	Marks
Practical Report Copy	5	20
Viva	5	
Practical Exam	10	

Laboratory Work

Student should design ER diagrams of organization or particular subsystem with the organization. Use different Tools for drawing ER diagrams. Those ER diagrams should be converted into relational model and create database schema by using DDL. Finally populate the relations with some data and write some queries that cover all features of DML discussed in class. Creating views and indices for the database should also be appreciated. For laboratory work students can use DBMS systems like Oracle, MySQL, SQL server etc. But MS access should not accepted as Laboratory work platform

Prescribed Textbook

- Silberschatz, H.F., & Sudarshan. S. (2010). *Database System Concepts, 6th Edition, McGraw Hill.*

References

- Raghu, R., &Johannes G. (2007). *Database Management Systems, 3rd Edition, McGraw-Hill.*
- Ramez, E., & Shamkant B. N. (2010). *Fundamentals of Database Systems, 6th Edition, Pearson Addison Wesley.*

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Course Title: Data Communication and Networking Nature of the Course: Theory and Practical
Course No.: CS. Ed. 244 Credits: 3
Level: B.Ed. Total Periods: 48+16
Semester: Fourth Practical: 2 hours per period

1. Course Description:

This course introduces the fundamental concepts of data communication and networking. It covers both basic and some advanced topics, providing students with a solid foundation in how data is transmitted and received across networks. The course will also discuss the different network protocols, network security techniques and management approaches. The course will emphasize practical understanding suitable for future educators in IT.

2. Course Objectives:

- Understand the basic principles of data communication.
- Be familiar with the different Network Models and Communication Models.
- Familiarize with various networking protocols and models.
- Gain insights into network topologies, hardware, and software.
- Learn about network security and management.
- Setup the Network in various organizations.

3. Specific Objectives and Contents

Specific Objectives	**Contents**
• Define and explain the importance of data communication. • Identify and describe the components of a data communication system. • Differentiate between various data representation methods and transmission modes. • Compare and contrast analog and digital data communication.	**Unit1: Introduction to Data Communication (4)** 1.1 Definition and Importance of Data Communication and Networking 1.2 Components and Modes of Communication 1.3 Data Representation and Transmission Modes 1.4 Signal: Analog and Digital Signal, Signal Characteristics: Frequency, Amplitude, Phase, Periodic Signal, Square Wave, Signal Propagation
• Define networking and explain its importance in modern communication. • Differentiate between various types of networks: LAN, MAN, WAN, PAN.	**Unit 2: Networking Fundamentals (4)** 2.1 Definition and Importance of Networking 2.2 Types of Networks: LAN, MAN, WAN, PAN, Client Server, and Peer to Peer Network

• Describe and analyse different network topologies: Star, Bus, Ring, Mesh. • Explain the OSI and TCP/IP models, including the layers and their functions. • Understand concept of frequency reuse and roaming in cell phone.	2.3 Network Performance: Bandwidth, Throughput, Latency. 2.4 Network Topologies: Star, Bus, Ring, Mesh 2.5 Layered Communicating Models: OSI and TCP/IP: Layers and Their Functions 2.6 Concept of Wireless Network and Cellular Telephony: Frequency Reuse and Roaming, Generations
• Identify the physical structure and different types of guided media: twisted pair, coaxial cable, and fiber optics. • Describe the propagation characteristics of radio waves, microwaves, and infrared waves. • Identify the advantages and disadvantages of each switching technique. • Identify the advantages and challenges associated with each data encoding technique.	**Unit 3: Transmission Media (4)** **3.1** Guided media: Twisted Pair, Coaxial Cable, Fiber Optics **3.2** Unguided Media: Radio Waves, Microwaves, Infrared **3.3** Introduction Switched Communication Network: Circuit Switching vs. Packet Switching, and Message Switching **3.4** Data Encoding: Analog to Digital , Analog to Analog , Digital to Digital , Digital to Analog
• Describe the functions of the Data Link Layer. • Explain error detection and correction techniques: Parity, CRC, Hamming code. • Understand flow control and congestion control mechanisms. • Analyze Media Access Control (MAC) protocols: ALOHA, CSMA/CD, CSMA/CA.	**Unit 4: Data Link Layer and MAC (9)** 4.1 Functions of the Data Link Layer 4.2 Error Detection and Correction: Error Detection: Parity, CRC, Hamming Code, Error Correction: Stop and Wait ARQ, Go-Back-ARQ 4.3 Flow control: stop and wait and sliding window flow control. 4.4 Media Access Control (MAC) Protocols: ALOHA, CSMA/CD, CSMA/CA
• Explain the functions of the Network Layer. • Understand and configure IP addressing: IPv4 and IPv6. • Apply sub netting and super netting techniques. • Compare and contrast different routing algorithms: Distance Vector, Link State. • Know the concept of Internet Governance	**Unit 5: Network Layer (8)** 5.1 Functions of the Network Layer 5.2 Computer Addresses: IP and Mac Address 5.3 Classification of IP Address 5.4 IPv4 and IPv6 5.5 Sub Netting and Super Netting 5.6 Routing Algorithms: Distance Vector, Link State 5.7 Internet and Governance of Internet (ICB, ICANN, ITU, W3C)

• Describe the functions of the Transport Layer. • Compare TCP and UDP, including their characteristics and use cases. • Explain the processes of connection establishment and termination. • Understand flow control and error control at the Transport Layer.	**Unit 6: Transport Layer (5)** 6.1 Functions of the Transport Layer 6.2 Transport Layer Protocols: TCP vs. UDP, ARP, DHCP, ICMP 6.3 Connection Establishment and Termination 6.4 Flow Control and Error Control at Transport Layer
• Describe the functions of the Application Layer. • Identify and explain common application layer protocols: HTTP, FTP, SMTP, DNS. • Know the DNS process • Understand the basics of web technologies: HTML, HTTP. • Describe email services and protocols.	**Unit 7: Application Layer (6)** 7.1 Functions of the Application Layer 7.2 Common Application Layer Protocols: HTTP, FTP, SMTP, DNS (Structure of DNS) 7.3 Basics of Web Technologies: HTML, HTTP 7.4 Email Services and Protocols: SMTP and POP
• Explain the importance of network security. • Identify different types of security threats: Viruses, Worms, Trojans, Phishing. • Describe basic security measures: Firewalls, Antivirus software, Encryption. • Introduce basic concepts of Cryptography: Symmetric and Asymmetric keys.	**Unit 8: Network Security (4)** 8.1 Importance of Network Security 8.2 Types of security threats: Viruses, Worms, Trojans, Phishing 8.3 Basic Security Measures: Firewalls, Antivirus Software, Encryption 8.4 Introduction to Cryptography: Symmetric and Asymmetric keys
• Identify and describe network management tools and techniques. • Explain the basics and operations of SNMP. • Understand network monitoring and performance analysis. • Develop troubleshooting skills for common network issues.	**Unit 9: Network Management and Troubleshooting (4)** **9.1** Network Management Tools and Techniques **9.2** SNMP: Basics and Operations **9.3** Network Monitoring and Performance Analysis **9.4** Troubleshooting of Common Network Issues

4. Lab Work

Students are recommended to perform the following tasks and lab work is also conducted under the supervisor's recommendation as well.

1. Familiarize students with networking tools: Wireshark, Packet Tracer, GNS3.

2. Learn basic network configuration commands: ipconfig, ping, tracert, netstat.
3. Set up a simple network using Packet Tracer.
4. Create and analyze different network topologies using Packet Tracer.
5. Evaluate the advantages and disadvantages of each topology.
6. Set up and configure routers and switches.
7. Configure IP addresses and subnet masks on network devices.
8. Demonstrate the use of different transmission media.
9. Set up a network using different transmission media and test connectivity.
10. Assign IP addresses and configure subnet masks.
11. Practice on sub-netting
12. Use subnet calculators to design efficient network layouts.
13. Configure static and dynamic routing on routers.
14. Implement routing protocols in Packet Tracer.
15. Configure firewall rules and observe their impact on network traffic.
16. Analyze network performance using monitoring tools.
17. Troubleshoot common network issues and resolve connectivity problems.

5. Methodology and Techniques

Modes of instruction*:* Lecture, seminar, exercise course, guided personal study, tutorial, independent study, project work, Assignments indifferent topics, group discussion, reflective writing.

Types of learning activities*:* attending lectures, performing specific assignments, writing papers, independent and private study, reading books, journals and papers, providing constructive feedback, group study and peer discussion.

6. Evaluation Scheme

6.1 Internal Evaluation 40%

Internal Evaluation will be conducted by the course teacher based on the following activities.

a) **Attendance and Participation in class activities:** **5+5=10 marks**

b) Assignment I: Reflective Notes and Class presentation: **5+5=10 marks**

(Reflective notes on 2 to 4 questions given by teacher at the end of every unit and presentation on any two questions)

c) Assignment II: One Term paper/Essay/Project and Interview: **5+5=10 marks**

(Logical essay/term paper/project on the topics chosen by students and approved by the teacher and interview)

d) Mid-term exam: **10 marks**

6.2 External Evaluation (Final Examination) 40%

Types of questions	Total questions to be asked	Number of questions to be answered and marks allocated	Total marks
Group A: Multiple choice items	8questions	8×1	8
Group B: Short answer questions	6with2'or'questions	6×4	24
Group C: Long answer questions	1with1'or'question	1×8	8

6.3 Practical Evaluation (20%)

Office of the Controller of Examination will conduct final practical examination at the end of final examination.

After completing the end semester theoretical examination, practical examination will be held. The external examiner will conduct the practical examination according to the following evaluation criteria. There will be an internal examiner to assist the external examiner. Three hours' time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Evaluation System:

Practical	Weightage	Marks
Practical Report Copy	5	20
Viva	5	
Practical Exam	10	

Reference Books

Stallings, W. (2013). *Data and computer communications* (10th ed.). Prentice Hall.

Tanenbaum, A. S., &Wetherall, D. J. (2010). *Computer networks* (5th ed.). Prentice Hall.

Forouzan, B. A. (2007). *Data communications and networking* (4th ed.). McGraw-Hill.

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Course Title: Computer Graphics
Course No.: CS. Ed. 245
Level: B.Ed.
Semester: Fourth

Nature of the Course: Theory and Practical
Credits: 3
Total Periods: 48+16
Practical: 2 hours per period

1. Course Description

This course provides an introduction to computer graphics algorithms, software and hardware. Topics include description of different I/O devices used in displaying graphics, algorithms for drawing different output primitives, 2D and 3D transformations, techniques of hidden surface removal, surface rendering methods, and color models.

2. Course Objectives

The objective of this course is to understand the theoretical foundation as well as the practical applications of 2D and 3D graphics. Throughout this course, students will be able to

- Gain knowledge and understanding of the structure of an interactive computer graphics system, and the separation of system components.
- Use C and OpenGL for graphics programming.
- Have algorithmic understanding of output primitives and 2D geometrical transformations.
- Represent 3D geometrical objects and transform them into 2D objects.
- Gain knowledge and understanding of techniques of hidden surface removal, surface rendering and color models.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Explain application areas of computer graphics. • Describe visualization of images and colors in monitors.	**Unit I: Computer Graphics Hardware (6)** 1.7. Introduction to computer graphics, Application Areas of Computer Graphics, Frame Buffer and Display Buffer. 1.8. Graphics Devices: Cathode Ray Tube, Raster and Random Scan Displays, CRTs for colour display, Beam Penetration C 1.9. RT, The Shadow - Mask CRT, Direct View Storage Tube.
• Apply C Library functions in drawing graphics.	**Unit II: Computer Graphics Software (6)**

• Explain importance of OpenGL in Graphics Programming • Use OpenGL for Graphics programming	2.1 Overview of C graphics functions. 2.2 Introduction to OpenGL: Basic OpenGL Syntax, Related Libraries, Header Files, Display-Window Management Using GLUT, A Complete OpenGL Program, Error Handling in OpenGL.
• Explain Line drawing algorithms and Implement them. • Discuss circle and ellipse generating algorithms and implement them. • Demonstrate Filling Algorithms by writing Programs	**Unit III: Output Primitives (7)** 6.5. Line Drawing Algorithms: Line Equation, DDA algorithm, Bradenham's Algorithm. 6.6. Circle Drawing Algorithm: Properties of Circle, Mid-point Circle Algorithm. 6.7. Ellipse Generating Algorithms: Properties of Ellipse, Mid-point Ellipse Algorithm 6.8. Filing Algorithms: Scan-Line Filling Algorithm, Boundary Filling Algorithm
• Apply transformations such as translation, rotation, scaling, reflection, and shear to images. • Use homogeneous coordinate system to represent geometrical transformations • Explain need and process of world to view-port coordinate transformation.	**Unit IV: 2D Transformations Clipping & Windowing (8)** 3.5. Transformations: Basic Transformations (Translation. Rotation, Scaling), Other Transformations (Reflection, Shear), Matrix Representations and Homogeneous Coordinates. 3.6. Composite Transformations: Translation, Rotation, Scaling, General Pivot-point Rotation, General Fixed-point Scaling. 3.7. 2D Viewing: Viewing Pipeline, Viewing coordinate Reference Frame, Window to Viewport Coordinate Transformation
• Able to represent 3D objects using different data structures. • Describe Bezier curves and B-splines used to represent curved surfaces. • Explain 3D transformations and use homogeneous coordinate system to represent it.	**Unit V: 3D Concepts & Transformations (8)** 4.7. 3D Object Representations: Polygon Surfaces (polygon Tables, Plane Equations, Polygon Meshes), Bezier Curve and Surfaces. 4.8. 3D Transformations: Basic Transformations (Translation, Scaling, Rotation), Other Transformations (Shear, Reflection), General 3D Rotations, Fixed Point Scaling, Composite Transformations.
• Understand the concepts behind visible surface detection and classify the techniques. • Explain image space methods used for visible surface detection. • Describe object space methods and hybrid methods in detecting visible surfaces.	**Unit VI: Visible Surface Detection (5)** 5.5. Classification of Visible-Surface Detection Algorithms: Object Space Methods, Image Space Methods 5.6. Object Space Methods: Blackface Detection, 5.7. Image Space Methods: Depth-Buffer Method, A-Buffer Method.

	5.8. Hybrid Methods: Depth-Sorting Method, Area Sub-division method, Octree Method
• Discuss different light sources and their applications in surface rendering • Explain illumination models and compare them • Discuss different algorithms used in rendering polygon surfaces	**Unit VII: Surface Rendering Methods (4)** 7.1 Light Sources: Point Source, Distributed Light Source, Diffuse Reflection, Specular Reflection. 7.2 Illumination Models: Ambient Light, Diffuse Reflection, Specular Reflection. 7.2 Polygon Rendering Methods: Constant Intensity Shading, Gouraud Shading.
• Use & explain different models used in generating colors and their applications • Describe conversion between RGB and HSV color model	**Unit VIII: Color Models and Applications (4)** 8.1. Properties of Light, XYZ Colour Model. 8.2. Colour Models: RGB Colour Model, YIQ Colour Model, CMY Colour Model, HSV Colour Model 8.3. Conversion between HSV and RGB Models, Colour Selection and Applications

6. Methodology and Techniques

Modes of instruction*:* Lecture, seminar, exercise course, guided personal study, tutorial, independent study, project work, Assignments in different topics, group discussion, reflective writing.

Types of learning activities

Attending lectures, performing specific assignments, writing papers, independent and private study, reading books, journals, and papers, providing constructive feedback, group study and peer discussion.

7. Evaluation Scheme

5.2 Internal Evaluation 40%

Internal Evaluation will be conducted by course teacher based on following activities.

e) Attendance and Participation in class activities: **5+5=10marks**

f) Assignment I: Reflective Notes and Class presentation: 5+5=10marks

(Reflective notes on2to4 questions given by teacher at the end of every unit and presentation on any two questions among them)

g) Assignment II: **One Term paper/Essay/Project and Interview: 5+5=10 marks**

(Logical essay /term paper /project on the topics chosen by students and approved by the teacher and interview)

h) Mid-term exam: **10 marks**

5.2 External Evaluation (Final Examination) 40%

Types of questions	Total questions to be asked	Number of questions to be answered and marks allocated	Total marks
Group A: Multiple choice items	8 questions	8×1	8
Group B: Short answer questions	6 with 2 'or' questions	6×4	24
Group C: Long answer questions	1 with 1 'or' question	1×8	8

5.3 Practical Evaluation (20%)

Evaluation System:

Practical	Weightage	Marks
Practical Report Copy	5	20
Viva	5	
Practical Exam	10	

Office of the Controller of Examination will conduct final practical examination at the end of final examination.

After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the following evaluation criteria. There will be an internal examiner to assist the external examiner. Three hours' time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Evaluation System:

Practical	Weightage	Marks
Practical Report Copy	5	20
Viva	5	
Practical Exam	10	

Laboratory Work

Student should write programs, prepare lab sheet for each of the topics discussed in classes. Minimum 3 lab hour per week is required. Students can write programs by using C programming language. It is recommended to use widely used graphics library OpenGL in laboratory. Students can also use C-Builder to implement algorithms studied in class. Lab sheet of around 30 programming problems is recommended.

The laboratory course consists of implementing following algorithms using high level languages and OpenGL.

- DDA Line Algorithm
- Bresenham's line drawing algorithm
- Mid Point Circle Algorithm
- Mid Point Ellipse Algorithm
- Basic transformation on 2D including Translation, Rotation and Scaling
- Simple 3D Object with basic transformations including Translation, Rotation and Scaling
- Clipping
- Hidden surface removal
- Basic Drawing Techniques in OpenGL

Prescribed Text

- Hearn, D., & Baker, M. P. (2003)**.** *Computer Graphics C Version***,** *Second Edition, Pearson Education.*
- Hearn, D., & Baker, M. P. (2010). *Computer Graphics with OpenGL***,** *Fourth Edition, Prentice Hall.*

References

- Foley, et al., 2013 **.***Computer Graphics: Principles and Practice, Third Edition, Addison-Wesley*.
- Shreiner, et al., 2013, *OpenGL Programming Guide: The Official Guide to Learning OpenGL***,** *8th Edition.*