

B.Tech. CSE Sem – IV [January-June 2021]

Sr. No.	Subject Code	Courses	L	T	P	Credit
1	CS3CO10	Theory of Computation	3	1	0	4
2	CS3CO28	Data Communication	3	0	0	3
3	CS3CO25	Data Base Management Systems	3	1	2	5
4	CS3CO08	Computer Programming – II	2	0	2	3
5	CS3CO09	Operating System	3	1	2	5
6	CS3ES12	Software Workshop-I	0	0	2	1
7	CS3ELXX	Elective-1	3	0	0	3
8	EN3MC01	Open Learning Courses	1	0	0	0
		Total	18	3	8	24
		Total Contact Hours	29			

Elective-1: (*Choose any one*)

[Track: Web Technology]: Internet and Web Technology (CS3EW01)

[Track: AI]: Artificial Intelligence (CS3EA01)

[Track: IOT]: Internet of Things (CS3EL06)

[Track: Data Engineering]: Data Science (CS3ED06)

[Track: CTIS (inurture)]: Introduction to Cloud Computing (CS3EY01)

[Track: Data Science(inurture)]: Statistics & Probability (CS3ET01)

Course Code	Course Name	Hours Per Week			
		L	T	P	Credits
CS3CO10	Theory of Computation	3	1	0	4

Prerequisite:

Students should have a background in discrete mathematics, data structures, and programming languages.

COURSE CONTENTS

Unit-I: Finite Automata and Regular Languages

Motivation for studying theory of computation, Notion of formal languages and grammars, Kleene's Closure, Regular Expressions and Regular languages, closure properties of regular languages, Finite Automata. Finite Automata with output: Mealy and Moore machines, applications.

Unit-II: Nondeterminism and Minimization

Nondeterministic Finite Automata, Acceptance condition. Kleene's Theorem, Myhill-Nerode relations, Minimization Algorithm, Non-Regular languages, Pumping Lemma for regular languages.

Unit-III: Grammars and Context-Free Languages

Grammars and Chomsky Hierarchy, Context-Free Grammars, Context-Free Languages (CFLs), Inherent Ambiguity of CFLs, closure properties of CFLs, Eliminating useless symbols; null-productions; and unit productions, Chomsky Normal Form, Greibach Normal Form, Cock-Younger-Kasami(CYK) Algorithm, Applications to Parsing.

Unit-IV: Pushdown Automata

Pushdown Automata (PDAs), PDAs vs CFLs. Deterministic PDAs and CFLs, applications, notion of acceptance for PDAs: acceptance by final states, and by empty stack; the equivalence of the two notions, Proof that CFGs generate the same class of languages that PDAs accept, Pumping Lemma for CFLs.

Unit-V: Turing Machines and Computability

Introduction to Turing Machines, Configurations, Halting vs Looping, Turing computability, Nondeterministic, multitape and other versions of Turing machines. Church's thesis, Universal Turing Machines, Linear Bounded Automata (LBAs) and context-sensitive languages, Recursive and Recursively enumerable languages, Undecidability of Halting Problem and unsolvable problems about Turing Machines, the diagonalization language and proof that it is not Recursively enumerable.

Text Books:

1. Peter Linz, An Introduction to Formal Languages and Automata, Jones & Bartlett Learning, Canada.
2. John C. Martin, Introduction to Languages and the Theory of Computation, Tata McGrawHill.

Reference Books:

1. J.E. Hopcroft, Rajeev Motwani and J.D.Ullman, Introduction to Automata, Languages and Computation, Pearson Education, Asia.
2. Daniel I.A. Cohen, Introduction to Computer Theory, John Wiley.
3. H.R. Lewis and C.H.Papadimitrou, Elements of the Theory of Computation, Prentice Hall Inc.

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3CO28	Data Communication	3	0	0	3	3

UNIT-I:

Introduction to digital communications, Components, Data Representation, Data Flow. Analog and Digital Signals and their representation, Transmission Impairment, Data Rate Limits- Nyquist's theorem, Shannon's theorem, Signal propagation, Signal types, Transmission mode and techniques, Transmission Media-Guided and Non-Guided, Noise.

UNIT-II: -

Encoding of Signals -Analog to Digital Conversion, Digital to Digital conversion, - Unipolar, Polar, Bipolar line & block codes, Digital to Analog, Analog to Analog conversion, Spread Spectrum-FHSS, DHSS, CDMA. Modulation and Demodulation of Signals. Multiplexing: FDM, TDM, and WDM, QAM.

Data compression-Frequency dependant codes, run length encoding, Relative encoding, LZ Compression.

UNIT-III

Switched Communication Networks: Circuit, Message, Packet & Hybrid Switching, Data Gram Network, Connection oriented services Vs Connectionless services. Public Switching Telephone Network, Digital Subscriber Line, ADSL, HDSL, SDSL, VDSL. Study of various types of topology and their comparative study.

UNIT-IV

Reference model- OSI and TCP/IP model and its comparison, Layers in the model and its requirement, critiques of OSI and TCP/IP model, Use of Computer Networks. Architecture of Internet. Addressing-Physical, Logical, Port. Various Networking devices, Peer to Peer Protocols and service model.

UNIT-V

Data Link Layer: -Transmission Errors: Content Error, Error detection & Error correction, Bit error rate, Error detection methods: Parity checking, Checksum Error Detection, CRC, Hamming code. Framing, Flow error Control - ARQ, Sliding Window Protocol, HDLC and PPP. L-2 Switches, Bridges.

Text Book:

1. Andrew S.Tannenbaum, Computer Networks, Pearson Education.
2. William Stallings, Data and Computer Communication, Pearson Education.
3. Behrouz A.Fourouzan, Data Communication and Networking, Mc Graw Hill Publication.
4. Alberto Leon-Garcia, Indra Widjaja, Communication Networks-Fundamental concepts and key Architecture, TMH.

Reference Books:

1. Aftab Ahmad, Data Communication Principles for fixed and wireless networks, Kluwer Academic Publishers.
2. Gilbert Held, Data Communications Networking Devices: -Operation, Utilization, Lan and Wan Interworking, John Wiley and Sons.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credit
CS3CO25	Database Management System	3	1	2	5

Unit I

Basic Concepts: Data Vs Information, Definition of Database, Advantages of Database Systems, Components of DBMS, DBMS Architecture and Data Independence, Data modeling, Entity Relationship Model, Relational, Network, Hierarchical and Object-Oriented Models. Data Modeling Using the Entity Relationship Model.

Unit II

Relational Database: Relational Databases, Relational Algebra, Relational Algebra Operation, Tuple Relational Calculus, Domain Relational Calculus. Data Definition with SQL, Inserts, Delete and Update Statements in SQL, Views, Data Manipulation with SQL, PL/ SQL constructs: Triggers, Cursors etc.

Unit III

Database Design: Design Guidelines, Key concepts, Relational Database Design, Integrity Constraints, Domain Constraints, Referential Integrity, Functional Dependency, decomposition, Normalization Using Functional Dependencies: Normal Forms, First, Second and Third Normal Forms. Boyce Codd Normal Form, Multivalued Dependencies and Forth Normal Form, Join Dependencies and Fifth Normal Form, Decomposition in 2NF, 3NF and BCNF.

Unit IV

Database Transactions Processing: Introduction to Transaction Processing, Transaction Concepts, Desirable Properties of Transactions, Schedules, Concepts of Recoverability and Serializability, Concurrency control: introduction, locking protocols.

Unit V

Query Processing and Optimization, File organization and indexes, hashing techniques, B tree, B+ tree etc. Introduction to advanced databases: Distributed databases, Object oriented databases, mobile and web databases, Introduction to data warehousing and mining.

Text Books:

1. F.R. Mcfadden, J. Hoffer, M.Prescott, Modern Database Management, Addison Wesley.
2. Elmasri, Navathe, Fundamentals of Database System, Pearson Education Asia.

Reference Books:

1. C.J. Date, An Introduction to Database Systems, Pearson Education Asia.
2. Henry F Korth, Abraham Silbershatz, Database System Concepts, Mc Graw Hill.

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3CO08	Computer Programming-II Java	2	0	2	4	3

Unit I: Basics of JAVA: Overview of Java, History and Evolution of Java, Feature of Java, Difference between Java, C++ and C, Structure of java program, Basics of JDK, JRE and JVM, Installation of JDK, Simple Java Program, Compilation and Execution of Java program. Elements of Java: keywords, data types, variable, declaration and initialization of a variable, the scope and life time of variable, constants, literals, identifiers, operators, types of java statements, Unicode System, Naming Convention, Comments, Arrays, type conversion and casting.

Unit II: Dynamic Method Dispatch: Garbage Collection, static and dynamic binding, Inheritance and its types, Interfaces. Java Packages: Definition of package, types of package, differentiate package from header file, importing package, creating package.

Unit III: String in Java: Overview of string, Immutable String, String Comparison, String Concatenation, Substring, Methods of String class, String Buffer class, Creating Immutable class to_string method.

Unit IV: Exception Handling: Defining exception, types of exception, exception class, try and catch block, multiple catch blocks, Nested try, finally block, throw keyword, Exception Propagation, throws Keyword. Multithreading: Overview of thread, thread types, Life Cycle of a thread, creating thread, sleeping a thread, joining a thread, thread Priority, Daemon thread.

Unit V: I/O Handling: File Output Stream & File Input Stream, Buffered Output Stream & Buffered Input Stream, Input from keyboard by Input Stream Reader, Input from keyboard by Console, Input from keyboard by Scanner, Print Stream class. Java Applets: Applet Basics, the Applet Class, Applet Architecture, Applet Initialization and Termination, the HTML APPLET Tag, Passing Parameters to Applets. Introducing the AWT: Introduction to Windows, Graphics, and Text, AWT Classes, Window Fundamentals, Component, Container, Panel, Frame.

Text Books:

1. E. Balagurusamy, Programming with java A Primer, McGraw-Hill.
2. Herbert Schildt, The Complete Reference Java 2, Tata McGraw-Hill.

References:

1. Horstmann & Cornell, Core Java 2 (Vol I & II), Pearson.
2. Sharanam Shah, Core Java 8 for Beginners, Shroff Publisher.
3. Joshua Bloch, Effective Java, Sun Microsystems.

List of Experiments:

1. Write a program that accepts two numbers from the user and print their sum.
2. Write a program to calculate addition of two number using prototyping of methods.
3. Program to demonstrate function overloading for calculation of average.
4. Program to demonstrating overloaded constructor for calculating box volume.
5. Program to show the detail of students using concept of inheritance.
6. Program to demonstrate package concept.
7. Program to demonstrate implementation of an interface which contains two methods declaration square and cube.
8. Program to demonstrate exception handling in case of division by zero error.
9. Program to demonstrate multithreading.
10. Program to display “Hello World” in web browser using applet.
11. Program to add user controls to applets.
12. Write a program to create an application using concept of swing.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credit
CS3CO09	Operating Systems	3	1	2	5

Unit I: Introduction Language Processors, Language Processing Activities and Language Processors Development Tools, Assemblers, Compiler, Macros and Macro Processors, Linkers, Introduction to OS. Operating system functions, evaluation of O.S., Different types of O.S.: Batch, Multi-Programmed, Time-Sharing, Real-Time, Distributed, Parallel.

Unit II: Process: Concept of Processes, Process Scheduling, Operations on Processes, Cooperating Processes, Inter-Process Communication. Precedence Graphs, Critical Section Problem, Semaphores, Threads. CPU Scheduling: Scheduling Criteria, Preemptive & Non-Preemptive Scheduling, Scheduling Algorithms, Algorithm Evaluation, Multi-Processor Scheduling, Deadlock: Deadlock Problem, Deadlock Characterization, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock, Methods for Deadlock Handling.

Unit III: Memory Management: Concepts of Memory Management, Logical and Physical Address Space, Swapping, Fixed and Dynamic Partitions, Best Fit, First Fit and Worst Fit Allocation, Paging, Segmentation, and Paging Combined with Segmentation.

Unit IV: Concepts of Virtual Memory, Cache Memory Organization, Demand Paging, Page Replacement Algorithms, Allocation of Frames, Thrashing, Demand Segmentation, Role of Operating System in Security, Security Breaches, System Protection, and Password Management.

Unit V: Disk Scheduling, File Concepts, File Manager, File Organization, Access Methods, Allocation Methods, Free Space Managements, Directory Systems, File Protection, File Organization & Access Mechanism, File Sharing Implement Issue, File Management in Linux, Introduction to Distributed Systems.

Text Books:

1. Silberschatz, Galvin, Operating Systems Concepts, Wiley Publications.
2. Andrew S. Tenenbaum, Modern Operating Systems, Pearson Education Asia / PHI.

Reference Books:

1. Terrence Chan, UNIX System Programming Using C++, Prentice Hall India.
2. W. Richard Stevens, Advanced Programming in UNIX Environment, Pearson Education.
3. William Stallings, Operating Systems, Pearson Education Asia.

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3EW01	Internet and Web technology	3	0	0	3	3

Unit – I

Introduction: Concept of WWW, HTTP Protocol: Request and Response, Web browser architecture and Web servers and Application server, Features of Web 2.0, Internetworking with TCP/IP, basics of DNS, SMTP, POP3.

Unit - II

Web Design: Concepts of effective web design, Planning and publishing website, Introduction to web architecture, HTML: list, tables, images, frames, forms, Document type Definition (DTD), Document Object Model (DOM), Cascading Style Sheets and their types, Java Script: Introduction, documents, forms, statements, functions, objects.

Unit - III

Introduction to XML, XML vs HTML uses of XML, simple XML, XML key components, DTD and Schemas, embedding XML into HTML documents, Transforming XML using CSS, XSL and XSLT.

Unit - IV

PHP: working with variables and constants, controlling program flow, working with functions, arrays, files and directories, working with forms and databases, Introduction to Servlet, Lifecycle, API, and Servlet Packages.

Unit - V

Introduction to Java Server Page (JSP), JSP Application Design, JSP objects, Conditional Processing, declaring variables and methods, sharing data between JSP pages, Sharing Session and Application Data, Database Programming using JDBC, web application framework, MVC framework, Introduction to bootstrap, angular JS.

Text Books:

1. J. C. Jackson, Web Technologies: A computer science perspective, Pearson Education.
2. Black Book, Web Technologies, Kogent learning solutions Inc. dreamtech Press.
3. A. S. Godbole & A. Kahate, Web Technologies: TCP/IP Architecture, and Java Programming, TMH.

Reference Books:

1. Ralph Moseley and M. T. Savaliya, Developing Web Applications, Wiley-India.
2. Paul S. Wang Sanda, S Katila, An Introduction to Web Design, Programming, CENGAGE Learning.
3. P.J. Deitel& H.M. Deitel, Internet and World Wide Web How to program, Pearson.

Course Code	Course Name	Hours Per Week			
		L	T	P	Credits
CS3EA01	Artificial Intelligence	3	0	0	3

Unit I: Introduction to artificial intelligence, various types of production systems, Characteristics of production systems, Study and comparison of breadth first search and depth first search techniques.

Unit II: Optimization Problems: Hill-climbing search Simulated annealing like hill Climbing, Best first Search. A* algorithm, AO* algorithms etc, and various types of control strategies, Heuristic Functions, Constraint Satisfaction Problem.

Unit III: Knowledge Representation, structures, Predicate Logic, Resolution, Refutation, Deduction, Theorem proving, Inferencing, Semantic networks, Scripts, Schemas, Frames, Conceptual dependency.

Unit IV: Uncertain Knowledge and Reasoning, forward and backward reasoning, monotonic and nonmonotonic reasoning, Probabilistic reasoning, Baye's theorem, Decision Tree, Understanding, Common sense, Planning.

Unit V: Game playing techniques like minimax procedure, alpha-beta cut-offs etc, Study of the block world problem in robotics.

Text Book:

1. Elaine Rich, Kevin Knight and Nair, Artificial Intelligence, TMH
2. S. Russel, Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson.

Reference Books:

1. Saroj Kausik, Artificial Intelligence, Cengage Learning 4
2. Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press,
3. Nils Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann.
4. David Poole, Alan Mackworth, Artificial Intelligence: Foundations for Computational Agents, Cambridge Univ. Press..

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3ED06	Data Science	3	0	0	3	3

Unit I

Introduction to Data Science, Definition and description of Data Science, history and development of Data Science, terminologies related with Data Science, basic framework and architecture, importance of Data Science in today's business world, primary components of Data Science, users of Data Science and its hierarchy, overview of different Data Science techniques.

Unit II

Sample spaces, events, Conditional probability and independence. Random variables. Discrete and continuous random variables, densities and distributions, Normal distribution and its properties, Introduction to Markov chains, random walks, Descriptive, Predictive and prescriptive statistics, Statistical Inference, Populations and samples, Statistical modeling,

Unit III

Exploratory Data Analysis and the Data Science Process - Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA - The Data Science Process - Case Study:

Unit IV

Data Visualization: Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects, Exercise: create your own visualization of a complex dataset.

Unit V

NoSQL, use of Python as a data science tool, Python libraries: SciPy and sci-kitLearn, PyBrain, Pylearn, Matplotlib, challenges and scope of Data Science project management.

Text books

1. Data Science from Scratch: First Principles with Python 1st Edition by Joel Grus
2. Principles of Data Science by Sinan Ozdemir, (2016) PACKT.

Reference Books

1. Data Science for Dummies by Lillian Pierson (2015)
2. Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking by Foster Provost, Tom Fawcett

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3EY01	Introduction to Cloud Computing	3	0	0	3

Unit I: Fundamentals of Cloud Computing:

Cloud Computing Basics – History of Cloud Computing, Characteristics of Cloud Computing, Need for Cloud computing, Advantages and Possible Disadvantages of cloud computing, Cloud Deployment Models – Public, Private, Hybrid, Community, Other deployment Models. Evolving Data Center into Private Cloud, Datacenter Components, Extracting Business value in Cloud Computing – Cloud Security, Cloud Scalability, Time to Market, Distribution over the Internet, Cloud Computing Case Studies.

Unit II: Cloud Delivery Models

Introduction to Cloud Services, Infrastructure as a Service (IaaS) – Overview, Virtualization, Container, Pricing Models, Service Level Agreements, Migrating to the Cloud, IaaS Networking options, Virtual Private Cloud(VPC), IaaS Storage – File and Object storage, Data Protection, IaaS security, Benefits, Risks and Examples of IaaS. Platform as a Service (PaaS) – Overview, IaaS vs PaaS, PaaS Examples, benefits and risks. Software as a Service (SaaS) – Introducing SaaS, SaaS Examples – Office 365, Google G Suite, Salesforce.com, Evaluating SaaS – user and vendor perspective, Impact of SaaS, Benefits and risks of SaaS. Other Services on Cloud, Cloud Delivery Models Considerations

Unit III: Cloud Platforms

Introducing Cloud Platforms, Evaluating cloud platforms, Cloud Platform technologies – Amazon Web Services, Microsoft Azure, Google Cloud Platform, Salesforce.com, Impact of Cloud platforms. Private Cloud Platforms – Introducing Private clouds – Microsoft Azure stack, Open stack, AWS Greengrass, Impact of Private clouds

Cloud Migration: Delivering Business Processes from the Cloud: Business process examples, Broad Approaches to Migrating into the Cloud, The Seven-Step Model of Migration into a Cloud, Efficient Steps for migrating to cloud., Risks: Measuring and assessment of risks, Company concerns Risk Mitigation methodology for Cloud computing, Case Studies

Unit IV: Cloud Computing - Challenges, Risk and Mitigation

Cloud Storage, Application performance, Data Integration, Security. Ensuring Successful Cloud Adoption: Designing a Cloud Proof of Concept, Vendor roles and capabilities, moving to the Cloud. Impact of Cloud on IT Service Management. Risks and Consequences of Cloud Computing – Legal Issues, Compliance Issues, Privacy and Security.

Unit V: Managing the Cloud

Managing and Securing Cloud Services, Virtualization and the Cloud, Managing Desktops and devices on the cloud, SOA and Cloud computing, Managing the Cloud environment, planning for the Cloud – Economic Cost Model and Leveraging the Cloud, Cloud computing resources, Cloud Dots and Don'ts.

Text Books:

1. Kirk Hausman, Susan L. Cook, Telmo Sampaio, “CLOUD ESSENTIALS CompTIA® Authorized Courseware for Exam CLO-001”, John Wiley & Sons Inc.
2. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, “Cloud Computing for Dummies”, Wiley Publishing Inc.

Reference Books:

1. Erl,” Cloud Computing: Concepts, Technology & Architecture”, Pearson Education.
2. Srinivasan, “Cloud Computing: A Practical Approach for Learning and Implementation “Pearson Education.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
CS3ET01	Statistics and Probability	3	0	0	3

Unit I: Introduction to Statistics

History of statistics, importance of statistics in different field of research, Types of statistics, types of data, variables, types of variables – based on measurement, based on observation, difference between cross sectional and time series data, importance of cross sectional and time series data in statistical analysis, important terminologies – sample, population, universe, statistics, statistic, parameter, estimation, estimator, probability distribution function, probability density function, probability mass function, sampling distribution and standard error, basic arithmetic operators in statistics, application of statistics in different research areas.

Unit II: Summarizing data using Statistical Measures

Descriptive Statistics – Measure of central tendency - Mean: Arithmetic mean, geometric mean and harmonic mean with its mathematical properties, mathematical relationship among these different means, median for raw data – odd number and even number, grouped data, mode for raw data and grouped data, properties of mean, median and mode and relationship among mean, median and mode, measure of dispersion – standard deviation, variance, covariance and its properties, coefficient of variation, quartiles, quartile deviation and mean deviation, graphical representation of data: Unidimensional, bidimensional and multidimensional.

Unit III: Testing of Hypothesis

Introduction to testing of hypothesis, Statistical assumptions, Level of significance, confidence level, Type I Error, Type II error, Critical value, power of the test, sampling distribution, small sample test – t test for one and two sample mean, F test, Large Sample test – Z test for equality of single mean, equality of two sample mean, equality of single proportion, equality of two sample proportions, multiple comparison of sample means, one way analysis of variance with unequal sample sizes, Introduction to general linear model, assumptions of ANOVA, factors and levels in ANOVA, layout of one way ANOVA, skeleton of one way and two way ANOVA, calculation and examples for one-way and two-way ANOVA.

Unit IV: Theory of Random variables and Expectations

Random variables- discrete and continuous random variables, statistical properties of random variables, Expectation of a random variables, expectation of random variable in terms of variance and covariance, jointly distributed random variables, moment generating function, characteristic function, limit theorems related to random variables.

Unit V: Introduction to Probability theory

History of probability theory, definition of various terms related to probability – trial, events, exhaustive events, mutually exclusive events, equally likely events, independent events, introduction to Apriori probability, limitations of classical probability, statistical or empirical probability, theory of sets, elements of sets, operations on sets, algebra of sets, axiomatic approach to probability, probability function, theorems on probabilities of events, law of probability theory, Introduction to conditional probability and expectations, examples for conditional probability and expectation, properties of conditional random variables, identity for compound random variables.

Text Books

1. SC Gupta and VK Kapoor, “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons Publication
2. **Reference Books:**
 1. Sheldon M. Ross, “Introduction to Probability Models”, Elsevier Publication, Academic Press, UK
 2. Sheldon M. Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Elsevier Publication, Academic Press, UK

Course Code	Course Name	Hours Per Week				
		L	T	P	Hrs.	Credits
CS3ES12	Software Workshop-I	0	0	2	2	1

This course has been associated with program electives of corresponding semesters. The lab experiments of respective program electives will be performed during the lab hours for respective students.