SCHEME OF STUDIES
DIPLOMA IN INFORMATION SCIENCE & ENGINEERING
(C-20)

V Semester Scheme of Studies - Diploma in Information Science and Engineering [C-20]

Programme Specialization Pathway

Pathway	Course Category / Teaching Department	Course Code	Pathway Title	Hours per Semester L	T	P	Total contact hrs /Semester	Credits	CIE Marks Max	Min	SEE-1 Marks (Theory) Max	Min	SEE-2 Mark (Practical) Max	Min	Total Marks	Min Marks for Passing	Assigned Grade	Grade Point	SGPA and CGPA
1	ISE Specialization pathways in emerging areas Student may select any one of the specializations	20IS51I	1. Artificial Intelligence and Data Science	104	52	312	468	24	240	96	60	24	100	40	400	160			
		20CS52I	2. Full Stack Development	104	52	312	468	24	240	96	60	24	100	40	400	160			
		20CS53I	3. Cloud Computing	104	52	312	468	24	240	96	60	24	100	40	400	160			
		20CS54I	4. Cyber Security	104	52	312	468	24	240	96	60	24	100	40	400	160			

Science and Research Pathway

Pathway	Course Category / Teaching Department	Course Code	Pathway Title	L	T	P	Total	Credits	CIE Marks Max	Min	SEE Marks Max	Min	Total Marks	Min Marks for Passing			Both SGPA & CGPA
2	BS/SC/ISE Specialization pathway in Science and Research **(Student need to take all four papers in this pathway)**	2OSC51T	Paper 1-Applied Mathematics	52	26	0	78	6	50	20	50	20	100	40			
		2OSC52T	Paper 2 – Applied Science	52	0	52	104	6	50	20	50	20	100	40			
		2ORM53T	Paper 3 – Research Methodology	52	0	52	104	6	50	20	50	20	100	40			
		2OTW54P	Paper 4 – Technical Writing	39	13	52	104	6	60	24	40	16	100	40			
			Total	195	39	156	390	24	210	84	190	76	400	160			

Entrepreneurship Pathway

Pathway	Course Category / Teaching Department	Course Code	Pathway Title	L	T	P	Total	Credits	CIE Max	Min	SEE Max	Min	Total Marks	Min Marks for Passing			
3	ES/ISE	20ET51I	Entrepreneurship and Start up	104	52	312	468	24	240	96	160	64	400	160			

L:- Lecture   T:- Tutorial P:- Practical BS- Basic Science:: ES-Engineering Science:: SC: Science , I: Integrated :: IS: Information Science and Engineering

Note : In 5th Semester student need to select any one of the pathways consisting of 24 credits

Students can continue their higher education irrespective of the pathways selected.

VI Semester Scheme of Studies - Diploma in Information Science and Engineering [C-20]																
Pathway	Course Category / Teaching Department	Course Code	Pathway	Course		Total contact	Credits	CIE Marks		SEE Marks		Total Marks	Min Marks for Passing	Assigned Grade	Grade	SGPA and CGPA
								Max	Min	Max	Min					
Internship	ES/ISE	20IS61S	Specialisation pathway	Internship/ project	40 Hours / week Total 16 Weeks	640	16	240	96	160	64	400	160			
		20IS61R	Science and Research Pathway	Research project	40 Hours / week Total 16 Weeks	640	16	240	96	160	64	400	160			
		20IS61E	Entrepreneurship and Start up pathway	Minimum Viable Product - MVP/ Incubation/ Startup proposal	40 Hours / week Total 16 Weeks	640	16	240	96	160	64	400	160			

Note : Student shall undergo Internship/Project/research project/MVP/Incubation/Startup proposal in the same area as opted

in 5th semester pathway.

Artificial Intelligence
and
Data Science

Program	Information Science	Semester	5
Course Code	20IS51I	Type of Course	L:T:P (104:52:312)
Course Name	Artificial Intelligence and Data Science	Credits	24
CIE Marks	240	SEE Marks	160

Introduction:

Welcome to the curriculum for the Artificial Intelligence and Data Science (AI&DS) Specialisation. This specialisation course is taught in Bootcamp mode. Bootcamps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn how to produce a computer-assisted solution when data is too complex for humans to find answers as they combine both data science and machine learning skills that are needed for today's job market.

Some common examples include; Amazon Alexa - converting spoken audio into language; Google Image Search – uses image recognition to return specific search results; Samsung Smart Fridges – uses data and machine learning to produce intuitions about your behaviour. Leading to the successful completion of this bootcamp, you shall be equipped to either do an internship at an organization working in AI or do a project in AI. After the completion of your Diploma, you shall be ready to take up roles like Machine Learning Engineer, Data Scientist, Data Analyst, and more.

This course will teach you Fundamentals of AI, Python and Python libraries, data visualization, machine learning models, maths like linear algebra, data interpretation, Version control system, cloud deployment and more. Details of the curriculum is presented in the sections below.

Pre-requisite

Before the start of this specialisation course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of

Computer, Fundamentals of Electrical and Electronics Engineering, Project Management skills and Multimedia & Animation.

In the 2nd year of study, you would have studied Python Programming, Computer Hardware, Maintenance and Administration, Computer Networks, Database System Concepts and PL/SQL, Data Structures with Python, Operating System and Administration, Object oriented programming and Design with Java, Software Engineering principles and practices.

In this year of study, you shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Course Cohort Owner

A Course Cohort Owner is a faculty from the core discipline, who is fully responsible for one specialised field of study and the cohort of students who have chosen to study that specialised field of study.

Guidelines for Cohort Owner

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.
3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.
4. The industry session shall be addressed by industry subject experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.
6. Cohort owner shall plan and accompany the cohort for any industrial visits.
7. Cohort owner shall maintain and document industrial assignments, weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom sessions can augment or use supplementally teaching and learning opportunities including good quality online courses available on platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM , etc.

Course outcome: A student should be able to

CO1	Explain the concept of AI, its applications, constituents and challenges of ethics in AI.
CO2	Analyze and visualize any given dataset.
CO3	Evaluate, optimize, build and test an AI model for a given requirement.
CO4	Perform comparative analysis of methods or algorithms for a given requirement.
CO5	Select the appropriate tools, production environment and deploy the model.

Detailed course plan

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1	1	1	1. AI based movie (Screening)			4	- AI influence in companies viz, Amazon, Microsoft, Google, IBM - Latest developments in AI domain - Google's DeepMind AI Just Taught Itself To Walk - YouTube - Introducing Amazon Go and the world's most advanced shopping technology - YouTube - IBM Watson - Understanding the evolution of AI and HMI (human machine interface) Discussion on how AI will Impact of daily life, work life, work force, jobs, products and services – T	2		1
	1	1	2	Fundamentals of AI - What is artificial intelligence? - How AI works - Purpose of AI - Types of Artificial Intelligence - Goals of AI - Applications of AI	4			- Significance of data in AI - AI Software Development life cycle - Compare traditional software development with AI Software Development - Example – Game rules (Chess) Explore and prepare a report on all popular AI cloud services (ML & DL) offered by vendors	2		1

			- Ethics in AI Examples of AI in real world - T						

	5	4	3	Why Do We Need a Version Control System?
				
				Fundamentals of Git
				
				Git installation and setup
				
				basic local Git operations
				  ▪ creating a repository,
				  ▪ cloning a repository,
				  ▪ making and recording changes
				  ▪ staging and committing changes,
				  ▪ viewing the history of all the changes
				  ▪ undoing changes
					1	3	Git Branching and merging
							
							Basic
							  ▪ Creating and switching to new branches
							  ▪ Switching between branches
							  ▪ Merging local branches together
								1	2

	5	4	4	GitHub - Basics of distributed git - Account creation and configuration - Create and push to repositories - versioning - Collaboration Migration	1	3	Create repository – named mini project-1 Push the same to GitHub TOC - Git Essentials: Become a Git and GitHub Ninja | Infosys Springboard (onwingspan.com)		3
			5	**Developmental Assessment**			Assessment Review and corrective action		3
	1	1,5	6	Real industry experience of AI	2	3	Weekly Assignment(1PM-2PM)		
2	1	1	1	**Peer Review**		4	DataScience - Why data science?	2	1

						- What is data science? - How Data Science works? Data Science - Uses - Components - Tools Data Science process - significance and steps - Architecture - Project Life cycle Real world use cases		

1,5	1	2	- Pipelines
			  ▪ Data engineering
			  ▪ Machine learning
			  ▪ Deployment
			- Predictive analytics
			- Business Intelligence
			- Data analytics in everyday life
			Discussion: Data in daily life
			Python Packages for DataScience
			  ▪ Scientifics computing libraries
			  ▪ Visualization Libraries
			  ▪ Algorithmic libraries
				2	2	**Machine Learning**
						- Fundamentals
						- Machine learning types
						- Applications
						TOC - Machine Learning Fundamentals
							Infosys Springboard (onwingspan.com)
							Prediction – continuous value
							Big Data
							- What is Big Data?
							- Vs of Big Data
							- Sources of data
							- Role of Big Data in AI & DataScience
								2	1

			Environment setup: install required packages Explore above listed packages						
	1,5	1,4	3	Introduction to Cloud Computing Essentials of Cloud Computing Cloud Deployment Models Cloud Service Models Serverless Services Major Cloud service Providers Virtualization Explore the cloud service providers and services offered by them - T	2	2	Introduction to Containers Cloud Native application development Explore AI (ML and DL) services across public cloud platforms Note: teacher has to choose a public cloud platform to perform the fallowing activities - Getting to know cloud platform Creating an account	1	2
	1,5	4,5	4	Walking through the administrative console and Cloud SDK Explore Virtual machines (PaaS, Iaas and SaaS) and storage options Deploy a simple application on the cloud AI Platform overview	1	3	Essentials of cloud billing SLA TOC - Essentials of Cloud Computing	Infosys Springboard (onwingspan.com) Tutorial - Automatically Create Machine Learning Models - Amazon Web Services Tutorial - Automatically Create Machine Learning Models - Amazon Web Services	1	2
			5	**Developmental Assessment**			Assessment Review and corrective action		3
	1,5	2,3,4	6	Build applications using AI cloud services	2	3			
3	1,5	2,3,4	1	Peer review	4		Python recap Database connectivity	1	2

						Explore NumPy Module - Array Aggregation Functions - Vectorized Operations - Use Map, Filter, Reduce and Lambda Functions with NumPy - TOC - Pandas and NumPy Tips, Tricks, and Techniques | Infosys Springboard (onwingspan.com)		
1,5	2,3,4	2	Explore Pandas modules - Aggregation and Grouping - Time Series Operations - Pivot and melt function - Use Map, Filter, Reduce and Lambda Functions with Pandas dataframes - TOC - Unpacking NumPy and Pandas | Infosys Springboard (onwingspan.com)		4	**Contd.**		3
1,2,5	2,3,4	3	**Data visualization with python** - Visualization fundamentals - Why visualization - Coordinate Systems and Axes - Directory of Visualizations Amounts, Distributions, Proportions, x-y Relationships, Uncertainty	2	2	- Visualizing Amounts - Visualizing distributions - Visualizing proportions - Visualizing associations - Visualizing time series **Consider a dataset and infer the relations with the help of different plots.**		3

			Basics of python visualization with Matplotlib - Understand the anatomy of a figure - Plot creation - Plotting routines - Basic plot customizations Saving plots					
	1,2 ,5	2,3 ,4	4	- Visualizing trends - Visualizing uncertainty - Visualizing categorical data - visualize proportions - visualize data on multi-plot grid - Composite views for informative summaries of data	1		3	Basics of python visualization with Seaborn The Course Overview - Viewer Page | Infosys Springboard (onwingspan.com)			3
			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action			3
	5	2,3 ,4	6	**How to create project plan and product backlog for AI project** Create Git Repository for following Regression Project Classification Project Clustering project Natural Language Processing	2		3	Weekly Assignment			
4	2	2,3 ,4	1	**Peer review** **Mini Project Activity (2)** - **Regression**		4		**Data engineering pipeline** **Data Collection** - Population and sample	1		2

			- **Classification**
			 (Individual/ Team of 2)
			 - Define Problem statement
			 - Create project plan and product backlog
			 - Create git repository for the project
			 Work progress should be monitored weekly
							- Types of data
							     ▪ Data type (type 1 (cross sectional, time series), type 2 (univariate, multivariate))
							     ▪ Variable types (categorical, ordinal, ratio, interval)
							 - Data Collection
							 Key terminologies in Statistics – T
							 Mini Project Activity
							 Data collection for the stated problem			

2	2,3,4	2	**Probability** - Introduction - Axioms - Properties - Conditional and joint Probability - Bayes' Theorem Infosys Springboard (onwingspan.com) TOC - Probability Distribution using Python | Infosys Springboard (onwingspan.com) **Introduction to Statistics** Types - Descriptive statistics - Inferential statistics	2	2	**Measure of Dispersion** - Range - Variance - Standard deviation - z-score - Quartiles - Interquartile range **Measure of Shape** - Skewness - Kurtosis **Use relevant python packages to compute Dispersion for the parameters of a dataset**	1		2

			Measure of Central tendency - Mean - Median - Mode **Use relevant python packages to compute central tendency for the parameters of a dataset** **Visualize above computation with various techniques**	1			**Visualize above computation with various techniques**		
2	2,3,4	3	**Probability Distributions** Random variable and types Probability Distributions - Types Discrete Distribution - Probability Mass Function - Cumulative Distribution Function - Uniform distribution - Binomial Distribution - Poisson Distribution **Use relevant python packages to compute and visualize data distribution for a given dataset**	2		2	Continuous Distribution - Probability Density function - Normal distribution - Central Limit Theorem - Student's Distribution - Chi-Square Distribution **Use relevant python packages to compute and visualize data distribution for a given dataset**	1		2
2	2,3,4	4	**Statistical Inference**	1		3	Continuous Distribution	1		2

				- Introduction to Sampling - Sample size - Sampling methods - Distribution of sample proportions - Population - Estimating population proportion - Distribution of Differences in Sample Proportions Estimate the Difference Between Population Proportions			- Probability Density function - Normal distribution - Central Limit Theorem - Student's Distribution - Chi-Square Distribution **Use relevant python packages to compute and visualize data distribution for a given dataset**			
			5	**Developmental Assessment**				Assessment Review and corrective action			
	2,5	2,3,4	6	**ANOVA - one and two way**	2		3				
5	2,5	2,3,4	1	**Peer Review**		4		**Exploratory data analysis** - overview - EDA goals and benefits **Univariate data analysis** - Characterizing data with descriptive statistics - Univariate distribution plots - Univariate comparison plots - Univariate composition plots **Mini Project Activity** Data Exploration and analysis for the stated problem	1		2
	2,5	2,3,4	2	**Univariate analysis tests**	2		2	**Multivariate analysis**	1		2

			Hypothesis testing Error, Test statistic, type, interpreting test statistics. Understanding p-value				Finding relationship in data - Covariance - Correlation		
2,5	2,3,4	3	Multivariate distribution plot Multivariate comparison plot Multivariate relationship plot Multivariate composition plot - TOC - Exploratory Data Analysis with Pandas and Python 3.x | Infosys Springboard (onwingspan.com) **Mini Project Activity – Status review** (Data Exploration and analysis for the stated problem)	1		3	Contd.		3
2,5	2,3,4	4	**Introduction to Linear Algebra** **Why Linear algebra?** **Applications of Linear algebra.** **Linear algebra using python** - Scalars - Vectors - Matrices - Tensors Gradients - Eigen values and eigen vectors	1		3	Linear transformation - Introduction - Stretching - Reflection - Rotation - Projection **Use relevant python packages to perform Linear Transformation**	1	2

			- Norms and Eigen decomposition **Use relevant python packages to perform operations over vectors and matrices.** TOC - Basics of Linear Algebra using Python | Infosys Springboard (onwingspan.com) Interactive Scenario: Introduction to Vector Algebra Using Python (oreilly.com)						
		5	**CIE 2 – Written and Practice Test**			Assessment Review and corrective action			3
	2,5	2,3,4	6	Statistics and Linear algebra	2		3	Weekly assignment			

6	2,5	2,3,4	1	Peer review
				Mini Project Activity – Status review
						4		**Data Preprocessing**
								Importance of data preprocessing
								Data cleaning
								- Assess Data quality
								- Data anomalies
								- Detect missing values with pandas dataframe functions: .info() and .isna()
								- Diagnose type of missing values with visual and statistical methods (eg. chi-squared test of independence)
								Approaches to deal with missing values
								  ▪ Keep the missing value as is
								  ▪ Remove data objects with missing values
								  ▪ Remove the attributes with missing values
								Estimate and impute missing values
									1		2

2,5	2,3,4	2	Practice: Dealing with missing values with different approaches
			
			Outliers
			Detecting outliers
			  ▪ univariate outlier detection
			  ▪ bivariate outlier detection
			  ▪ Time series outlier detection
				1		3	Dealing with outliers
							  ▪ Do nothing
							  ▪ Replace with the upper cap or lower cap
							  ▪ Perform a log transformation
							  ▪ Remove data objects with outliers
							Practice: Dealing with outliers with different approaches
							TOC - Data Preprocessing | Infosys Springboard (onwingspan.com)
							TOC - Data Cleaning and Transformation | Infosys Springboard (onwingspan.com)
								1		2

2,5	2,3,4	3	Data Integration
			  ▪ Overview
			  ▪ data integration challenges
			  ▪ Approaches
			      - Adding attributes
			      - Adding data objects
			Practice: data integration
				1		3	Data reduction
							- Distinction between data reduction and data redundancy
							- Objectives
							- Methods
							    o numerosity data reduction
							    o dimensionality data reduction
							Practice: Data reduction with numerosity data reduction method
								1		2

2,5	2,3,4	4	Data transformation
			Need for data transformation.
			  ▪ **Normalization**
				1		3	Data transformation with
							  ▪ ranking transformation
							discretization
								1		2

			▪ Standardization Data transformation with ▪ binary coding ▪ ranking transformation discretization							
		5	**Development Assessment**				Assessment Review and corrective action			3
	2,5	2,3,4	6	**Feature engineering**	2		3	Weekly Assignment			
7	2,3,5	2,3,4	1	Peer Review **Mini Project Activity – Status review**		4		**Data Splitting** Importance of data splitting - Training set - Validation set - Testing set Underfitting and overfitting Practice: split training and testing data sets in Python using train_test_split() of sci-kit learn. Explore the options of train_test_split()	1	2
	2,3,5	2,3,4	2	**Machine Learning pipeline:** **Model training** Supervised Learning: Regression What is Regression? Types of regression Regularization in ML	2		2	Understanding Simple linear regression - Regression equation - Assumptions - Gradient descent - Setting up the regression problem Practice: student score based on study hours	1	2

			Real-Life Applications - T Linear regression Overview Types - simple linear regression - Multiple linear regression - Polynomial linear regression Applications of Linear Regression - T				Problem statement: • Create a model to analyses the relation between CIE and SEE result • Create a model to analyze the relation between crop yield and rain fall rate Build linear regression model using - Stats model - Scikit learn		
2,3,5	2,3,4	3	**Model Evaluation & testing** Evaluate regression model: Evaluation Metric - Coefficient of Determination or R-Squared (R2) - Root Mean Squared Error (RSME) - Optimize regression model Gradient descent	2		2	Cross-validation Why do we need Cross-Validation? Techniques - Hold out method - Leave One Out Cross-Validation K-Fold Cross-Validation	1	2
2,3,5	2,3,4	4	Multiple Linear Regression - Overview - Assumptions - Normal Equation - Applications	1		3	Implementation in python - Build regression model - Evaluate the model - To minimize the cost function		3

			Identification and collection of regression dataset - T Perform data exploration, preprocessing and splitting on datasets like - Boston housing price from sci-kit learn datasets - Cricket match result - past data - Performance of a cricket player - past data - Crop yield - past data						
		5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action		3
	2,3,5	2,3,4	6	**Optimization and performance matrices for regression**	2		3	Weekly Assignment		
8	2,3,4,5	2,3,4	1	Peer review **Mini Project Activity – Status review**		4		Explore other regression algorithms - T Rebuild the model with other regression algorithms such as - Random Forest Regressor - Support Vector Regression - Lasso regression Evaluate and compare the performance of each.	1	2
	2,3,4,5	2,3,4	2	Supervised learning – classification What is classification? Types:	2		2	Decision trees - What is decision tree? - Understanding Entropy, information gain	1	2

			- Binary classification - Multi-Label Classification - Multi-Class Classification - Imbalanced Classification Classification models Applications - T Practice: Iris dataset from sci-kit learn Perform data exploration, preprocessing and splitting			- How to stop overfitting - Pruning Decision Tree Classifier - How it works? - Understanding the parameters - Applications		
2,3,4,5	2,3,4	3	Build decision tree-based model in python for like Breast Cancer Wisconsin (diagnostic) dataset from sci-kit learn Or any classification dataset from UCI , Kaggle	1	3	Evaluation Metrics for Classification - confusion matrix, - Accuracy - Precision and Recall - Specificity - F1-score - AUC-ROC ▪ How to compute ▪ How does it work When to use	1	2
2,3,4,5	2,3,4	4	Evaluation Metrics for Classification- contd. Evaluation of decision tree model with different metrics		4	Hyper parameter tuning for Decision Tree Classifier	1	2
		5	**Developmental Assessment**			Assessment Review and corrective action		3

	3,4 ,5	2,3 ,4	6	Hyper parameter tuning for classification	2		3	Weekly Assignment		
9	2,3 ,4, 5	2,3 ,4	1	Peer review **Mini Project Activity – Status review**		4		Logistic regression - Overview - Types - How does logistic regression work? - Assumptions - Understanding sigmoid function - Applications Practice: build Logistic regression model in python	1	2
	2,3 ,4, 5	2,3 ,4	2	build Logistic regression model in python Evaluation and optimization of the model	1		3	Support Vector Machine - Introduction to SVM - How does it work? - Applications Practice: Build a SVM Model in python for Fish dataset from Kaggle	1	2
	2,3 ,4, 5	2,3 ,4	3	Build a SVM Model in python How to optimize SVM?	1		3	Ensemble Learning Introduction Basic Ensemble Techniques - Max Voting - Averaging - Weighted Average Advanced Ensemble Techniques - Stacking	1	2

				Practice/Activity				Teaching/Tutorial			
								- Blending			
								- Bagging			
								- Boosting			
								Explore and list the Ensemble Algorithms - T			
								Random Forest			
								- Introduction			
								- How does it work?			
								- Hyper parameters			
								Applications			
	2,3,4,5	2,3,4	4	Build Random Forest-based model in python for Breast Cancer Wisconsin (diagnostic) dataset from sci-kit learn Or dataset from UCI , Kaggle			4	Evaluation and optimization			3
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			
	3,4,5	2,3,4	6	Comparison of classification algorithms with real world scenario	2		3	Weekly Assignment			
10	2,3,4,5	2,3,4	1	Peer review **Mini Project Activity – Status review**		4		Unsupervised learning – - What is unsupervised learning? - Common approaches - Challenges - Clustering Types Applications of unsupervised learning - T K-means – Working of K-means How to Choose the Right Number of Clusters?	1		2

	2,3,4,5	2,3,4	2	**Implementation in python** Evaluation Metrics - Inertia - Dunn Index Evaluate the model using mentioned metrics	1		3	**Contd.**	3
	2,3,4,5	2,3,4	3	Dimensionality Reduction - Importance of Dimension Reduction in machine learning Common methods to perform Dimension Reduction - T Dimensionality Reduction using PCA in python	2		2	Dimensionality Reduction using PCA in python	3
	5	4,5	4	MLOps - Overview - Why MLOps? - ML pipeline - Versioning - Model registry	2		2	- Monitoring - Deployment - Model monitoring	3
			5	**Developmental Assessment**				Assessment Review and corrective action	3
	3,4	2,3,4	6	Compare various clustering techniques	2		3	Weekly Assignment	
11	1,2,3,5	2,3,4	1	Peer Review **Mini Project Activity – Status review**		4		Natural Language Processing Understanding natural language processing NLP approaches – rule based, statistical NLP use cases	1		2

						How to use dictionary?				
						Commonly used NLP tools & libraries				
						Setup environment				
						(spaCy or similar nlp package)				
	2,3,5	2,3,4	2	Text processing tasks (Processing Words) Document Assembler Annotation Tokenization - Sentence tokenization - Word tokenization - Visualize frequency distribution of words - Visualize with word cloud Stop word - Dropping stop words Dropping punctuations	1		3	Spell Correction Normalization - Stemming - Lemmatization			3
	2,3,5	2,3,4	3	Parts of speech tagging Named Entity Recognition	1		3	Vectorizer N-Gram	1		2
	2,3,5	2,3,4	4	TF-IDF Build a pipeline for text processing	1		3	Contd.			3
			5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action			3
	2,3,5	2,3,4	6	NLP – text summarization	2		3	Weekly Assignment			
12	2,3,5	2,3,4	1	Peer review Mini Project Activity – Status review		4		NLP use case – Sentiment Analysis (SA) What is sentiment analysis? Why is SA important?	1		2

						Business applications for SA		
						How does sentiment analysis work?		
						Transformers		
						Conduct Sentiment analysis to classify movie		
						reviews with		
						- spaCy		
						TensorFlow and keras		
2,3,4,5	2,3,4	2	NLP use case – Sentiment Analysis (SA) Contd.	2	2	Ethics in AI - Importance of AI ethics - Ethical challenges of AI - AI code of ethics Group Discussion: Discussion on the Ethics of AI Ethics of AI: Safeguarding Humanity | Professional Education (mit.edu)	1	2
1,5	2,3,4	3	Containers Why containers? What is a docker? How docker works? Components of docker - Docker container - Docker client - Docker daemon - Docker image - Docker registry	2	2	Publish the container in Registry	1	2

			Install docker on desktop and start the docker tool. TOC - Containers & Images | Infosys Springboard (onwingspan.com) Docker file Docker image Commands to create docker file. Build docker image with docker file create docker container from docker image Run the docker container TOC - Deploying and Running Docker Containers | Infosys Springboard (onwingspan.com) TOC - Docker, Dockerfile, and Docker-Compose (2020 Ready!) | Infosys Springboard (onwingspan.com)							
5	2,3,4	4	Deployment strategies	1		3	Contd.		3
		5	**Developmental Assessment**				Assessment Review and corrective action		3
1,3,5	2,3,4	6	Using cloud service for MLOps	2		3	Weekly Assignment		

| 13 | 1,2 ,3, 4,5 | 2,3 ,4 | 1-6 | **Internship**

a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship.

b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies.

c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internship. | | | | **Project**

a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective.

b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified.

c) Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome. | | | |

**Note: Saturday session from 9 AM -2 PM

References

Sl. No	Description
1	Hands-On Artificial Intelligence for Beginners By Patrick D. Smith
2	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, By Aurélien Géron
3	Machine Learning with Python for everyone, Mark E Fenner
4	Hands on Data processing in Python , Joy Jafari
5	Deep Learning with TensorFlow2 and Keras , Antonio Gulli, Amita Kapoor,Sujith Pal
6	Cloud Computing, Concepts, Technology and Architecture by Thomas Erl
7	Khan Academy
8	Fundamentals of Data Visualization, Claus O. Wilke
9	Pro Git ,Scott Chacon, Ben Straub
10	Mathematics for Machine Learning, A. Aldo Faisal, Cheng Soon Ong, and Marc Peter Deisenroth
11	Machine Learning, Pipelines, Deployment and MLOps Tutorial	DataCamp
12	MLOps Python Tutorial for Beginners -Get Started with MLOps (projectpro.io)

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		3	60
SEE 2 – Practical		3	100
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

* The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE

Note : Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	Information Science & Engineering		Semester		V
Course	Artificial Intelligence and Data Science		Max Marks		30
Course Code	20IS51I		Duration		4 hours
Name of the course coordinator					

Note: Answer one full question from each section.

Qn.No	Question	CL L3/L4	CO	PO	Marks
	Section-1 (Theory) – 10 marks				
1.a)	In recent years most of the companies are turning to text based chatbot for resolving consumer queries. What is the reason for it and how is it impacting the business.	L4	1		5
b)	Create two series as shown using pd.series() function. Series_A = [1,2,3,4,5] Series_B = [4,5,6,7,8] Get the items not common to both.	L3	2		5
2.a)	Ramesh is a solutions manager for an enterprise and has deployed all the applications in the on-premise datacentre. He has been asked to plan the infrastructure for an online foot ware store that the enterprise is developing. The traffic forecast for the application varies based on various parameters. List the implications if they continue with on-premise solution.	L4	1		4
b)	Create a dataframe with following data.

	First Name	Last Name	Type	Department	YoE	Salary
0	Aryan	Singh	Full-time Employee	Administration	2	20000
1	Rohan	Agarwal	Intern	Technical	3	5000
2	Riya	Shah	Full-time Employee	Administration	5	10000
3	Yash	Bhatia	Part-time Employee	Technical	7	10000
4	Siddhant	Khanna	Full-time Employee	Management	6	20000

| L3 | 2 | | 6 |

	1. Make a pivot table which shows average salary of each type of employee for each department. 2. Make a pivot table which shows the sum and mean of the salaries of each type of employee and the number of employees of each type.				

Section-2 (Practical) - 20 marks

3)	Data from an online platform has been collected. This data contains fuel consumption and 11 aspects of automobile design and performance for 32 automobiles. Variable description is given below. **Dataset - 'mtcars.csv'**	L3,L4			20

Sl No	Variables	Description	Categories
1	mpg	Miles/(US) gallon	
2	cyl	Number of cylinders	4, 6, 8
3	disp	Displacement (cu.in.)	
4	hp	Gross horsepower	
5	drat	Rear axle ratio	
6	wt	Weight (1000 lbs)	
7	qsec	Fastest time to travel 1/4 mile from standstill (in seconds)	
8	vs	Engine cylinder configuration	0, 1 (0 -V-shape; 1 - Straight Line)
9	am	Transmission type	0, 1 (0 - automatic; 1 - manual)

| 10 | gear | Number of forward gears | 3, 4 , 5
Manual transmissions have either 4 or 5 forward gears; Automatic either 3 or 4 | | | | |
| 11 | carb | Number of carburettors | 1, 2, 3, 4, 6, 8 | | | | |

Create the following plots to visualize/summarize the data and customize appropriately.

1. histogram to check the frequency distribution of the variable 'mpg' (Miles per gallon) and note down the interval having the highest frequency.
2. scatter plot to determine the relation between weight of the car and mpg
3. bar plot to check the frequency distribution of transmission type of cars.
4. Box and Whisker plot of mpg and interpret the five number summary.
5. Create a git repository and push source code to repo.

Note : Theory questions shall be aligned to practical questions

Scheme of evaluation

Sl. No	Description	Marks
1	Importing libraries, data, removing missing values	4
2	Creating plots and customization	8
3	Create Git repository and push files	4
4	Interpretation of thus created plots	4
Total		**20**

Assessment framework for SEE (Theory) – 100 Marks / 3 hours (Reduced to 60 marks)

Programme:	Information Science & Engineering			Semester: V
Course:	Artificial Intelligence and Data Science			Max Marks: 100
Course Code:	20IS51I			Duration: 3 Hrs

Instruction to the Candidate: Answer one full question from each section.

Qn.No	Question	CL	CO	Marks
	Section-1			
1.a)	With Industry 4.0, artificial intelligence is finding place in every aspect of life. What happens if AI replaces humans in the workplace?	L4	1	10
b)	For the given scenarios you are required to build an AI solution. Which AI techniques can be applied / best suited for stated problems. Justify 1. Extract and digitize the customer information from the Know Your Customer (KYC) forms. 2. To identify if employees are wearing face mask in the office campus 3. To identify and narrow down tumour regions and further predict if the tumour is malignant or not 4. Automated inspection and cost estimation step in the Insurance claim business process To identify the location of a moving car within an image	L3		10
2.a)	How will machines affect human interactions?	L3		10
b)	For the following scenarios you are required to build a predictive model. Which machine learning technique/ algorithm can be applied / best suited for stated problems. Justify your recommendation. a. Predicting the food delivery time b. Predicting whether the transaction is fraudulent c. Predicting the credit limit of a credit card applicant d. To group similar customers of an online grocery store, based on their purchasing patterns, to offer discounts to its customers. Predict the probability of a mechanical system breakdown, based on its system vibration and operating temperature	L3		10
	Section-2			
3.a)	How to handle the missing values in the dataset? Explain.	L3	2	

b)	The statistical summary of Iris dataset is as follows.	L4		
	 ``` 1 sepal-length sepal-width petal-length petal-width 2 count 150.000000 150.000000 150.000000 150.000000 3 mean 5.843333 3.054000 3.758667 1.198667 4 std 0.828066 0.433594 1.764420 0.763161 5 min 4.300000 2.000000 1.000000 0.100000 6 25% 5.100000 2.800000 1.600000 0.300000 7 50% 5.800000 3.000000 4.350000 1.300000 8 75% 6.400000 3.300000 5.100000 1.800000 9 max 7.900000 4.400000 6.900000 2.500000 ``` Analyse and explain statistical metrics from above summary.			

4.a)	Consider a real estate company that has a dataset containing the prices of properties in the Delhi region. It wishes to use the data to optimise the sale prices of the properties based on important factors such as area, bedrooms, parking, etc.
	Essentially, the company wants —
	   a. To identify the variables affecting house prices, e.g. area, number of rooms, bathrooms, etc.
	   b. To create a model that quantitatively relates house prices with variables such as number of rooms, area, number of bathrooms, etc.
	   c. To know the accuracy of the model, i.e. how well these variables can predict house prices.
	Discuss the steps to be followed to build such a model. Recommend the suitable techniques to consider at each step.
		L3		

b)	Describe univariate, bivariate, and multivariate analysis with suitable examples.	L4		
	Section- 3			
5.a)	N-grams are defined as the combination of N keywords together. Consider the given sentence: "Data Visualization is a way to express your data in a visual context so that patterns, correlations, trends between the data can be easily understood." Generate bi-grams and tri-grams for the above sentence a. Before performing text cleaning steps.	L3	3	

	b. After performing following text cleaning steps: 1. Stop word Removal Replacing punctuations by a single space			
b)	K-means clustering with Euclidean distance suffer from the curse of dimensionality. Is the statement true and why?	L4		
6.a)	The sinking of the Titanic is one of the most infamous shipwrecks in history. On April 15, 1912, during her maiden voyage, the widely considered "unsinkable" RMS Titanic sank after colliding with an iceberg. Unfortunately, there weren't enough lifeboats for everyone onboard, resulting in the death of 1502 out of 2224 passengers and crew. You are asked to build a machine learning model to predict whether a passenger survived or not. Describe each step you will follow to build this model.	L3		
b)	You work for a textile manufacturer and have been asked to build a model to detect and classify fabric defects. You trained a machine learning model with high recall. You want quality control inspectors to gain trust in your model. Which technique should you use to understand the rationale of your classifier? Justify	L4		
	Section-4			

7.a)	A machine learning model was built to classify patient as covid +ve or -ve. The confusion matrix for the model is as shown below. Compute other performance metrics and analyse the performance of the model.
	
	Actual
	
	      1 0
	Predicted 1 397 103
	          0 126 142
		L3	4	

b)	A Machine Learning Engineer is preparing a data frame for a supervised learning task. The ML Engineer notices the target label classes are highly imbalanced and multiple feature columns contain missing values. The proportion of missing values across the entire data frame is less than 5%. What should the ML Engineer do to minimize bias due to missing values? Support your argument.	L4		
8.a)	A data scientist is working on optimising a model during the training process by varying multiple parameters. The data scientist observes that, during multiple runs with the identical	L3		

	parameters the loss function converges to different, yet stable values. What should the data scientist do to improve the training process? Justify.				
b)	A company has collected customer comments on its products, rating them as safe or unsafe, using decision trees. The training dataset has the following features: id, date, full review, full review summary, and a binary safe/unsafe tag. During training, any data sample with missing features was dropped. In a few instances, the test set was found to be missing the full review text field. For this use case, which is the most effective course of action to address test data samples with missing features. Justify	L4			
Section-5					
9.a)	What are the deployment strategies borrowed from DevOps that can be utilized in MLOPs. Explain anyone strategy.	L3	5		
b)	Machine learning models can be resource heavy. They require a good amount of processing power to predict, validate, and recalibrate, millions of times over. How can containerisation of ML model solve this problem?	L3			
10.a)	How will you deploy a trained machine learning model as a predictive service in a production environment. Explain.	L3			

b)	For the below given scenarios, suggest best suited cloud deployment model and list the challenges with it.
	
	1. For ,
	    a. Variable workload
	    b. Test and Development
	
	2. For,
	    a. Cloud bursting
	    b. On demand access
	    c. Sensitive data
		L3			

Problem Statement

An insurance company wants to improve its cash flow forecasting by better predicting patient charges, using demographic and basic patient health-risk metrics at the time of hospitalization. Build and deploy a machine learning model to predict charge amount.

---

	age	sex	bmi	children	smoker	region	charges
0	19	female	27.900	0	yes	southwest	16884.92400
1	18	male	33.770	1	no	southeast	1725.55230
2	28	male	33.000	3	no	southeast	4449.46200
3	33	male	22.705	0	no	northwest	21984.47061
4	32	male	28.880	0	no	northwest	3866.85520

Scheme of evaluation

Sl. No	Description	Marks
1	Problem analysis	10
2	Selection of tools/technics and Importing libraries	10
3	Data visualization	15
4	Data preprocessing	15
5	Construct predictive model, generate metrics	30
6	Deploy the constructed model	20
Total		**100**

Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1.	Computers	Intel i7, 4GB RAM, 500GB SSD	**20**
2.	Python (Anaconda Distribution), Git, Jira, Jenkins, TensorFlow or similar tools		
3.	Cloud – AWS/AZURE/GCB or any similar cloud environment		
4.	Broadband connection		

Full Stack Development

Government of Karnataka

DEPARTMENT OF COLLEGIATE and TECHNICAL EDUCATION

Program	Computer Science & Engineering	Semester	5
Course Code	**20CS52I**	Type of Course	**L:T:P (104:52:312)**
Course Name	**Full Stack Development**	Credits	**24**
CIE Marks	**240**	SEE Marks	**160**

Introduction:

Welcome to the curriculum for the Full Stack Development Specialisation. This specialisation course is taught in Bootcamp mode. Bootcamps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn a complete suite of software development skills to build application like front-end, middleware, and back-end Java web developer technologies, test and deploy code, store data using MongoDB, and much more.

This course will teach you Fundamentals of business process automation, React, Spring, MongoDB, REST API, DevOps practices, cloud deployment and more. Details of the curriculum is presented in the sections below.

Pre-requisite

Before the start of this specialisation course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Computer, Fundamentals of Electrical and Electronics Engineering, Project Management skills and Multimedia & Animation.

In the 2nd year of study, you would have studied Python Programming, Computer Hardware, Maintenance and Administration, Computer Networks, Database System Concepts and PL/SQL,

Data Structures with Python, Operating System and Administration, Object oriented programming and Design with Java, Software Engineering principles and practices.

In this year of study, you shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Course Cohort Owner

A Course Cohort Owner is a faculty from the core discipline, who is fully responsible for one specialised field of study and the cohort of students who have chosen to study that specialised field of study.

Guidelines for Cohort Owner
1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.
3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.
4. The industry session shall be addressed by industry subject experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.
6. Cohort owner shall plan and accompany the cohort for any industrial visits.
7. Cohort owner shall maintain and document industrial assignments, weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom sessions can augment or use supplementally teaching and learning opportunities including good quality online courses available on platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM , etc.

Course outcome: A student should be able to

CO1	Explain typical business process in an organization and identify opportunities for digital transformation.
CO2	Document system requirements and write an appropriate development plan.

CO3	Design, develop and test an automated business process.
CO4	Develop RESTful API's and test functions as per the defined requirements.
CO5	Select an appropriate production environment, UI and deploy the application.

Detailed course plan

We ek	C O	P O	Da ys	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1	1	1	- What is an Enterprise? - Organizing the Enterprise - process - Understanding /Types of business activities - What is business process? - Why to automate business process? **Ref. No 1**	3		1	- Digital transformation through Convergence of IT & OT - Digital Transformation Success Stories - How technology has impacted digital transformation - Case study: Digital transformation through IT/OT convergence **Ref. No 2**	1		2
	1	1,5	2	**Industrial visit:** Visit small or medium scale nearby industry and know the business entity and activities. Understand the different work divisions with a business entity.			4	**Map the relationship between various divisions of business entity both vertical and horizontal relationships** **Understanding the business process and workflow within a business entity**			3
	1	2,3	3	**Report of industrial visit.** - Document the major business divisions and their activities. - Draw the workflow for each identified division.			4	- Identify the typical processes and workflows that can be automated. - Introduction to Full stack development, its components, tools used, etc. - Understanding Full stack framework both within firewall and on the cloud			3

			- Create a map of workflows to represent interaction among divisions and the entire business process as well.					
	1,2	2,3	4	Recap - Design Thinking - Design thinking for software development - Apply design thinking to automate the observed activities in the industrial visit **Ref. No 3**	1	3	Contd.	3
			5	**Developmental Assessment**			Assessment Review and corrective action	3
	1,2	2,3, 4	6	Full stack development – industrial perspective How to create project plan and product backlog for project and User story creation	2	3	Weekly Assignment(1PM-2PM)	
2	2,3	2,3	1	**peer review** project activity: Make student teams (2 -3 students per team), each team is responsible for automating activities of an identified business entity. Integration of each team's work must lead to an enterprise application.	4		**Recap – software development (Agile methodology)** - Define goal of product - Define epics - Create roadmap for epics - Cost estimation - Risk management	2	1

						Note: Consider any web application in any sector (Retail, Health, Logistics,Finance, etc)		
2,3	2,3	2	- Creating user stories for the epic - Creating Acceptance criteria - sprint planning - Backlog Refinement - Sprint Demo - Burn down charts - Sprint retrospective Create and manage product backlog using appropriate tool like Jira Create Sprint 1 with required user stories	2	2	Design principles - Availability - Performance - Consistency - Scalability - Manageability - cost Architectural patterns - Monolithic - Layered - Service oriented architecture - Microservice architecture **Ref. No 4** Step 01 - Need for Architecture - Viewer Page | Infosys Springboard (onwingspan.com)	2	1
2,3	2,3	3	Design methods for security - Application security - Authentication and authorization methods and their usage and considerations o Token based	2	2	Design methods for Datastores - Structured - Semi structured - Unstructured **Recap of**	1	2

				o Cookie based o OpenID o Third party access o SAML o Multi factor authentication - Encryption Design and implement authentication flow using anyone of the above listed.			**Data base design**			
	2,3	2,3,4	4	Design principles for – UI / UX Create UI/UX design - for created user stories (wireframing) Technology, tools and frameworks for application development	1	3	Contd.			3
			5	**Developmental Assessment**			**Assessment Review and corrective action**			3
			6	Comparison of various enterprise application development technology stacks (development, engineering, deployment, Monitoring) Security architecture and best practices in enterprise application programming.	2	3	Weekly Assignment(1PM-2PM)			
3	2,3	4	1	Peer review Project status review Demonstration of artifacts of the project		4	DevOps engineering practices - Configuration management - Continuous integration - Automated testing	1	2	

| 2,3 | 4 | 2 | **Configuration management**

Why Do We Need a Version Control System?

Fundamentals of Git

Git Client installation and setup

basic local Git operations

  ■ creating a repository,
  ■ cloning a repository,
  ■ making and recording changes
  ■ staging and committing changes,
  ■ viewing the history of all the changes

undoing changes | 1 | | 3 | - Infrastructure as code
- Continuous delivery
- Continuous deployment
- Continuous monitoring

Explore the various tools used - T

Git Branching and merging

Basic
  ■ Creating and switching to new branches
  ■ Switching between branches
  ■ Merging local branches together

GitHub
- Basics of distributed git

Account creation and configuration
- Create and push to repositories
- versioning
- Collaboration
- Migration

Create repository – named mini project-1

Push the same to GitHub

TOC - Git Essentials: Become a Git and GitHub Ninja \| Infosys Springboard (onwingspan.com) | 1 | | 2 |

5	1,4	3	**Cloud basics** - Cloud Infrastructure Overview - Cloud computing architecture and its components - Service models - Deployment models - Virtualization - Cloud Native Application Development o Essentials of Cloud - Viewer Page | Infosys Springboard (onwingspan.com)	3	1	- Create cloud account (AWS, GCB or any other service provider) and explore the features - Create and setup a virtual machine. - Create a simple webapp using cloud services - How to use cloud service for user authentication flow, allowing users to sign up, sign in, and reset their password - Build a Basic Web Application on AWS (amazon.com)	3
2,3		4	**Continuous integration** - Use any suitable build CI/CD tool (such as Jenkins, bitbucket, GitHub Actions etc.) or cloud-based services to create build pipeline having steps code build, test, code quality check. - Working of the tool / cloud service used. *Note: Create build pipeline for simple web applications such as To-do app, BMI calculator, Number converter, WordCount etc.*	1	3	- Contd..	3
		5	**CIE 1 – Written and Practice Test**			**Assessment Review and corrective action**	3

	2,3	4	6	Comparison of cloud services How to make full stack development efficient by using DevOps	2		3	Weekly Assignment(1PM-2PM)		
4	2,3, 5	3,4	1	Peer review Project status review Demonstration of artifacts of the project		4		Recap HTML, CSS and JavaScript Fundamentals (Code structure – statements, comments, variables, Constants, Data types, Interaction, Operators, Comparisons, Control flow, Functions) **Setting Up the Environment and Tools for front end development** - Installing VS Code - VS Code extensions JSON- Tutorial *Note: suitable cases to be used to learn and implement program constructs.*	1	2
	2,3, 5	3,4	2	JS objects Methods, Constructors, Object properties - Data properties - Accessor properties - Prototype *Practice: use suitable cases to implement above concepts*	1		3	- Contd.		3

2,3,5	2,3,4	3	ES6 - Arrow functions - Template strings - Prototype methods - Spread operator - Map - Set Create a form like registration form, feedback form, after submit hide create form and enable the display section	2		2	Contd.		3
2,3,5	2,3,4	4	Introduction to TypeScript Why TypeScript? Setting up development environment for TypeScript - Install TypeScript compiler - Install Live server Create and run first program in TypeScript - Basic Types - Control flow statement - Functions TypeScript "Hello, World!" (typescripttutorial.net)	2		2	- Contd..		3
		5	**Development Assessment**				Assessment Review and corrective action		3

	2,3,5	2,3,4	6	Modern UI technologies	2		3	Weekly Assignment(1PM-2PM)			
5	2,3,5	2,3,4	1	**Peer review** Project status review Demonstration of artifacts of the project		4		Introduction to React - What is React? - Setting up React development environment - Installing Node.js - Anatomy of React app (folder structure) - Creating and running a React.js app **Ref. No 7** Build a Full-Stack React Application on AWS (amazon.com)	1		2

	2,3,5	2,3,4	2	Introduction to JSX
				- What is JSX?
				- Expressions in JSX
				- Specifying Attributes with JSX
				- Specifying Children with JSX
				- Rendering Elements
				   o DOM
				   o React DOM
				   o React Virtual DOM
					2		2	- Components
								- What is a component?
								- Function and Class Components
								- Rendering a Component
								- Composing Components
								- Create your first React Component.
									1		2

	2,3,5	2,3,4	3	Props & State - State - Props	2		2	- JSX for React components - How to crate JSX elements? - How to test components	1		2

			- Communication between components using Props - Understanding Component life cycle Component life cycle methods - Mounting phase - Updating phase - Unmounting phase - Error Handling						
	2,3,5	2,3,4	4	Handling Events Conditional Rendering Lists & Keys	2		2	Forms - Use of HTML tags in forms like select, input, file, textarea, etc. - controlled components - uncontrolled components Lifting State Up			3
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
	2,3,5	2,3,4	6	Testing single page application	2		3	Weekly Assignment			
6	2,3,5	2,3,4	1	Peer review Project status review Demonstration of artifacts of the project		4		Context Fragments Higher-Order Components	2		1
	2,3,5	2,3,4	2	React Router - React router – parameters	1		3	Contd..			3

			- React router key components Implement navigation using react router							
2,3,5	2,3,4	3	**React Hooks** - Introduction - React Hooks – useState, useEffect, useContext and useReducer Custom Hooks	1		3	Build single page application – like shopping Cart			3
2,3,5	2,3,4	4	Build single page application			4	Recap - Object oriented concepts and design principles - Data Structures - Database Concepts - Java and servlet basics - Java Collections (List, Set, Map) ,Threads Setting up the environment and tools Install java (latest stable version) and add environment variable Install java editor (such as IntelliJ, Eclipse or any other) Install DBMS (MySQL, PostgreSQL or any other) XML – T	1		2

			5	**Development assessment**			Assessment Review and corrective action		3
	2,3,5	2,3,4	6	**State Management with Redux**			Weekly Assignment(1PM-2PM)		
7	3,4	2,3,4	1	**Peer review** Project status review Demonstration of artifacts of the project	4		Basics of Apache Maven or Gradle – project management tool Understanding pom.xml TOC - Maven Basics | Infosys Springboard (onwingspan.com)	2	1

	3,4	2,3,4	2	Introduction to Spring Framework
				What is Spring?
				- Why Spring Framework?
				- Spring Framework Architecture
				- Key components of Spring Framework
				- SpringBoot
				  Why SpringBoot?
				  Compare Spring and SpringBoot
				understanding the spring initializer interface
				TOC - Introducing Spring 5.0 | Infosys Springboard (onwingspan.com)
				TOC - Spring Essentials | Infosys Springboard (onwingspan.com)
					2	2	- Spring Annotations
							  Create Spring application with Spring Initializer using dependencies like Spring Web, Spring Data JPI
							How to run the project
							Getting Started | Building an Application with Spring Boot
								1	2

	3,4	2,3,4	3	Inversion of Control and Dependency Injection What is inversion of control?	2	2	Contd.		3

			What is dependency injection? Types of DI - Constructor - Property - Method Practice : constructor injection Property injection Method injection TOC - DI in Spring Framework | Infosys Springboard (onwingspan.com) TOC - Introduction to the Spring Framework | Infosys Springboard (onwingspan.com)						
3,4	2,3,4	4	Spring IoC container – ApplicationContext ComponentScanning DI in spring Boot - Constructor injection - Setter injection - Field injection Autowiring - Qualifier - Bean Scope (Object scope)	1		3	Contd..		3

			Autowiring dependencies						
		5	**CIE 3 – Written and Practice Test**			Assessment Review and corrective action			3
	3,4	2,3,4	6	**Converting monolithic application to microservices architecture**	2	3	Weekly Assignment		
8	3,4	2,3,4	1	**Peer review** Project status review Demonstration of artifacts of the project		4	Application Programming Interface (API) - What is an API? - How API works? - Why we need APIs? - API types (Open APIs, Partner APIs, Internal APIs, Composite APIs) - Types of API Protocols (SOAP, REST) Common API examples	2	1
	3,4	2,3,4	2	API endpoints What is API endpoint? Why are API endpoints important? API endpoint examples How to Test API Endpoints HTTP Concepts - HTTP working - HTTP Method (GET, POST, PUT, DELETE) Understanding of JSON structure for API request and response data	2	2	Basics of REST - Evolution of API - Overview of REST - REST architectural style, components, views, - REST constraints - Properties of REST API - REST API Design Principles How to create RESTful service Install Postman	2	1

						Test created APIs with the help of Postman		
3,4	2,3,4	3	Spring REST – creating Spring REST controller - Controller Layer (handling request and responses) - Service Layer (Application business logic) - Repository layer (Communicate with DB)	1	3	Limitations of JDBC API Object relational Mapping – features and benefits JPA – Java Persistent API Spring Data JPA configuration Create ORM entity class Create database and configure using SpringBoot application property file ***Note – Hibernate or any other ORM framework can be used*** About Hibernate Framework - Viewer Page | Infosys Springboard (onwingspan.com)	1	2
3,4	2,3,4	4	Create REST controller for CRUD operations Versioning Spring REST APIs Practice: Create user registration form. Build models for considered use case.	1	3	Contd..		3
		5	**Development Assessment**			Assessment Review and corrective action		3
3,4	2,3,4	6	Spring Transactions			Weekly Assignment		

	3,4	2,3,4	1	**Peer review** Project status review Demonstration of artifacts of the project		4		Transaction management and compliance to ACID principles	1	2
	3,4	2,3,4	2	Securing REST APIs with Spring Security API security configuration	1		3	Build user authentication flow and authorization using SpringSecurity		3
	3,4	2,3,4	3	**Junit – Tutorial** Writing Junit test cases for CRUD operations Test controller endpoints		4		Contd..		3
9	3,4	2,3,4	4	Introduction NoSQL - 1 - Brief history - Features & Benefits - Types - Cap theorem - BASE **Explore and compare the features of various NoSQL databases - T**	1		3	Getting started with MongoDB - MongoDB overview - features - key components of Architecture - data modelling Working with MongoDB - MongoDB Shell – mongosh Mongo Compass GUI Setup - Download and Install MongoDB Community Server Or - MongoDB Atlas Setup - Create an Atlas account and get ready to use MongoDB Atlas - Configure MongoDB Atlas	1	2

						- Explore Compass (MongoDB's GUI tool) - Create and Manage MongoDB Data types and operators – T		
		5	**CIE 4 – Written and Practice Test**			Assessment Review and corrective action		3
	3,4	2,3,4	6	API Gateway			Weekly Assignment	
10	3,4	2,3,4	1	**Peer review** Project status review Demonstration of artifacts of the project		4	- Create and Drop database - Create and Drop Collections - CRUD Operations on document	1	2
	3,4	2,3,4	2	- CRUD Operations on document		4	Limit and Sort Records Cursor	1	2
	3,4	2,3,4	3	Indexing Aggregation Create and manage users and roles Migration to MongoDB	1	3	Contd.		3
	3,4	2,3,4	4	ACID transactions in MongoDB Perform CRUD Operations on MongoDB through REST API using Spring Boot Starter Data MongoDB How to run MongoDB on cloud?	1	3	Contd.		3
		5	**Development Assessment**			Assessment Review and corrective action		3
	3,4	2,3,4	6	MongoDB implementation, administration and deployment			Weekly Assignment	

11	3,4,5	2,3,4	1	Peer review Project status review Demonstration of artifacts of the project		4	Application Testing - Manual - Automated Application testing tools Functional testing UI testing TOC - Introduction to Automation Testing	Infosys Springboard (onwingspan.com)	2		1
	3,4,5	4	2	Integration testing System testing Integrate the work of each group and carry out integration testing	1	3	Acceptance testing Acceptance tests and test plan User acceptance testing Bug tracking – using Jira or similar tools	1		2
	5	4	3	Deployment process - Manual deployment - Automated deployment How to implement automated deployment? Top Deployment tools and their features Best Deployment practices Setup deployment pipeline Continuous deployment Static code analysis Automated review and peer review Practice – code analysis using tools	2	2	Containers Why containers? What is a docker? How docker works? Components of docker - Docker container - Docker client - Docker daemon - Docker image - Docker registry	2		1

							Install docker on desktop and start the docker tool. TOC - Containers & Images | Infosys Springboard (onwingspan.com)		
	5	4	4	Docker file Docker image Commands to create docker file. Build docker image with docker file create docker container from docker image Run the docker container TOC - Docker, Dockerfile, and Docker-Compose (2020 Ready!) | Infosys Springboard (onwingspan.com) TOC - Deploying and Running Docker Containers | Infosys Springboard (onwingspan.com)	1	3	Contd..		3
			5	**CIE 5 – Written and Practice Test**			Assessment Review and corrective action	3	
	3,4	2,3,4	6	Automation and cloud application testing					
12	5	4	1	**Peer review** Project status review Demonstration of artifacts of the project	4		**Container orchestration** What is orchestration? Orchestration engine Orchestration tools	2	1

						TOC - Container Orchestration | Infosys Springboard (onwingspan.com) TOC - Docker Skills: Advanced Docker Orchestration | Infosys Springboard (onwingspan.com)		
5	4	2	Kubernetes Introduction Why Kubernetes? Kubernetes configuration - Deployment - Service - Load balancer/ingress Create a cluster and deploy an app Learn Kubernetes Basics | Kubernetes Booking.com Case Study | Kubernetes Spotify Case Study | Kubernetes	1	3	Deployment strategies Blue green deployment Canary Deployment	1	2
5	4	3	Disaster recovery and their types How does it work? Elements of disaster recovery plan Build a disaster recovery plan Load Balancing Load balancer and its functions	2	2	Contd..		3

5	4	4	Application monitoring - Need for application monitoring - Components of application performance management. - How to select application monitoring tools? - Explore and compare APM tools	2		2	Contd.		3
		5	**Development Assessment**				Assessment Review and corrective action		
		6	Cloud orchestration	2		3			
13	1,2, 3,4, 5	2,3, 4	1	**Internship** **a)** Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship. **b)** Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies. c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internship.			**Project** **a)** Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective. **b)** Design and develop the project solution or methodology to be used to solve at least one of the problems identified. c) Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.		

**Note: Saturday session from 9 AM -2 PM

References

Sl. No	Description
1	Charlie Chaplin - Factory Scene - Modern Times (1936) - YouTube What is a Business Process? - YouTube What Is Business Process Automation? - YouTube
2	- Digital Transformation | What is Digital Transformation | Digital Transformation 2021 | Simplilearn - YouTube - Digital transformation: are you ready for exponential change? Futurist Keynote Speaker Gerd Leonhard - YouTube - Digital Transformation Through IT/OT Convergence | Accenture
3	https://www.youtube.com/watch?v=_r0VX-aU_T8
4	How to build Scalable and Robust Enterprise Web Application? | Cashapona
5	SaaS vs PaaS vs IaaS: What's The Difference & How To Choose – BMC Software | Blogs
6	https://www.atlassian.com/ https://www.atlassian.com/devops
7	Hello World – React (reactjs.org)
8	Hands-On Full Stack Development with Spring Boot 2.0 and React
9	React Cookbook , David Griffiths and Dawn Griffiths
10	Build a Basic Web Application on AWS (amazon.com)
11	A Docker Tutorial for Beginners (docker-curriculum.com)
12	Spring Boot 2.0 Projects By Mohamed Shazin Sadakath
13	Kubernetes

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

* The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE

Note : Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	Computer Science & Engineering	Semester		V
Course	Full Stack Development	Max Marks		30
Course Code	20CS52I	Duration		4 hours
Name of the course coordinator				

Note: Answer one full question from each section.

Qn.No	Question	CL L3/L4	CO	PO	Marks
Section-1 (Theory) – 10 marks					
1.a)	Explain how digital transformation can bring revolution in teaching learning process	L4	1	1	5
b)	How DevOps enables faster development of new products and easier maintenance of existing deployments?	L3	1	4	5
2.a)	Passwords alone fail to provide protection because they can be guessed and phished. How to strengthen authentication for a banking portal?	L3	1	2	5
b)	The cloud is a hot topic from small businesses to global enterprises. If an organization begins to consider switching its business to the cloud, it is crucial to understand the differences and advantages of the various cloud services. The three main cloud services to consider are IaaS, PaaS and SaaS. For each of these service types, which of the following are managed by you as a consumer and service provider. **Applications, Virtualization, Operating System, Storage, Networking, Data, Server.**	L4	1	4	5
Section-2 (Practical) - 20 marks					
3)	In an open-source community, many developers contribute to an application. A new contributor develops a feature 'A' and wants to commit to master repository. As an admin you have to make sure that only reviewed code is committed to master branch.	L3	5	4	20

Note : Theory questions shall be aligned to practical questions

Scheme of evaluation

Sl. No	Description	Marks
1	Problem analysis and identification of tools to be used	4
2	Implementation	12
3	Demonstration of solution	4
Total		20

Assessment framework for SEE (Theory) – 100 Marks / 3 hours (Reduced to 60 marks)

Programme: **Computer Science & Engineering**			**Semester: V**		
Course: **Full Stack Web Development**			**Max Marks: 100**		
Course Code: **20CS52I**			**Duration: 3 Hrs**		

	Instruction to the Candidate: Answer one full question from each section.			
Qn.No	**Question**	**CL**	**CO**	**Marks**
	Section-1			
1.a)	Digital transformation is creating new — or modifying existing — business processes, culture, and customer experiences to meet changing business and market requirements. Explain how digital transformation has brought revolution in retail purchases with an example	L4	1	10
b)	Diagnostic imaging procedures are cutting-edge technology, but at the same time they are an unpleasant experience for patients – and even more for paediatric patients. Explain how design thinking helped Doug Dietz, an industrial designer, create a scanner experience that children loved.	L4		10

2.a)	Identify the tasks involved in the process of receiving Admission Ticket for semester exams in your college. Which of the identified tasks can be automated and illustrate automation of one task.	L4		10
b)	Identify the following cloud service types and list their characteristics and advantages. Cisco WebEx Google App Engine, Amazon EC2	L3		10
Section-2				
3.a)	BookingHall is an online convention hall booking application that helps its users to book hall for functions across Karnataka. This application allows users to log in for booking a hall. Users can find the halls in a specific locality. Once found, user can check the availability of a hall for specific dates. Users can block a hall for required duration. Once blocked, user can get the booking details. Identify and write the user stories for this application.	L4	2	12
b)	Write test cases for the above application.	L3		8
4.a)	eDesert is an online shopping application that helps its users to buy variety of authentic deserts. This application allows users to log in for buying deserts. Users can search for a desert, sort the desert list based on rating or price. Users can select the items and add them to the cart. Once the selection is done, users can go to the cart page for payment. Identify and write the user stories for this application.	L4		12
b)	Write test plan and test cases for the above application.	L3		8
Section- 3				
5.a)	The HR team of an organization needs an application to maintain its employee details. Create a Spring Boot application to maintain Employee details such as employee id, employee name, and department and perform the following database operations. - Insert a new employee detail - Remove employee details based on employee id - Search employee based on name or ID	L3	3	12
b)	Design an application that consumes EmailService , to send emails to recipient mail addresses. The design should accommodate any new email services. It should also support additional messaging feature.	L3		8

6.a)	The write operations on the collection are very high. Explain the technic applicable to manage the given scenario.	L3		12
b)	Compare the database communication through JDBC and ORM.	L3		8
Section-4				
7.a)	Ram is a developing a feature of an online apparel application as service. How should he handle the different requests to the service.	L3	4	12
b)	Users of Instagram, a photo sharing application, can share photographs not only with Instagram friends but also with friends on other social networking applications such as Twitter and Facebook. Explain how is this possible.	L3		8
8.a)	Develop the data access layer of the Employee Management Application to perform the database operations given below using Spring Data JPA Add the operation given below using Spring Data JPA: Update the employeeContactNumber for the given employee id.	L3		10
b)	Create a RESTcontroller class to perform CRUD operations on product and corresponding request and response DTOs. The product class should contain three data members product name, product category, price. Use proper SpringBoot annotations.	L3		10
Section-5				
9.a)	Discuss the Components of Docker container.	L3	5	6
b)	Draw the CI/CD build process flow diagram for an online foot ware store application and explain each component.	L3		8
c)	You want to have two versions of your application in production, but be able to switch all traffic between them. Explain the deployment strategy suitable for the given situation.	L3		6
10.a)	Create a form to add a new product detail to the product catalogue using React.	L3		10
b)	Ted is a DevOps engineer. He wants to automate the deployment process. He wants to do deployment frequently on multiple servers and change the CPU speed and RAM based on the requirement.	L3		10

Assessment framework for SEE 2 (Practice)

Problem Statement

1. InfyCabs is an application for booking cabs. Its following functionalities needs to be exposed as REST API:

   - Book a cab
   - Get booking details
   - Cancel booking

The service and persistence layer of this application is already implemented. You have to implement the API layer of this application for exposing the above functionalities.

CabBookingAPI
Implement the CabBookingAPI class based on the class diagram and instructions given below:
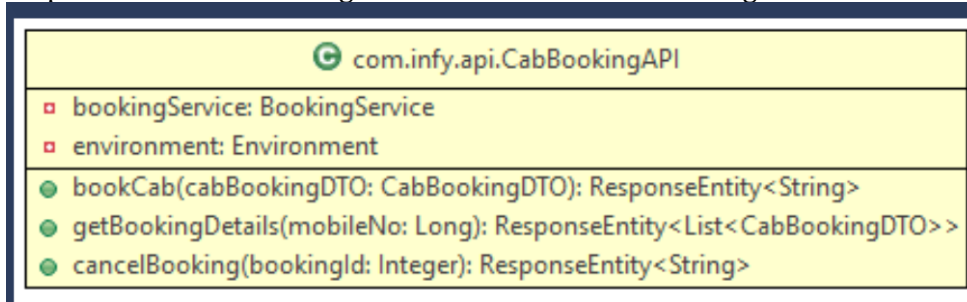
Annotate this class with proper annotation to declare it as REST controller class.
Annotate this class with proper annotation so that all its methods are mapped with /bookings as base URI.
Inject bookingService and environment using appropriate annotation.

Method description:

bookCab(CabBookingDTO cabBookingDTO)

- This is a REST controller method to book a cab.
- Implement it using proper annotations according to description given below:
  Resource endpoint: /
  HTTP method: POST
  Input: Booking details as part of HTTP request body.

- It should invoke the bookCab() method of BookingServiceImpl class which returns a booking id.
- Retrieve the success message associated with property API.BOOKING_SUCCESSFUL from application.properties files using environment and append it to booking id in following format:
    <success message>booking id
- It returns an object of ResponseEntity created using above message and HTTP status code as CREATED.

getBookingDetails(Long mobileNo)

- This is a REST controller method to get cab booking details based on mobile number of user.
- Implement it using proper annotations according to description given below:
  Resource endpoint: /{mobileNo}
  HTTP method: GET
  Input: mobileNo as path variable.
- It should invoke the getDetails() method of BookingServiceImpl class which returns a List<CabBookingDTO>.
- It returns an object of ResponseEntity created using List<CabBookingDTO> obtained in previous step and HTTP status code as OK.

cancelBooking(Integer bookingId)

- This is a REST controller method to cancel cab booking based on bookingId.
- Implement it using proper annotations according to description given below:
  Resource endpoint: /{bookingId}
  HTTP method: PUT
  Input: bookingId as path variable.
- It should invoke cancelBooking() method of BookingServiceImpl class.
- Retrieve the message associated with property "API.BOOKING_CANCELLED" from the properties file.
- It returns an object of ResponseEntity created using above message and HTTP status code as OK.

2. Test the thus created REST APIs

Analyse the given problem statement	10
Selecting suitable tools to implement above case	10
Implementation	40
Use of appropriate annotations	20

Testing	20
Total	100

Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
5.	**Computers**	Intel i7, 4GB RAM, 500GB SSD	**20**
6.	**Eclipse/InteliJ , Java, Apache Maven, Spring 5.0, MongoDB, MySQL, Node.js, React, Jira, Git, Bitbucket,Jenkins,GitHub Actions.**		
7.	**Cloud – AWS/AZURE/GCB or any similar cloud environment**		
8.	**Broadband connection**		

Cloud Computing

Government of Karnataka

DEPARTMENT OF COLLEGIATE and TECHNICAL EDUCATION

Program	Computer Science & Engineering	Semester	5
Course Code	20CS53I	Type of Course	L:T:P (104:52:312)
Course Name	Cloud Computing	Credits	24
CIE Marks	240	SEE Marks	160

Introduction:

With technological advances, the future is set to be highly competitive and agility is the need of the hour. With cloud computing, organizations can save money on storage, servers and management services, as these services can be moved to the cloud with minimum cost, making the operations more efficient. The cloud offers businesses more flexibility overall versus hosting on a local server. And, for need of extra bandwidth, a cloud-based service can meet that demand instantly, rather than undergoing a complex (and expensive) update to the existing IT infrastructure.

This specialisation course is taught in Bootcamp mode. Bootcamps are 13 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning.

This course will teach you Fundamentals of cloud computing Architecture, Compute instances, High Availability and Scalability in Cloud, Databases, Cloud Storage Service, DNS Services and Content Delivery, Serverless Computing, Container Services, Monitoring & Auditing and Cloud Security. Details of the curriculum is presented in the sections below.

Note: Faculty and students are required to use Amazon Web Service (AWS) cloud platform to practice the lab exercises in week 1 to week 9 and similarly use Microsoft Azure cloud platform for week 10 to week 12 of the curriculum.

Pre-requisite

Before the start of this specialisation course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Computer, Fundamentals of Electrical Electronics Engineering, Project Management skills and Multimedia & Animation.

In the 2nd year of study, you would have studied Python Programming, Computer Hardware, Maintenance and Administration, Computer Networks, Database System Concepts and PL/SQL, Data Structures with Python, Operating System and Administration, Object oriented programming and Design with Java, Software Engineering principles and practices.

In this year of study, you shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Course Cohort Owner

A Course Cohort Owner is a faculty from the core discipline, who is fully responsible for one specialised field of study and the cohort of students who have chosen to study that specialised field of study.

Guidelines for Cohort Owner

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.
3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.
4. The industry session shall be addressed by industry subject experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.
6. Cohort owner shall plan and accompany the cohort for any industrial visits.
7. Cohort owner shall maintain and document industrial assignments, weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table

9. The cohort owner along with classroom sessions can augment or use supplementally teaching and learning opportunities including good quality online courses available on platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM , etc.

Course outcome: A student should be able to

CO1	Work in cloud environment to demonstrate various aspects of Cloud computing and leverage them for project needs
CO2	Demonstrate the Public cloud services like compute, storage, networking, IAM, databases and configure them for given specification
CO3	Design, build and deploy a cloud native application using public cloud services
CO4	Adopt Cloud security policies, Monitor and troubleshoot basic issues in Cloud services
CO5	Administer cost, privileges and manage an existing deployed network

Detailed course plan

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1	1	1	**Building blocks of cloud computing** - Introduction - Basic Architecture of Computer - Servers vs Desktop and laptops - Client-Server Computing - Hard Drives - HDDs and SDDs - Storage - block vs file vs object - Distributed Networking	3		1	- IP addressing - Networking - Routers and Switches - Networking - Firewalls - Databases - Server virtualization - Docker Containers - Application Programming Interfaces (API)	2		1
	1	1	2	**Introduction to cloud computing** - Introduction - From Mainframes to Clouds Evolution – How to host an application in traditional IT Infra - What is Cloud Computing - Example Cloud Application deployment	2		2	Cloud Computing Service Models - Software as a Service (SaaS) - Platform as a Service (PaaS) - Infrastructure as a Service (IaaS) Cloud Deployment Models – - Public - Private - Hybrid - Community List out the examples for each cloud models Benefits of Cloud	2		1
	1	4	3	**Cloud Architecture** - Introduction	3		1	- Monolithic and Microservices Architectures	2		1

				- Stateful vs Stateless Service - Scaling up vs Scaling out - Load Balancing - Fault Tolerance - Loose coupling				- Event-driven Architecture - List out the Popular Cloud service providers along with their features (AWS, Azure, GCP) - Open-Source cloud computing platforms			
	1	4	4	**AWS Cloud Overview** - Amazon Web Service (AWS) - Regions and AZ - Creating an AWS Account - Shared Responsibility Model and AWS Acceptable Policy	1		3	- Tour of AWS Console and Services in AWS hands-on			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1	**1,5**	6	**Industry Class: Build blocks of Cloud Computing**	2			Weekly Assignment(1PM-2PM)			
2	1	1	1	Peer Review		4		**AWS Identity and Access Management (IAM) Services** - What is IAM ? - What is IAM used for ? - Principle of least privilege - IAM Introduction: Users, Groups, Policies - IAM Users & Groups Hands on	1		2

2	1,4	2	- AWS IAM Multi-factor authentication (MFA) Overview - IAM MFA Hands On - AWS Access Keys, CLI & SDK - AWS CLI Setup - AWS CLI Hands On - AWS Cloud Shell	1		3	- IAM Policies - IAM Policies Hands On - IAM Roles for AWS Services - IAM Roles Hands On - IAM Security Tools - IAM Security Tools Hands On - IAM Best Practices **Cloud Computing instances in AWS** - Virtualization in Cloud Computing - What is Virtualization? - Virtualization as a Concept of Cloud Computing - Architecture of Virtualization - Types of Virtualizations	1		2
1,2	**4**	3	**Amazon Elastic Compute Cloud (Amazon EC2) Instance** - EC2 Basics - Create a EC2 instance with EC2 user data - EC2 instance types basics - Security groups and classic ports	1		3	- Lab - Security Groups - How to SSH to EC2 Instance - EC2 Instance Connect - EC2 Instance Roles Demo - Private vs Public vs Elastic IP - Lab - Private vs Public vs Elastic IP - EC2 Placement groups - Lab - EC2 Placement groups	1		2

							-			
1	1,3,	4	- Elastic Network Interface (ENI) Overview - Lab - ENI - EC2 Hibernate - Lab - EC2 Hibernate - EC2 Advance concepts (Nitro, vCPU, Capacity Reservations) - Amazon Elastic Block Store EBS Overview - Lab - EBS - EBS Snapshots - Lab - EBS Snapshots	2		2	- Amazon Machine Image (AMI) Overview - Lab - AMI - EC2 Instance Store - EBS Volume Types - EBS Multi-Attach - EBS Encryption - EFS - Lab - EFS - EFS vs EBS	1		2
		5	**Developmental Assessment**				Assessment Review and corrective action			3
1,5	2,3,4	6	**Industry Class: Amazon EC2 Instance and IAM**	2		3	Weekly Assignment			
3 1,5	2,3,4	1	Peer Review **Mini Project/ Activity – Status review**		4		**Cloud Networking** - Introduction - CIDR, Private vs Public IP - Subnet Overview - Networking - VPC - Default VPC Overview - VPC Overview	2		1

							-		
1,3,5	**2,3,4**	2	- Lab - VPC - Lab - Subnet - Internet Gateways & Route Tables - Lab - Internet Gateways & Route Tables - Bastion Hosts - Lab - Bastion Hosts - NAT Instances - Lab - NAT Instances -	1		3	- NAT Gateways - Lab - NAT Gateways - NACL & Security Groups - Lab - NACL & Security Groups	1	2
2,5	**2,3,4**	3	- VPC Reachability Analyzer - Lab - VPC Reachability Analyzer - VPC Peering - Lab - VPC Peering - VPC Endpoints - Lab - VPC Endpoints	1		3	- VPC Flow Logs - Lab - VPC Flow Logs - Site to Site VPN, Virtual Private Gateway & Customer Gateway - Lab - Site to Site VPN, Virtual Private Gateway & Customer Gateway	1	2
2,5	2,3,4	4	- Direct Connect & Direct Connect Gateway - AWS PrivateLink - VPC Endpoint Services - AWS ClassicLink - Transit Gateway - VPC Traffic Mirroring	1		3	- IPv6 for VPC - Lab - IPv6 for VPC - Egress Only Internet Gateway - Lab - Egress Only Internet Gateway - Networking Costs in AWS	1	2

		5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action		3
	1,2,4	4	6	**Industry Class: Cloud Networking**	2		3	Weekly Assignment		
4	1,2	**2,3,4**	1	Peer Review **Mini Project/ Activity – Status review**		4	**High Availability and Scalability in Cloud** - High Availability and Scalability - Elastic Load Balancer (ELB) and Auto Scaling Groups (ASG) - Classic Load Balancer (CLB) - Lab - CLB - Application Load Balancer (ALB) - Lab - ALB	2	1
	1,2	1,3	2	- Network Load Balancer (NLB) - Lab - NLB - Gateway Load Balancer (GWLB) - Elastic Load Balancer - Sticky Sessions - Elastic Load Balancer - Cross Zone Load Balancing -	1	3	- Elastic Load Balancer - SSL Certificates - Elastic Load Balancer - Connection Draining - Auto Scaling Groups (ASG) Overview - Lab - ASG	1	2
	1,2,4	**2,3,4**	3	- Auto Scaling Groups - Scaling Policies - Lab - Auto Scaling Groups - Scaling Policies	1	3	- Amazon RDS Overview - RDS Read Replicas vs Multi AZ - Lab - Amazon RDS	1	2

			Databases in Cloud - Introduction - Amazon RDS, Aurora, ElasticCache				- RDS Encryption + Security			
	1,2,4	2,3,4	4	- Amazon Aurora - Lab - Amazon Aurora - Aurora - Advanced Concepts	1		3	- ElasticCache Overview - Lab - ElasticCache	1	2
			5	**Developmental Assessment**				Assessment Review and corrective action		3
	1,2,4	2,3,4	6	**Industry Class: Databases in AWS**	2		3	Weekly assignment		
5	1,2,5	2,3,4	1	Peer Review **Mini Project/ Activity – Status review**		4		**Cloud Storage Service** - AWS Storage Services - Amazon S3 - Section Introduction - S3 Buckets and Objects - Lab - S3 Buckets and Objects - S3 Versioning - Lab - S3 Versioning - S3 Encryption - Lab- S3 Encryption	1	2
	1,2,5	2,3,4	2	- S3 Security & Bucket Policies - Lab - S3 Security & Bucket Policies	1		3	- S3 Consistency Model - S3 MFA Delete	1	2

			- S3 Websites - S3 CORS - Lab - S3 CORS				- Lab - S3 MFA Delete - S3 Default Encryption - S3 Access Logs - Lab - S3 Access Logs - S3 Replication (Cross Region and Same Region)			
1,2,5	**2,3,4**	3	- Lab - S3 Replication - S3 Pre-signed URLs - Lab - S3 Pre-signed URLs - S3 Storage Classes + Glacier - Lab - S3 Storage Classes + Glacier	1		3	- S3 Lifecycle Rules - Lab - S3 Lifecycle Rules - S3 Analytics - S3 Performance - S3 Event Notifications	1		2
1,2,5	**2,3,4**	4	- Athena Overview - Lab - Athena - AWS Snow Family Overview - Lab - AWS Snow Family - Amazon FSx - Lab - Amazon FSx	1		3	- Storage Gateway Overview - Lab - Storage Gateway - AWS Transfer Family - Compare AWS Storage options	1		2
		5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
1,2,5	**2,3,4**	6	**Industry Class: Cloud Storage Service**	2		3	Weekly Assignment			

6	2,3,5	2,3,4	1	Peer Review **Mini Project/ Activity – Status review**		4		**DNS Services and Content Delivery** - What is DNS? - AWS Route 53 Overview - Route 53 - Registering a domain - Route 53 - Creating our first records - Route 53 - EC2 Setup - Route 53 - TTL	1	2
	1,2,3,5	2,3,4	2	- Route 53 CNAME vs Alias - Routing Policy - Simple, Weighted - Routing Policy - Latency - Route 53 - Health Checks - Lab - Route 53 - Health Checks - Routing Policy - Failover, GeoLocation, Geoproximity	1	3	- Lab - Routing Policy - Traffic Flow & Geoproximity Hands On - Routing Policy - Multi Value - 3rd Party Domains & Route 53 - What is CDN ? - Advantages of CDN - CloudFront & AWS Global Accelerator -	1	2
	1,2,3,5	2,3,4	3	- CloudFront Overview - Lab - CloudFront with S3 - CloudFront Signed URL / Cookies - CloudFront Advanced Concepts - AWS Global Accelerator – Overview - Lab - AWS Global Accelerator	1	3	**Serverless Computing in Cloud** - What is Serverless computing ? - Benefits of serverless computing - Serverless application patterns - Serverless computing in AWS	1	2

1,2,3,5	2,3,4	4	- AWS Lambda Overview - Lab - Lambda - Lambda Limits - Lambda@Edge - Amazon DynamoDB - Lab - Amazon DynamoDB	1		3	- API Gateway Overview - Lab - API Gateway Overview - API Gateway Security - AWS Cognito Overview - Serverless Application Model (SAM) Overview - Serverless Solutions Architecture	1	2
		5	**Developmental Assessment**				Assessment Review and corrective action		3
2,3,5	2,3,4	6	**Industry Class: DNS & Serverless**	2		3	- Weekly Assignment		
7 2,3,5	2,3,4	1	Peer Review **Mini Project/ Activity – Status review**		4		**Container Services** - The need for containers - Introduction to Docker - Lab - Deploying Docker on a virtual machine	1	2
1,2,3,5	2,3,4	2	- Lab - Running the nginx container on the Linux VM - Lab - Practice Docker commands - The need for an image registry	1		3	**Amazon ECR** - Lab - Amazon ECR - Publishing to Amazon ECR	1	2
2,3,5	2,3,4	3	**Amazon ECS** - Lab - Creating ECS Cluster	1		3	**Kubernetes** - What is Kubernetes ?	1	2

				- Lab - Creating ECS Service - Amazon ECS - Auto Scaling, Rolling Updated and Solutions Architectures				- Kubernetes components - Learn Kubernetes Basics		
	1,2,3,5	2,3,4	4	- Create a Cluster in Kubernetes - Deploy an App ('Hello World' webpage) - Explore your App	1		3	- Expose your App Publicly - Scaling your App Amazon EKS Overview	1	2
			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action		3
	2,3,5	2,3,4	6	**Industry Class: Container Services and Kubernetes**	2		3	Weekly Assignment		
8	2,3,5	2,3,4	1	Peer review **Mini Project/ Activity – Status review**		4		**Disaster Recovery and Migrations** - Disaster Recovery in AWS - Database migration service (DMS) - Lab - DMS - Datasync Overview - AWS Backup - Lab - AWS Backup - Transferring large datasets into AWS	1	2
	2,3,5	2,3,4	2	**AWS Elastic Beanstalk** - Introduction - Elastic Beanstalk Overview - Creating Beanstalk Environment	1		3	- Beanstalk CLI and Deployment Process - Beanstalk lifecycle policy overview and hands-on - Beanstalk Extensions	1	2

			- Beanstalk Deployment modes - Lab – Beanstalk Deployment Modes				- Beanstalk and Cloudformation - Beanstalk with Docker - Beanstalk Cleanup	
2,3,5	2,3,4	3	**AWS CI/CD** - Introduction to CI/CD in AWS - CodeCommit overview - Lab- CodeCommit - CodePipeline Overview - Lab – CodePipeline - CodeBuild Overview - Lab – CodeBuild	1	3	- CodeDeploy Overview - Lab – CodeDeploy - CodeStar Overview - Lab – CodeStar - CodeArtifact Overview		3
2,3,5	2,3,4	4	**AWS CloudFormation** - CloudFormation Overview - Lab – CloudFormation Create Stack - Lab – CloudFormation Update and delete Stack - YAML crash course - CloudFormation Resources - CloudFormation Parameters	1	3	- CloudFormation Mappings - CloudFormation Outputs - CloudFormation Conditions - CloudFormation Intrinsic Functions - CloudFormation RollBacks - CloudFormation Changesets, Nested Stacks and StackSet - CloudFormation Drift		3
		5	**Developmental Assessment**			Assessment Review and corrective action		3

	2,3,5	**2,3,4**	6	**Industry Class: Disaster Recovery and Migrations**	2		3	Weekly Assignment		
9	3	2,3	1	Peer review **Mini Project Activity – Status review**		4		**Monitoring and Auditing** - AWS Monitoring - CloudWatch Metrics - CloudWatch Custom Metrics and Dashboards - CloudWatch Logs - Lab - CloudWatch Logs -	2	1
	2,3,5	**2,3,4**	2	- CloudWatch Agent & CloudWatch Logs Agent - CloudWatch Alarms - Lab - CloudWatch Alarms - AWS CloudWatch Events - Amazon EventBridge	1		3	- AWS CloudWatch Events - Amazon EventBridge - CloudTrail Overview - Lab - CloudTrail		3
	2,3,5	**2,3,4**	3	- AWS Config - Overview - Lab - AWS Config - CloudTrail vs CloudWatch vs Config - AWS Cost Explorer	1		3	**Cloud Security** - Introduction - Defense in depth in security - AWS Security & Encryption - KMS Overview		3

							- Lab - KMS with CLI			
5	3,4	4	- KMS Key Rotation - SSM Parameter Store Overview - Lab - SSM Parameter Store (CLI) - Lab - SSM Parameter Store (AWS Lambda) - AWS Secrets Manager - Overview - Lab - AWS Secrets Manager	1		3	- CloudHSM - Shield - DDoS Protection - Web Application Firewall (WAF) - Lab - WAF & Shield - Amazon GuardDuty - Amazon Inspector - Macie - AWS Well Architected Framework with more focus on Security			3
		5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3
4	2,3	6	**Industry Class: Cloud Monitoring and Security**	2		3	Weekly Assignment			
10	1	3,4	1	Peer Review **Mini Project/ Activity – Status review**		4		**Microsoft Azure Cloud Overview** - Regions, Region Pairs, Sovereign Regions - Availability Zones and Data Centers - Resources, Resource Groups, Subscriptions, Management Groups - Overview of Azure Services - VM and App Services - Azure Storage and Data Services - Azure Networking Services and Microservices	1		2

							- Tour of the Azure Portal - Azure Free Account - Creating an Azure Free Account		
1,2,3	3,4	2	**Azure Active Directory** - Introduction to Azure Active Directory - Azure Active Directory Features - Azure Subscriptions - Creating an Azure subscription - Trust between Azure Subscription and Azure AD - Creating a user in Azure AD			4	- MFA or 2FA in azure - Lab - MFA on per user basis - Conditional Access Policies - Lab - Conditional Access Policies - Azure Powershell and Azure CLI - Azure CLI Hands on - What is Powershell - Installing Powershell in Azure - Quick look at a couple of commands - Installing Azure CLI	1	2
1,3	2,3,4	3	**Cloud Compute Services in Azure** - Azure Virtual Machines - The Virtual Machine Service - Deploying a Virtual Machine - Lab - Building a Windows Virtual Machine - Connecting to the Virtual Machine - Lab - Installing IIS	1		3	- State of the Virtual Machine - Lab - State of the Virtual Machine - Lab - Building a Linux Virtual Machine - Lab - Deploying a web server on the Linux virtual machine	1	2

	1,3	3,4	4	**Cloud Networking Services in Azure** - Virtual Networks - Introduction - The network interface - Lab - Working with Azure virtual networks - Lab - Deploying a machine to the virtual network - Attaching a secondary network interface - Lab - Adding a secondary network interface	1	3	- Network Security Groups - Lab - Network Security Groups (Working with rules, Priority setting, Subnets) - Virtual Network Peering - Lab - Virtual Network Peering - Setup and Implementation - Virtual private network	3
			5	**Developmental Assessment**			Assessment Review and corrective action	3
	2,3	3,4	6	**Industry Class: Networking Services in Azure**	2	3	Weekly Assignment	
11	1,5	2,3,4	1	Peer Review **Mini Project /Activity – Status review**		4	**High Availability and Scalability in Azure Cloud** - Explore Availability and Scalability in Azure - Availability Sets - Lab - Availability Sets	1	2

							- Use case scenario - Availability sets		
							- Availability Zones		
							- Lab - Availability Zones		
							- Azure virtual machine scale sets		
2,3	2,3, 4	2	**Database Services in Azure** - Azure Database Service - Major Database Features - Database on VM - Azure SQL - Which Azure SQL to Choose? - Creating and Connecting to Azure SQL - Connecting the Catalog to the Database - Securing the Database Connection	1		3	**Cloud Storage Service in Azure** - Azure Storage Data Services - Introduction - Benefits of Azure Storage - What are storage accounts - Different types of storage accounts - Lab - Creating an Azure storage account - Azure Blob service - Lab - Blob service - Uploading a blob, Accessing the blob	1		2
2,3	3	3	**DNS Services and Content Delivery in Azure** - Azure Private DNS - Lab- Azure Private DNS - Azure Public DNS - Azure CDN - Azure CDN Features	1		3	- How to use Azure CDN ? - Lab - Create Azure CDN - Create a storage account - Enabling CDN for storage account			3

2,3	2.3, 4	4	**Serverless Computing in Azure** - Azure Serverless - How Azure Does Serverless - Overview of Azure Functions	1		3	- Lab - Creating and Testing a Azure Function - Logic Apps - Lab - Creating an Testing a Logic App			3
		5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action			3
3	2,3	6	**Industry Class: Cloud Databases**	2		3	Weekly Assignment			
12	1	2,3, 4	1	Peer Review **Mini Project /Activity – Status review**				**Container Services in Azure** - Azure Container Registry - Lab - Azure Container Registry - Publishing to the Azure Container Registry - Publishing to the Azure Container Registry - Resources	2	1
	1,2, 3	2,3, 4	2	**Azure Container Instances** - Lab - Azure Container Instances and Azure Container Groups	2		2	**Kubernetes in Azure** - Azure Kubernetes Services (AKS) Overview - Lab - Deploying an Azure Kubernetes cluster - Lab - Deploying our application	1	2

	1,2, 3,4, 5	2,3, 4,6	3	**Azure Cloud Monitoring** - Azure Monitor Service - Quick look at Azure Monitor - Lab - Azure Monitor - Alerts	2		2	- What is a Log Analytics Workspace - Lab - Creating a Log Analytics workspace			3
	2,3	3,4	4	**Azure Cloud Security** - VM Security Best Practices - Networking Security Best Practices			4	- Database Security Best Practices - Zero Trust security - Azure Key Vault			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1,3	5	6	**Industry Class: Kubernetes in Azure**	2		3	Weekly Assignment			
13	1 to 4	2,3, 4,6		**Internship** **a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship.** **b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies.** **c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of**	2	4	19	**Project** **a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective.** **b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified.**		4	11

				learning you expect to learn during internship.			c) Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.			

**Note: Saturday session from 9 AM -2 PM

References

Sl. No	Description
1	AWS Certified Cloud Practitioner Study Guide: CLF-C01 Exam by David Clinton (Author)
2	AWS Certified Solutions Architect Study Guide: Associate SAA-C02 Exam (Aws Certified Solutions Architect Official: Associate Exam) By Ben Piper and David Clinton
3	https://aws.amazon.com/training/awsacademy/
4	AWS Certified Cloud Practitioner : Study Guide with Practice Questions and Labs - Third Edition
5	https://docs.microsoft.com/en-us/learn/certifications/exams/az-900
6	Microsoft Azure AI: A Beginner's Guide Rekha Kodali
7	Learn Microsoft Azure Step by Step in 7 days for .NET Developers (English, Paperback, Pawar Saillesh)
8	https://zoomgroup.com/training/india/free-ebooks/aws-lab-manual-view/html5forwebkit.html?page=0
9	https://docs.aws.amazon.com/general/latest/gr/aws-general.pdf
10	https://www.skylinesacademy.com/az900-azure-fundamentals-ultimate-study-guide

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

* The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE (1)

Note: Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	Computer Science Engineering	Semester	V
Course	Cloud Computing	Max Marks	30
Course Code	20CS53I	Duration	4 hours
Name of the course coordinator		CIE	1(3RD WEEK)

Note: Answer one full question from each section.

Qn.No	Question	CL L3/L4	CO	PO	Marks
	Section-1 (Theory) – 10 marks				
1.a)	What are the steps involved in creating the VPC in AWS.	L4	1,2		5
b)	Suppose you are hosting a e-commerce application on cloud. Illustrate with example how do the following factors affect the cloud infrastructure. 1. Scaling up vs Scaling out 2. Load Balancing 3. Fault Tolerance 4. Loose coupling 5. Stateful vs Stateless Service	L3	1,2		5
2.a)	What is AWS IAM? Illustrate the need of AWS IAM Multi-factor authentication (MFA) with example.	L4	1,2		5
b)	How do you control traffic in and out of AWS EC2 instance.	L3	1,2		5

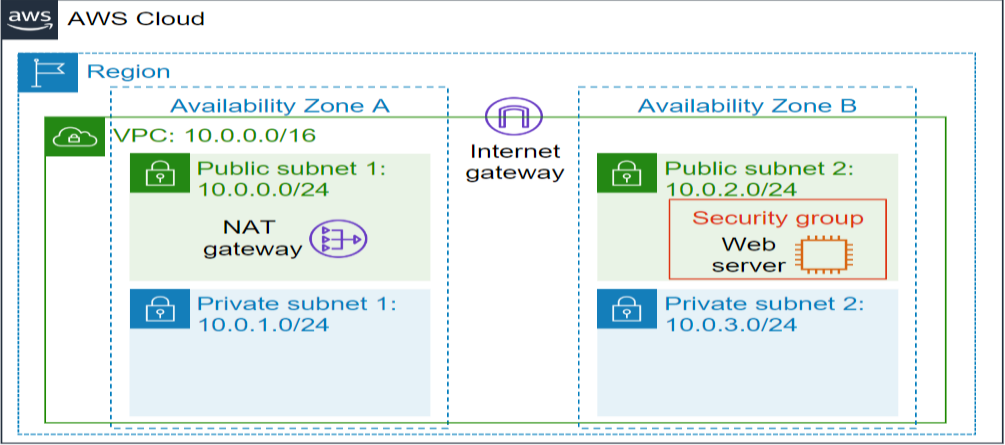|					
Section-2 (Practical) - 20 marks					

3)	. Create a Custom Amazon VPC by demonstrating the following
	   1. Sign in to the AWS Management Console as an administrator or power user.
	. 2. Select the Amazon VPC icon to launch the Amazon VPC Dashboard.
	   3. Create an Amazon VPC with a CIDR block equal to 192.168.0.0/16, a name tag of My First VPC, and default tenancy.
	
	Scheme of evaluation:
	<table><tr><td>Sl.</td><td>Description</td><td>Marks</td></tr><tr><td>1</td><td>Sign into AWS Management Console</td><td>5</td></tr><tr><td>2</td><td>Launch of Amazon VPC</td><td>5</td></tr><tr><td>3</td><td>Creation of VPC</td><td>10</td></tr></table>
		L3	1,2		20

4)	Create an Amazon Elastic Compute Cloud (Amazon EC2) instance. <table><tr><td>Sl.</td><td>Description</td><td>Marks</td></tr><tr><td>1</td><td>Launch of EC2 instance</td><td>5</td></tr><tr><td>2</td><td>Configuration of EC2 instance</td><td>5</td></tr><tr><td>3</td><td>Termination of instance</td><td>10</td></tr></table>	L3	1,2		20

Note : Theory questions shall be aligned to practical questions

Assessment framework for SEE 1 (Theory) – 100 Marks / 3 hours (Reduced to 60 marks)

Program	: Computer Science Engineering		Semester: Vth
Course	: CLOUD COMPUTING		Max Marks: 100
Course Code : 20CS53I			Duration :3 Hrs

Q. No	Question	CL	CO	Marks
	Instruction to the Candidate: Answer one full question from each section.			
	Section-1			
1.a)	Why is AWS more economical than traditional data center for applications with varying compute workloads? Illustrate with the example.	3	1,2	10
b)	How does AWS IAM improves the security of the applications? Illustrate the Multi-factor authentication (MFA) with example.	4		10
2.a)	Illustrate the following AWS Cloud services 　　a. EC2 Instances 　　b. S3 Storage 　　c. AWS Shield 　　d. WAF Firewall 　　e. NACL	4		10
b)	Illustrate the steps involved in creating an AWS EC2 Instance.	3		10
	Section-2			
3.a)	Differentiate between Security Group and NAC in AWS	3	1,2	10
b)	Explain the steps involved in Securing a new AWS account from Account root user.	4		10
4.a)	How is Elastic Load Balancer (ELB) and Auto Scaling Groups (ASG) are used?	4		10
b)	Write a note on the following 　　a. VPC 　　b. Subnets 　　c. Security groups 　　d. Route Table	4		10

Section- 3					
5.a)	How to configure an Amazon S3 bucket for static website hosting.	3	1,3	10	
b)	Create a Amazon S3 bucket for pre-signed URLs.	3		10	
6.a)	Explain different Amazon S3 object-level storage classes available with use cases.	3		10	
b)	Explain the Amazon EFS features and illustrate the steps in Amazon EFS implementation.	3		10	
Section-4					
7.a)	A company wants to store data that is not frequently accessed. What is the best and cost-effective solution that should be considered? Compare the same with traditional methods.	4	1,4	10	
b)	What are the Amazon Managed services responsibilities?	4		10	
8.a)	What is the AWS Well-Architected Framework? Explain the pillars of Well-Architected Framework	3		10	
b)	Highlight the benefits of Container services and steps involved in Kubernetes service in AWS	4		10	
Section-5					
9.a)	Illustrate the following in Microsoft Azure. 1. Regions, Region Pairs, Sovereign Regions 2. Availability Zones and Data Centers, Resources, Resource Groups	3,4	1,5	10	
b)	Different types of storage account in MS Azure Cloud.	3,4		10	
10.a)	What are Virtual Networks in MS Azure Cloud. Explain with example.	3		10	
b)	Write a note on Virtual Machine Security Best Practices in Azure Cloud.	4		10	

Scheme of Evaluation for SEE 2 (Practical)

Sl. No	Description	Marks
Problem Statement:	Suppose client wants to migrate web application that is on-prem into cloud. How to create an EC2 Instance, deploy the application and create the AWS S3 storage.	
1	Deploy a simple application in AWS Cloud by creating the instances.	25
2	Create a S3 storage in AWS	20
3	Create a VPC for the below architecture in AWS Cloud.	20
4	Create the Virtual machine and Storage in Microsoft Azure cloud.	25
5	Viva voce/Result	10
Total		**100**

Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
9.	Computers	Intel i5, 4GB RAM, 500GB SSD	**20**
10.	AWS and AZURE Cloud account – Students subscription	Atleast $100 for each account	**20 AWS account** **20 Azure account**
11.	Broadband connection	Atleast 250MBPS	**1**

Cyber Security

Government of Karnataka

DEPARTMENT OF COLLEGIATE and TECHNICAL EDUCATION

Program	Computer Science & Engineering	Semester	5
Course Code	20CS54I	Type of Course	L:T:P (104:52:312)
Course Name	Cyber Security	Credits	24
CIE Marks	240	SEE Marks	160

Introduction:

Welcome to the curriculum for the Artificial Intelligence and Machine Learning (AI&ML) Specialisation. This specialisation course is taught in Bootcamp mode. Bootcamps are 13 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning.

In the era of connected computing devices, securing the personal data, application, system, network and organization becomes the challenging task in the field of Computer science and Engineering. The specialization prepare students to take up job or to become entrepreneur in the challenging area of Cyber security

Pre-requisite

Before the start of this specialisation course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Computer, Fundamentals of Electrical and Electronics Engineering, Project Management skills and Multimedia & Animation.

In the 2nd year of study, you would have studied Python Programming, Computer Hardware, Maintenance and Administration, Computer Networks, Database System Concepts and PL/SQL, Data Structures with Python, Operating System and Administration, Object oriented programming and Design with Java, Software Engineering principles and practices.

In this year of study, you shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Course Cohort Owner

A Course Cohort Owner is a faculty from the core discipline, who is fully responsible for one specialised field of study and the cohort of students who have chosen to study that specialised field of study.

Guidelines for Cohort Owner

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.

2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.

3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.

4. The industry session shall be addressed by industry subject experts (in contact mode/online / recorded video mode) in the discipline only.

5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.

6. Cohort owner shall plan and accompany the cohort for any industrial visits.

7. Cohort owner shall maintain and document industrial assignments, weekly assessments, practices and mini project.

8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table

9. The cohort owner along with classroom sessions can augment or use supplementally teaching and learning opportunities including good quality online courses available on platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM , etc.

Course outcome: A student should be able to

CO1	Design, optimize, operate and maintain a secure network/system/application/cloud and data resources for given requirements
CO2	Apply cryptography to secure a cyber system.
CO3	Respond to incidents to mitigate immediate and potential threats .
CO4	Test, implement, deploy, maintain and review the infrastructure to effectively manage the network and resources.
CO5	Monitor network to actively remediate unauthorized activities.

Detailed course plan

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1	1	1	- Protecting your personal data - Online identity - Where is your data ? - Smart devices - What do attackers want ? - Identity theft - Protecting your organization data - Traditional data - Cloud; IoT; Big data - Types of data - Sensitive and non sensitive data - Personal data, PII data - Data classification - Ex: Govt. of India classification of data - Unclassified - Restricted - Confidential - Secret - Top secret -	4	-	-	Introduction and Basic concepts of cyber security What is Cyber security, Security principles CIA, AAA Vulnerability, Threat, Risk, attack and Impact People, Process and Technology McCumbers Cube Cyber Security - Brief history and types - Infrastructure, network, cloud, IOT, application. - Purpose and Importance - Challenges - Applications How does cyber security work?	3		

1	1,5	2	Recap –
			Topology
			OSI Model
			TCP/IP Model
			 Internet protocols
			Network resources
			Router and Firewall, Hub, switch – security issues
			Basic Network terminologies
				3	1	Hackers
						    Who are they?
						    What is not hacking
						    Types of hackers
						    Hacking methodologies
						    Purpose
						Activity: Stuxnet - a case study
							1	2

1,2,3	1,2,3	3	Analysing a Cyber Attack
			    Types of Malwares
			        Spyware
			        Malware
			        Backdoor
			        Ransomware
			        Scareware
			        Rootkit
			        Virus
			        Trojan horse
			        Worms
			        Symptoms of attack
			
			Methods of Infiltration
			    Social Engineering
			        Pretexting
			        Tailgating
			        Something for something (quid pro quo)
			        Denial-of-Service and DDoS
			        Botnet
			        On the Path attack
				3	1	- Defence in depth
						- What is defence in depth
						- Layers
						- Needs for Defence in depth
						- Examples
						- Host encryption
						- Anti-virus
						- Firewall
						- E-Mail gateway
						- Password management
						- Honeypot
						- Multi Factor Auth
								3

			SEO Poisoning
			Wi-Fi Password Cracking
			Password Attacks
			    Password spraying
			    Dictionary attack
			    Brute force
			       Password Cracking Times
			    Rainbow
			    Traffic interception
			
			    Advanced Persistent Threats
			Security Vulnerability and Exploits
			    Hardware Vulnerabilities
			       Meltdown and Spectre
			    Software Vulnerabilities
			       Categorizing Software
			Vulnerabilities
			       Software updates					

1,2,3	1,2,3	4	Data Maintenance
			    Using free tools
			    Back Up Your Data
			    How Do You Delete Your Data
			Permanently?
			       Tools
			Who owns your data?
			    Terms of service
			    Understand the term; what are you
			agreeing to?
			    The data use policy
			    Privacy settings
			    Before you sign up protect your data
			    Activity: Check terms of service of the
			popular application you use on your phone and
			check their data sharing policy, access to device
			etc.
				2	1	1	Protecting Your Computing Devices
							
							    turn the firewall on
							
							    install antivirus and antispyware
							
							    manage your operating system and
							browser
							
							    set up password protection.
								3

				Safeguarding Your Online Privacy
				    Two Factor Authentication
				    Open Authorization
				    Social Sharing
				    Email and Web Browser Privacy
				Activity: Discover your own risky online behaviour
				    Scenario 1: posting private info on social media
				    Scenario 2: What password you choose when creating new account for social service
				    Scenario 3: Using public Wi-Fi
				 - Scenario 4: Using trial version of the software
				
				Activity: Check if your password is
				compromised
				 Note :Use Have I been pwned
				 -						

			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1,2	2,3,4	6	**class: Cyber security at workplace**	2		3	Weekly Assignment(1PM-2PM)			
Reference materials : skillsforall.com – Introduction to Cyber security										
2	1,2,3,4	2,3,4	1	Peer review Project / activity Propose problem statement		4		Why Do We Need a Version Control System? Fundamentals of Git Git installation and setup basic local Git operations ▪ creating a repository,	1		2

						▪ cloning a repository, ▪ making and recording changes ▪ staging and committing changes, ▪ viewing the history of all the changes undoing changes		
2,3	2,3,4	2	History of cryptography (overview: Caesar cipher, enigma cipher) Introduction (high level overview only) Enc (sym - stream + block ciphers, asym) Hashing Digital signature, MAC - PRNG	2	2	Algebra: groups, rings, fields - definitions + examples AES (SPN structure, rounds, modes of operation - high level overview with diagram) MAC + SHA2/3 (high level + security requirements))	1	2
2,3	2,3,4	3	RSA (with numerical examples) Digital signature (RSA)	2	2	Number theory - primes, modular arithmetic, gcd, Euler totient function - definitions + examples	1	2
2,3	2,3,4	4	Practice sessions/ student activities: - Numerical/programming exercises: subset of math / Caesar cipher / one time pad / RSA / GCD / primality Cryptanalysis (brute force over keys, birthday attacks on hash functions, hardness of	1	3	Practice sessions/ student activities: Inspect digital certificates using a web browser and visiting popular websites - Identify the crypto algorithms in TLS - Design a toy crypto algorithm like key generation + encryption + decryption / digital signature / hash function		3

			factoring integers, discrete log problem, side-channel attacks – high level overview) Applied crypto (PKI, Full disk encryption, blockchain: overview						
		5	**Developmental Assessment**				Assessment Review and corrective action			3
		6	**Industrial class : Application of cryptography**	2		3	Weekly Assignment			

References :

- https://www.youtube.com/user/Computerphile - YouTube channel by Dr. Mike Pound

- https://nptel.ac.in/courses/106105031/ : Cryptography and Network Security by Prof. Debdeep Mukhopadhyay, IIT Kharagpur

- https://www.coursera.org/learn/crypto and https://www.coursera.org/learn/crypto2 : by Prof. Dan Boneh, Stanford University

- http://williamstallings.com/Cryptography/ - student resources by Prof. William Stallings

| 3 | 1,4 | 2,3,4 | 1 | Peer review
 Project / activity
 Propose problem statement and network design requirements | | | 4 | How Internet/Application works (Security aspects – end-to-end packet path)

 Network architecture concepts
 Understanding vulnerabilities in different OSI layers and protocols (TCP, UDP, IP, ICMP) | | | 3 |

1,5	2,3,4	2	Network Security : Concepts- Firewall, IDS, IPS, VPN	2		2	Protocols : IPSec, SSL, TLS (versions and vulnerabilities)	1	2
1,5	1,4	3	Web Security : Concepts-HTTP, HTML, Frames, browser design	2		2	Attacks and vulnerabilities: Injection attacks : SQL, HTTP header, OS command	1	2
1,5	2,3,4	4	o Wireless Security : Introduction to security issues in cellular networks, WIFI, LAN systems, RFID systems	2		2	- DOS attacks, countermeasures (in relation to wireless networks)	1	2
		5	**CIE 1 : Written and practice test**				Assessment Review and corrective action		3
2,3	2,3,4	6	**Industrial class :** High availability and load balancing	2		3	Weekly Assignment		

References :

1. https://www.cisco.com/c/en_in/products/security/what-is-network-security.html
2. https://purplesec.us/firewall-penetration-testing/
3. How hackers do it: Tricks, Tools, and Techniques
4. https://cse29-iiith.vlabs.ac.in/
5. https://nptel.ac.in/courses/106105031/ : Cryptography and Network Security by Prof. Debdeep Mukhopadhyay, IIT Kharagpur.
6. https://wiki.apnictraining.net/netsec-20220627-bdnog14/agenda

4	2,3,5	2,3,4	1	Peer review Project status review Demonstration of artifacts of the project		4		Windows Security Windows Security Infrastructure Windows Family of Products Windows Workgroups and Accounts Windows Active Directory and Group Policy	2	1

1,2, 3,5	2,3, 4	2	Windows as a Service End of Support Servicing Channels Windows Update Windows Server Update Services Windows Autopilot Windows Virtual Desktop Third-Party Patch Management Practice : Process observation and analysis with Process Hacker	2	2	Windows Access Controls NTFS Permissions Shared Folder Permissions Registry Key Permissions Active Directory Permissions Privileges BitLocker Drive Encryption Secure Boot - Practice : NTFS file system practical using NTFS Permissions Reporter	1	2
1,2, 3,5	2,3, 4	3	Enforcing Security Policy Applying Security Templates Employing the Security Configuration and Analysis Snap-in Understanding Local Group Policy Objects Understanding Domain Group Policy Objects Administrative Users Privileged Account Management Reduction of Administrative Privileges AppLocker User Account Control Windows Firewall IPsec Authentication and Encryption	2	2	Linux Security Linux Fundamentals Operating System Comparison Linux Vulnerabilities Linux Operating System Shell Kernel Filesystem Linux Unified Key Setup Linux Security Permissions Linux User Accounts Pluggable Authentication Modules Built-in Command-Line Capability	1	2

				Remote Desktop Services Recommended GPO Settings. Practice : Auditing and enforcement of system baseline configurations with security templates • PowerShell scripting and automation techniques			Service Hardening Package Management			
	1,2,3,5	2,3,4	4	Linux Security Enhancements and Infrastructure Operating System Enhancements ○ SE Linux ○ App Armor Linux Hardening ○ Address Space Layout Randomization ○ Kernel Module Security ○ SSH Hardening ○ Open SCAP ○ CIS Hardening Guides and Utilities	2	2	Log Files ○ Key Log Files ○ Syslog ○ Syslog Security ○ Log Rotation ○ Centralized ○ Logging ○ Audit id ○ Firewalls: Network and Endpoint ○ Rootkit Detection	1		2
			5	**Development Assessment** (Hardening the image win and linux CIS controls)			Assessment Review and corrective action			3
	1,2,3,5	2,3,4	6	Industrial Class : System Security	2	3	Weekly Assignment			
5	1,2,3,4,5	2,3,4	1	Peer review Project status review	4		Introduction to Application Security Secure SDLC	2		1

				Introduction to Software Application Development – How was it created, Why is it important? How does it work.
				Types of Application Software – Thick Client, Web Applications, Web Services, RESTFul Services, Middle Ware, Mobile Applications etc (Give an example of each).
				Explain Software Development Lifecycle – Requirements, Design, Develop, Deploy, Operate and Purge.
				Life Cycle Models – Waterfall, Agile, Iterative etc.
				SDLC Best Practices
								Provide a use case – Microsoft Secure SDLC Practice and Security controls covered in each stage at a higher level.
								Requirements (Determine Application Risk Profile based on Security Requirements, Determine Control Requirements, Establish Quality Gates)
								  b. Design (Architecture Design Review and Threat Modeling)
								  c. Implementation (Static Analysis, Software Composition Analysis, Secret Detection, Deprecate unsafe functions, use of plugins in IDE, Safe Commit and Change Management in Repositories)
								  d. Verification (Dynamic Analysis, Interactive Application Security Testing, Fuzz Testing, Abuse use case Testing, Architecture Verification).
								  e. Release (Run Time Application Self Protection, Web Application Firewall, SOP for Operations, Secure Provisioning, Deployment and De commissioning)
								  - f. Response (Incident Response).			

| 1,3, 4,5 | 2,3, 4 | 2 | Application Security – Requirements

1. Functional and Non Functional Requirements for an application

2. Security Requirements for an application

3. Determining Application Risk Profile Based on the security requirements.

4. Determining Control Requirements Based on Application Risk Profile and Eligibility Criteria for an application to undergo a certain security control.
Establish Security Toll Gates | 1 | 3 | Application Security Design:
Secure Architecture Review – For a given use case, with examples; conduct security architecture review using the OWASP standard. | 1 | | 2 |
| 1,3, 4,5 | 2,3, 4 | 3 | Application Security Design – Threat Modelling.
1. Why Threat Modelling
2. What is Threat Modelling
3. Threat Modelling Methodologies – STRIDE, PASTA, OCTAVE, TRIKE, VAST.
4. Threat Model Ranking – DREAD, CVSS, CWSS etc.
Threat Model Execution Phases: - Planning, Scoping, Deep Dive Discussions, Drawing a | 1 | 3 | - Using the Microsoft Threat Modeling methodology, execute a threat model for a given application architecture using Microsoft threat modeling tool. | | | 3 |

			Threat Model, Identifying Threats, Threat Objects, Security Controls, Threat Actors, Threat Traceability Matrix, Reporting and Debrief.					
	1,3, 4,5	2,3, 4	4	Application Security – Implementation - Explain use of Security Tools within IDE. - Static Code Analysis Tools – Explain with examples. - Explain Software Composition Analysis, Identifying Software Dependencies and CVE in underlying libraries. Demonstrate a tool like OWASP Dependency Check.	1	3	Explain Secret Detection using tools like Githound. - Change Management during pre-commit and post-commit in repositories. - Safe SCM practices (Take Github as an example). - Highlight deprecated unsafe functions in common programming languages.	3
			5	**CIE 2 – Written and Practice Test**			Assessment Review and corrective action	3
	1,2, 3,4, 5	2,3, 4	6	**Industrial class : Source Code Scan using a commercial tool like Microfocus Fortify or Checkmarz.**	2	3	Weekly Assignment	
6	1,2, 3,5	2,3, 4	1	Peer review Project status review		4	Application Security – Verification. Explain Dynamic Analysis using an example – owasp zap. Interactive Application Security Testing – Demonstrate using Contrast Security Tool.	3

2,3,5	2,3,4	2	For a given site (local), conduct a dynamic analysis scan using OWASP ZAP, Check for False positives and create a report			4	Introduce Manual Security Testing using OWASP Testing Guide. Add Misuse case testing to the framework in addition	1		2
2,3,5	2,3,4	3	Conduct a manual security testing for a local web application or an API using proxy tools like burp suite/paros etc and provide a report. Compare the results of both manual and automated scans. Application Security – Release 1. Explain Run Time Application Self Protection – Contrast Security or Microfocus Fortify Software can be used as an example. 2. Define Web Application Firewall. Demonstrate using a tool. Elaborate on Standard Operating Procedure for Operations, Secure Provisioning, deployment and decommissioning	1		3	- 1. Cover OWASP ASVS and its aid as a tool in architecture verification. Introduce OWASP SAMM – to attain software assurance maturity.	1		2
2,3,5	2,3,4	4	Measurement of Application Security – Define Metrics, Type of Metrics (Operations, Efficiency, Quality etc). Example Application Security Metrics from OWASP.	1		3	For the previous run scans, define metrics and evaluate the values at operational level.			3

			5	Development assessment				Assessment Review and corrective action			3
2,3, 5	2,3, 4	6		**Industrial class : Dynamic Analysis using Qualys**				Weekly Assignment Weekly Assignment (Suggestive Student Activities) 1. Install Web Goat and do an automated scan using one of the dynamic analysis tools. 2. Follow up with a manual security testing with OWASP Testing guide as an aid and compare the results of automated and dynamic scan.			

References:
1.   https://www.synopsys.com/glossary/what-is-sdlc.html
2.   https://www.synopsys.com/blogs/software-security/secure-sdlc/
3.   https://www.microsoft.com/en-us/securityengineering/sdl
4.   https://www.microsoft.com/en-us/securityengineering/sdl/threatmodeling
5.   https://www.microsoft.com/en-in/download/details.aspx?id=49168
6.   https://medium.com/@melsatar/software-development-life-cycle-models-and-methodologies-297cfe616a3a
7.   https://owasp.org/www-project-application-security-verification-standard/
8.   https://resources.infosecinstitute.com/topic/application-architecture-review/
9.   https://owasp.org/www-community/controls/Static_Code_Analysis
10.   https://owasp.org/www-project-web-security-testing-guide/
11.   https://owasp.org/www-project-zap/
12.   https://owasp.org/www-project-dependency-check/
13.   https://www.synopsys.com/glossary/what-is-software-composition-analysis.html
14.   https://owasp.org/www-project-samm/
15.   https://github.com/tillson/git-hound
16.   https://owasp.org/www-project-security-qualitative-metrics/
17.   https://www.qualys.com/apps/web-app-scanning/
18.   https://www.veracode.com/security/interactive-application-security-testing-iast
19.   https://en.wikipedia.org/wiki/Runtime_application_self-protection
20.   https://en.wikipedia.org/wiki/ModSecurity

21.	https://github.com/WebGoat/WebGoat
22.	https://spectralops.io/resources/how-to-choose-a-secret-scanning-solution-to-protect-credentials-in-your-code/
23.	https://www.geeksforgeeks.org/functional-vs-non-functional-requirements/
24.	https://owaspsamm.org/model/design/threat-assessment/stream-a/
25.	https://docs.42crunch.com/latest/content/concepts/security_quality_gates.htm

	1,3,4	2,3,4						
7	1,3,4	2,3,4	1	Peer review Project status review		4	Basics of cloud computing Why is cloud computing necessary? Introduction to key cloud services (Compute, storage, networking) Cloud delivery models IaaS v/s PaaS v/s SaaS Introduction to cloud vendors(Azure,AWS, GCP) Key Cloud Security Principles Shared responsibility model Principle of least privilege Defense in depth Threat actors, diagrams & trust boundaries Practice : Create a cloud account Create 2 accounts Setup 2Factor Authentication on both account	3
	1,3,4	2,3,4	2	Cloud asset management	1		3	Identity & Access management in the cloud Introduction to IAM Introduction to Federal Identity Management IAM Best Practices	3

						IAM Audit Intro to AWS/Azure clint and Web Portal			
	3,4	2,3,4	3	Vulnerability management Discovering cloud misconfiguration Remediating vulnerabilities Tracking open vulnerabilities using cloud native tools	1	3	Network security Security groups VPC WAF	1	2
	3,4	2,3,4	4	Incident response - Log analysis - Events & alerts - Key metrics (MTTD & MTTR)	1	3	Data protection in the cloud • Data protection at rest and at transit • Cloud data storage - AWS EBS, S3 / Azure SAS • Secrets Management		3
			5	**CIE 3 – Written and Practice Test** **Secure a vulnerable cloud env**			Assessment Review and corrective action		3
	3,4	2,3,4	6	**Industrial class :** 1. **Preventing DDoS in a cloud native env** **Hybrid cloud env**	2	3	Weekly Assignment		
8	1,3,4,5	2,3,4	1	Peer review Project status review		4	Intro to VAPT Developing a Hacker Mindset • Ethics of Penetration Testing • Goal of Penetration Testing • Thinking like a Hacker • ATT&CK Framework Overview • Introduction to the framework • Deep dive into the key topics	1	2

						o Reconnaissance			
						o Initial Access			
						o Privilege Escalation			
						o Lateral Movement			
						o Exfiltration			

1,3,4,5	2,3,4	2	Web Application Penetration Testing
			• Basics of Web
			  o HTTP Methods
			  o HTTP Requests & Response
			  o Session management & Cookies
						4	Web Application Penetration Testing
							• Finding common web vulnerabilities (OWASP top 10)
							• Burp Suite Essentials
							Practical:Setup Burp Suite on local machine and observe traffic of 1 website..
									3

1,3,4,5	2,3,4	3	Cloud Penetration Testing • Finding common cloud vulnerabilities • Introduction to tools: Nessus, NMAP, Prowler			4	Introduction to OSINT: • Scanning the internet (example: Shodan) • Google dorking • Subdomain enumeration & asset monitoring		3
1,3,4,5	2,3,4	4	Hands-on exercise 1: Complete 3 server-side and 3 client-side topic from Burp Suite academy: https://portswigger.net/web-security/learning-path	1		3	Hands-on exercise 2: Complete either the attacker or defender track in http://flaws2.cloud	1	2
		5	**Developmental Assessment**				Assessment Review and corrective action		3
1,3,4,5	2,3,4	6	**Industrial class :** How penetration testing is used in companies to improve their Security posture				Weekly Assignment		

9	1,3, 4,5	2,3, 4	1	Peer review
				Project status review
						4	Mobile Application Security Testing
							  o Basics of Mobile Application
							  o Introduction to Android Mobile OS
							  o Understanding Android Security Architecture
							  o Introduction to iOS Mobile OS
							  o Understanding iOS Security Architecture
								1	2

	1,3, 4,5	2,3, 4, 7	2	Understanding Android Application security • Reversing Android Application Package • Analysing Android Application Certificates and Signatures • Verifying Android Application Signatures • Analysing the Android Manifest file	1	3	Setting up the environment: • Installing Android Studio • Installing Geny Motion Emulator (Free) • Creating Android Virtual Devices • Using Android Debug Bridge (ADB) to interact with the Android Virtual Devices (AVD) • Transferring files between Host machine and AVD using ADB • Installing Android Applications onto AVD via ADB	1	2
	1,3, 4,5	2,3, 4, 7	3	Setup the following tools onto your machine and reverse the application on the DIVA Android application. - Apktool		4	Mobile Application Security Testing • Introduction to Mobile OWASP Top 10 • Burp Suite/OWASP Zap for Mobile Applications	1	2

			- Dex2Jar - JDGUI					
1,3,4,5	2,3,4	4	Setting up for Android Application Security Testing Install DIVA Android Application (https://github.com/payatu/diva-android) ● Mobile Security Exploitation ● Exploiting Insecure Data Storage ● Exploiting Insecure Cryptographic Implementations ● Exploiting Data Leakage Vulnerabilities	1	3	Exercise: Setup MobSF locally on your system and scan any 5 Android Applications.	1	2
		5	**CIE 3 – Written and Practice Test**			Assessment Review and corrective action		3
1,3,4,5	2,3,4	6	**Industrial class :** Bug bounty hunting			Weekly Assignment		

References :
1. **Basics of Web: https://www.hacker101.com/sessions/web_in_depth.html**
2. **NMAP Basics: https://www.freecodecamp.org/news/what-is-nmap-and-how-to-use-it-a-tutorial-for-the-greatest-scanning-tool-of-all-time/**
3. **HTTP Proxy:**
    a. **Burp Suite Essentials: https://www.youtube.com/playlist?list=PLoX0sUafNGbH9bmbIANk3D50FNUmuJIF3**\
    b. **OWASP Zed Attack Proxy: https://www.zaproxy.org/getting-started/**
4. **Vulnerability Scanning with Nessus: https://www.tenable.com/blog/how-to-run-your-first-vulnerability-scan-with-nessus**

5. **How to think like a Hacker:** https://www.darkreading.com/vulnerabilities-threats/how-to-think-like-a-hacker

The Cuckoo's egg (book)

10	3,4	2,3, 4, 7	1	Peer review Project status review		4	Incident management introduction and objectives Stages and life cycle of incident management Tracking incidents Incident remediation Reporting and documentation Incident Closure Incident management teams and models Incident management services and integration tools - Best practices of Incident Management	1		2
	3,4	2,3, 4, 7	2	Fundamentals · CIA · Threat Actors · Different kinds of hackers · Different kinds of teams – Blue, Red, Purple · Criminal Groups · Hactivist Groups · APT · Attack Vectors · Protect/Prevent · Detect/Respond · Trust Positive vs False Positive Data · Bits and Bytes	1	3	Network · Quick revision of OSI model, encapsulation, IP, Subnets, TCP/UDP, well known ports, TCP/IP, Layer 2 Network Protocols · Quick revision of SMTP, HTTP, HTRPS/TLS, DNS Web technologies · Quick revision of DOM, CSS, Javascript, Ajax, MVC, Databases, SQL Authentical protocols	1		2

			· Charter Encoding (ASCII, UTF-8,Base64) · File Magic Bytes, Hashes · Imphash · Ssdeep Windows & Linux - · Quick revision on basic commands, important files and directories, windows registry and processes, Audit in Linux				· Quick revision of Kerberos, SAML, OpenID, OAuth			
3,4	2,3,4	3	Understanding the tools and products used in any organization · Firewall, load balancers, proxy, email infrastructure, IDS, DNS, Ani-virus, Content Delivery Solutions, Malware Protection System, Endpoint Detection and Response, Network Access Control, Placement of all devices in the organization – Tier1, Tier 2, Tier 3, DMZ	1	3	Continued..			3
3,4	2,3,4	4	SIEM · Understanding logs · Email, Proxy, DNS, IDS, Firewall, AV, EDR, Web application, Unix, Windows Attack Types/Vectors · Phishing, Malware, Distributed Denial of Service, Vulnerabilities (Infrastructure, Application, third party), Web attacks, Misconfigurations, Brute force	1	3	Basics of Incident Response · Alert processing · Procedures, runbooks and reference · Response options · Escalations · Incident categories · Incident Resolution Codes Data Analysis			3

			Attack Models · The cyber kill chain, MITRE ATT&CK Framework, Pyramid of Pain				· Data vs Intelligence · Indicators of compromise (IoCs) · Malware analysis · Accessing IoCs · Contacting threat intelligence Analysis tools · Anomaly · Domain tools · WhoIS · Passive DNS · Virus total · Dynamic File analysis			
		5	**Developmental Assessment**				Assessment Review and corrective action		3
	3,4	2,3, 4, 7	6	**Industrial class :** Handling Internal and external incidents Complexity of Incident management Demo of real world SOC			Weekly Assignment		

References :
1.   https://nvlpubs.nist.gov/nistpubs/specialpublications/nist.sp.800-61r2.pdf

2.   https://www.cisa.gov/uscert/bsi/articles/best-practices/incident-management
https://www.infotech.com/research/ss/develop-and-implement-a-security-incident-management-program

Lab : https://letsdefend.io

| 11 | 3,4,5 | 2,3,4 | 1 | Peer review
Project status review | | 4 | GRC
(a) 1) Definition of GRC, introduction to IT governance
(b) 2) Importance of GRC in cyber security
(c) 3) Policies, processes and procedures
(d) 4) Importance of checklists, templates and guidelines
Enterprise risk management
(a) Understanding risks that enterprises face – Operational Risks, Strategy Risks, Credit risks, Reputational risk, Market risks, Cyber risk
(b) Cyber risk integration with Operational risk management | 1 | | 2 |
| | 3,4,5 | 2,3,4, 7 | 2 | -   Introduction to basics of risk management Probability, Impact:-- [Financial, Legal, Regulatory, Reputational], Threat, Risk Assessment, Risk Treatment:-- [Accept, Mitigate, Transfer, Avoid], Residual risk, risk acceptance, Control objective, Controls:-- Preventive control, detective control and corrective control | 1 | | 3 | Patch management

Importance of patch management; pre-requisites and sample patch management process

Vulnerability Management

Vulnerability management lifecycle understanding – Identify, Evaluate, Remediate, Report | 1 | | 2 |

							Types of vulnerabilities – Hardware, Network, Operating systems, Application, Human and Process related vulnerabilities Vulnerability Management process		
3,4, 5	2,3, 4, 7	3	Practice Session: (a) Define one control statement each for access control, physical security and backup management (b) Explain one human vulnerability with example and how it can be exploited including remedial measures (c) Design IT asset register template with 5 sample rows populated with data Give examples for each category of classified information in an organization – do a combination of government organization and private organisation			4	ITIL Process overview – Incident Management, Problem Management, Change Management, Configuration Management, Release Management, Supplier Management, IT Security Management, Service level management, Capacity Management, Availability Management, Service continuity Management		3
		4	Security frameworks and Compliances			4	Cyber Security Governance:	1	2

				Introduction to standards/best practices/framework and its primary objective, ISO 27001, COBIT, PCI-DSS, Hi-Tech (HIPAA), NIST, IT Act 2000 (amendment in 2008), CERT-IN Guidelines. <u>Regulatory requirements</u> (a) RBI framework for banking (Cyber security framework, Gopalakrishna committee, UCB tiered framework) (b) SEBI framework for Securities market (c) Guidelines on Information and cyber security for insurers from IRDAI (d) TRAI requirements on security for telecom sector (e) GDPR				(a) Security organization, Responsibilities and authority, Management/Board responsibilities on cyber security, Resource allocation and cyber security budget management, Security Education, training and awareness, Cyber metrics, KRI/KPIs			
			5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action	3	

| 3,4 | 2,3, 4,7 | 6 | **Industrial class :**

1. An industry perspective of GRC, VM and Security frameworks

Demo of a GRC tool | | | Weekly Assignment (Suggestive Student Activities)

(a) Identify use case of how changes or configuration in IT systems impacts security configuration resulting in cyber risk exposure

(b) Design a sample cyber security dashboard for reporting to top management

(c) Give two KRI examples each for the following domains:

    a. Patch Management
    b. Anti-virus management
c. Change Management | | | |

References :

1) https://www.armosec.io/blog/kubernetes-security-frameworks-and-guidance - Security Frameworks table

2) https://www.cybersaint.io/blog/what-is-grc

3) https://www.ibm.com/cloud/learn/grc

4) https://unece.org/fileadmin/DAM/trade/Publications/WP6_ECE_TRADE_390.pdf

5) https://www.pcisecuritystandards.org/documents/PCI_DSS-QRG-v3_2_1.pdf

6) https://www.nist.gov/

7) https://www.isaca.org/resources/cobit

8) https://www.meity.gov.in/writereaddata/files/itact2000/it_amendment_act2008.pdf

9) https://www.coso.org/SitePages/Guidance-on-Enterprise-Risk-Management.aspx?web=1

10) https://rbidocs.rbi.org.in/rdocs/notification/PDFs/NT41893F697BC1D57443BB76AFC7AB56272EB.PDF

11) https://rbidocs.rbi.org.in/rdocs/notification/PDFs/LBS300411F.pdf

1) https://rbidocs.rbi.org.in/rdocs/notification/PDFs/NOTI129BB26DEA3F5C54198BF24774E1222E61A.PDF

14)   https://www.sebi.gov.in/legal/circulars/dec-2018/cyber-security-and-cyber-resilience-framework-for-stock-brokers-depository-participants_41215.html

15) https://www.sebi.gov.in/sebiweb/home/HomeAction.do?doListing=yes&sid=1&ssid=6&smid=0

16) https://www.aicofindia.com/AICEng/General_Documents/Notices%20And%20Tenders/IRDAI-GUIDELINES.pdf

17) https://www.irdai.gov.in/ADMINCMS/cms/whatsNew_Layout.aspx?page=PageNo4315&flag=1

18) https://www.rapid7.com/fundamentals/patch-management/

19) https://www.rapid7.com/fundamentals/vulnerability-management-and-scanning/

1)18. https://www.techtarget.com/searchsecurity/tip/IT-security-frameworks-and-standards-Choosing-the-right-one

21)https://www.irdai.gov.in/ADMINCMS/cms/Uploadedfiles/07.04.2017-
Guidelines%20on%20Information%20and%20Cyber%20Security%20for%20insurers.pdf

https://www.trai.gov.in/sites/default/files/RecommendationDataPrivacy16072018_0.pdf

12	3,4,5	2,3,4	1	Peer review Project status review		4		DevOps and Security Challenges Understand the Core Principles and Patterns behind DevOps Recognize how DevOps works and identify keys to success	1		2
	3,4,5	2,3,4	2	Secure DevOps tools and workflows Conduct effective risk assessments and threat modeling in a rapidly changing environment Design and write automated security tests and checks in CI/CD Understand the strengths and weaknesses of different automated testing approaches in Continuous Delivery Inventory and patch your software dependencies Wire security scanning into Jenkins, Code Pipeline, and Azure DevOps workflows	1	3		Pre-Commit Security Controls Rapid Risk Assessment Git Hook Security Code Editor Extensions Branch Protections CodeOwners Peer Reviews Commit Security Controls Static Analysis Security Testing Component Analysis	1		2
	3,4,5	2,3,4	3	Secrets Management Managing secrets in CI / CD			4	Cloud Infrastructure as Code			3

									2
			Azure Key Vault AWS SSM Parameter Store AWS Secrets Manager HashiCorp Vault				Introduction to Cloud Infrastructure as Code AWS Cloud Formation Terraform Deploying Cloud Infrastructure as Code security analysis		
3,4,5	2,3,4	4	Configuration Management as Code Automating Configuration Management in CI / CD Using Ansible to Configure Virtual Machines Building Gold Images with Vagrant and Packer Certifying Gold Images with InSpec	1	3	Container Security Dockerfile and BuildKit Security Base Image Hardening with Hadolint and Conftest Container Image Security Scanning Container Images with Docker Scan and Trivy Container Registry Security Container Scanning with AWS ECR and Azure ACR Container Runtime Security Exercises Attacking the DevOps Toolchain Version Control Security Automating Static Analysis Protecting Secrets with Vault Infrastructure as Code Network Hardening Gold Image Creation Container Security Hardening	1	

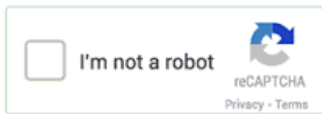|			5	**Developmental Assessment**				Assessment Review and corrective action			
			6	Industry Class :	2		3				
13			1	Internship a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship. b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies. Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internship.				Project a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective. b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified. Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.			

**Note: Saturday session from 9 AM -2 PM

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		3	**60**
SEE 2 – Practical		3	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

* The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE

Note : Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	Computer Science & Engineering	Semester		V
Course	Cyber Security	Max Marks		30
Course Code	20CS54I	Duration		4 hours
Name of the course coordinator				
Note: Answer one full question from each section.				

Qn.No	Question	CL L3/L4	CO	PO	Marks
	Section-1 (Theory) – 10 marks				
1.a)	Why do see this kind of "Captcha" in web applications ? What difference does it make to any web based application ?	L4	1		6
b)	Your creating new password for your online banking, how will you strengthen your password elaborate ?	L4	1		4
2.a)	Let p = 191 and q = 2. Alice picks x = 42 and B picks y = 33. Compute the shared secret between Alice and Bob using Diffie-Hellman key exchange protocol.	L4	1		5
b)	Given an implementation of RSA algorithm that uses primes p = 5 and q = 11, if the encryption key is 27, what is the decryption key?	L4	1		5
	Section-2 (Practical) - 20 marks				
3).a	You've just been issued with a new laptop at your organization and are getting ready to set it up. What steps would you take to secure it before use?	L4	1		10

Scheme of evaluation

Sl. No	Description	Marks
1	Setting up password	5
2	Installing antivirus and fire wall	10
3	Firewall Windows/Linux settings	5
Total		20

b — Design a simple crypto system (including key generation, encryption, decryption, digital signature or hash function) using any tool

Scheme of evaluation

Sl. No	Description	Marks
1	Designing crypto system	5
2	Key generation	5
3	Encryption/Decryption	5
4	digital signature or hash function	5
Total		20

Note : Theory questions shall be aligned to practical questions

Assessment framework for SEE (Theory) – 100 Marks / 3 hours (Reduced to 60 marks)

Programme: Computer Science & Engineering Course: Cyber Security Course Code: 20CS54I		Semester: V Max Marks: 100 Duration: 3 Hrs		
Instruction to the Candidate: Answer one full question from each section.				
Qn.No	**Question**	**CL**	**CO**	**Marks**
	Section-1			
1.a)	Which is the security protocol applied at layer 3 of the OSI stack? What are its benefits	L3/L4	1	10
b)	What is the need of defence in depth for a network ?	L3/L4		10
2.a)	How do you apply Microsoft Secure SDLC in each stage of software development ?	L3/L4		12
b)	Your creating new password for your online banking, how will you strengthen your password elaborate ?	L3/L4		8
	Section-2			
3.a)	Let p = 191 and q = 2. Alice picks x = 42 and B picks y = 33. Compute the shared secret between Alice and Bob using Diffie-Hellman key exchange protocol.	L3/L4	2	14
b)	Find Euler totient function: $\varphi(255), \varphi(256)$	L3/L4		6
4.a)	Given an implementation of RSA algorithm that uses primes p = 5 and q = 11, if the encryption key is 27, what is the decryption key?	L3/L4		12
b)	What is the final digit and two final digits of 3^{10000}?	L3/L4		8
	Section- 3			
5.a)	Describe Stages and life cycle of incident management	L3/L4	3	12
b)	What is the need of Dynamic File analysis ?	L3/L4		8
6.a)	Create a Threat Model for a social media Web Application at Design Time	L3/L4		10

			L3/L4		10
b)	Describe shared responsibility model in cloud		L3/L4		10
Section-4					
7.a)	How do you find vulnerability in your cloud based web application ? what are the common vulnerabilities ?		L4	4	12
b)	Illustrate setting up multi factor authentication on any public cloud system		L3		8
8.a)	Highlight deprecated unsafe functions in common programming languages		L4		10
b)	What is the need of static code analysis, Static Code Analysis Tools – Explain with examples		L4		10
Section-5					
9.a)	Illustrate lifecycles of security incident management		L3	5	8
b)	Design a sample cyber security dashboard for reporting to top management		L4		12
10.a)	Identify use case of how changes or configuration in IT systems impacts security configuration resulting in cyber risk exposure		L4		12
b)	Give two KRI examples each for the following domains: a. Patch Management b. Anti-virus management		L4		8

Assessment framework for SEE 2 (Practice)

Problem Statement : Conduct Penetration testing on any web site/web application and report the vulnerabilities	
Scheme of Evaluation	
1) Installing ZAP	20
2) Running an automated scan	20

3) Exploring the application manually
    1.   Explore pages protected by login
    2.   Exploring web application over a defined sequence
	30

4) Prepare a vulnerability report	20

5) Viva-voce (about the attack on discovered vulnerability and possible solutions)	10
Total	100

Note: Examiner to prepare/identify the web site/application to be tested and the vulnerabilities present in the web site/web application before exam

Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
12.	Computers	Intel i5, 4GB RAM, 500GB SSD	20
13.	Cloud – AWS/AZURE/GCP or any similar public cloud environment		20
14.	Broadband connection	Atleast 50MBPS	1