

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

WORK INTEGRATED LEARNING PROGRAMMES

COURSE HANDOUT

Part A: Content Design

| | |
|----------------------|--|
| Course Title | Cloud Computing |
| Course No(s) | CSI ZG527 / SS ZG527 / SE ZG527 |
| Credit Units | 5 1-2-2, (total 5 units or credits) ie 1 unit for class room hours, 2 unit for lab hours, 2 units for student preparation. Typically 1 unit translates to 32 hours |
| Course Author | Chandra Shekar RK / Nayan Khare |
| Version No | 1.5 |
| Date | 03/02/2020 |

Course Objectives

| No | Objective |
|------------|---|
| CO1 | Students will learn the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges; |
| CO2 | Students will learn the basic ideas and principles in data centre design and management |
| CO3 | Students will learn about cloud components and technologies and relevant distributed file systems |
| CO4 | Students will learn a variety of programming models and develop working experience |

Text Book(s)

| | |
|----|--|
| T1 | Dinkar Sitaram and Geetha Manjunath. Moving to the Cloud. Syngress (Elsevier) Pub, 2011 |
| T2 | Rajkumar Buyya, James Broburg & Anderzej M.G, Cloud Computing – Principles and Paradigms. John Wiley Pub, 2011 |

Reference Book(s) & other resources

| | |
|----|--|
| R1 | Cloud Computing bible by Barrie Sosinsky, Wiley Publishers, 2010 |
| R2 | Virtualization A Beginner's guide, Danielle Ruest, Nelson Ruest, TMH, 2009 |
| R3 | Cloud Computing bible by Barrie Sosinsky, Wiley Publishers, 2010 |
| R4 | Cloud security, a comprehensive guide to secure cloud computing, by Ronald L.Krutz et al, Wiley Publishers, 2010 |

Modular Content Structure

1. Introduction to Cloud Computing

- 1.1. Cloud Computing, services, deployment models
- 1.2. Introduction to Cloud Computing
- 1.3. Origins and Motivation
- 1.4. Types of Clouds and Services
- 1.5. Cloud Infrastructure and Deployment

2. Virtualization Techniques and Types

- 2.1. Introduction to Virtualization
- 2.2. Use & demerits of Virtualization
- 2.3. Types of Virtualization
- 2.4. x86 Hardware Virtualization
- 2.5. Manage the resources for the SaaS, PaaS and IaaS models
- 2.6. *Introduction to NFV – VNF*

3. Infrastructure as a Service

- 3.1. Introduction to IaaS
- 3.2. IaaS examples
- 3.3. Reference Model of AWS
- 3.4. Amazon cloud services - Compute, Database, Storage
- 3.5. Region Vs Availability zones
- 3.6. Case Study - Openstack
- 3.7. Managing Virtual Resources on the Cloud: Provisioning and Migration
 - 3.7.1. Virtual Machine Provisioning and Manageability
 - 3.7.2. VM Provisioning Process
 - 3.7.3. Virtual Machine Migration Services
 - 3.7.4. Migrations Techniques
 - 3.7.5. VM Provisioning and Migration in action

4. Containers (New)

- 4.1. Linux Containers - LXC and LXD
- 4.2. Dockers - Elements, Images, Files, Containers
- 4.3. Cloud and *Container* orchestration technologies

5. Platform as a Service and SaaS

- 5.1. Introduction to PaaS
- 5.2. PaaS examples
- 5.3. Windows Azure
- 5.4. 5 Principles of UI Design - AWS PaaS
- 5.5. Introduction to SaaS
- 5.6. Pros and Cons of SaaS model and applications

6. Capacity management and Scheduling in cloud computing

- 6.1. Capacity management and Scheduling
- 6.2. Distributed management of virtual machines
- 6.3. Reservation-based provisioning of virtualized resource
- 6.4. Provisioning to meet SLA commitments
- 6.5. Stages of VM life cycle within OpenNebula
- 6.6. Network model for OpenNebula

7. Issues and Challenges : Availability, Multi-Tenancy, Security and SLA

- 7.1. Multi-Tenancy, 4 levels of multi tenancy
- 7.2. Multi-tenant models for cloud
- 7.3. Introduction to cloud security
- 7.4. Cloud security Issues
- 7.5. Threat Model
- 7.6. Top 5 cloud security threats
- 7.7. who is responsible for managing security
- 7.8. Service License Agreements: Lifecycle and Management
- 7.9. Traditional approaches to SLO management
- 7.10. SLA Management in Cloud
- 7.11. Automated Policy based management
- 7.12. Managing Clouds: Services and Infrastructure

8. Distributed File System (DFS) and Hadoop

- 8.1. Introduction to Distributed File System (DFS)
- 8.2. Case Study HDFS
- 8.3. Hadoop components and importance of MapReduce
- 8.4. Setting started - Amazon EMR
- 8.5. Amazon EMR - Plan and Configure clusters (# only for CSI)
- 8.6. AMazon EMC - Manage Clusters (# only for CSI)
- 8.7. Understanding MapReduce (* Not for CSI)
- 8.8. Explore word count Java program (* Not for CSI)
- 8.9. MapReduce Facts (* Not for CSI)

Learning Outcomes:

| No | Learning Outcomes |
|-----|--|
| LO1 | Explain the core concepts of the cloud computing paradigm: how and why this paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing |
| LO2 | Apply the fundamental concepts in data-centres to understand the tradeoffs in power, efficiency and cost |
| LO3 | Discuss system virtualization and outline its role in enabling the cloud computing system model. |
| LO4 | Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS |
| LO5 | Analyze various cloud programming models and apply them to solve problems on the cloud |

Note to Faculty:

Some modules or topics are specific only to certain programmes. The faculty is instructed to choose the relevant topics/modules depending on the programme in which this course is being offered. Same needs to be reflected in the contact session plan.

Specific to MTech, CSI (Computing Systems & Infrastructure)

*** Specific to MTech (SW Systems) and MTech (SW Engg)**

Part B: Contact Session Plan

| | |
|------------------------|---------------------------------|
| Academic Term | First Semester 2020-2021 |
| Course Title | Cloud Computing |
| Course No | CSI ZG527 / SS ZG527 / SE ZG527 |
| Lead Instructor | D.V.N.SIVA KUMAR |

Glossary of Terms

1. Contact Hour (CH) stands for a hour long live session with students conducted either in a physical classroom or enabled through technology. In this model of instruction, instructor led sessions will be for 22 CH.
 - a. Pre CH = Self Learning done prior to a given contact hour
 - b. During CH = Content to be discussed during the contact hour by the course instructor
 - c. Post CH = Self Learning done post the contact hour
2. Contact Hour (CS) stands for a two-hour long live session with students conducted either in a physical classroom or enabled through technology. In this model of instruction, instructor led sessions will be for 11 CS.
 - a. Pre CS = Self Learning done prior to a given contact session
 - b. During CS = Content to be discussed during the contact session by the course instructor
 - c. Post CS = Self Learning done post the contact session
3. RL stands for Recorded Lecture or Recorded Lesson. It is presented to the student through an online portal. A given RL unfolds as a sequences of video segments interleaved with exercises
4. SS stands for Self-Study to be done as a study of relevant sections from textbooks and reference books. It could also include study of external resources.
5. LE stands for Lab Exercises
6. HW stands for Home Work.
7. M stands for module. Module is a standalone quantum of designed content. A typical course is delivered using a string of modules. M2 means module 2.

Teaching Methodology (Flipped Learning Model)

The pedagogy for this course is centered around flipped learning model in which the traditional class-room instruction is replaced with recorded lectures to be watched at home as per the student's convenience and the erstwhile home-working or tutorials become the focus of classroom contact sessions. Students are expected to finish the home works on time.

Contact Session Plan

- Each Module (M#) covers an independent topic and module may encompass more than one Recorded Lecture (RL).
- Contact Sessions (2hrs each week) are scheduled alternate weeks after the student watches all Recorded Lectures (RLs) of the specified Modules (listed below) during the previous week
- In the flipped learning model, Contact Sessions are meant for in-classroom discussions on cases, tutorials/exercises or responding to student's questions/clarification--- may encompass more than one Module/RLs/CS topic.
- Contact Session topics listed in course structure (numbered CSx.y) may cover several RLs; and as

per the pace of instructor/students' learning, the instructor may take up more than one CS topic during each of the below sessions.

Detailed Structure

Introductory Video/Document: << *Introducing the faculty, overview of the course, structure and organization of topics, guidance for navigating the content, and expectations from students*>>

- Each of the sub-modules of **Recorded Lectures** (RLx.y) shall delivered via **30 – 60mins videos** followed by:
- **Contact session** (CSx.y) of 2Hr each for illustrating the concepts discussed in the videos with exercises, tutorials and discussion on case-problems (wherever appropriate); contact sessions (CS) may cover more than one recorded-lecture (RL) videos.

Course Contents

| Contact Session 1 | | | | |
|--|--------|--|--|---------------------------------|
| M1: Introduction to Cloud Computing | | | | |
| Time | Type | | Description | Text/Ref Book/external resource |
| Pre -CS | RL1.1 | Cloud Computing, services, deployment models | Motivation Evolution of Web Technology Advances What is Cloud Computing? Drivers for the new Platform Cloud Summary | T1: Ch1 T2: Ch1 |
| | RL1.2 | 3-4-5 Rule of CC | Cloud Computing: Definition 3-4-5 rule of Cloud Computing 5-Characteristics of Cloud Computing 4-Deployment Models | |
| | RL1.3 | 3-4-5 Rule of CC Cloud Providers | 3 Cloud Service Models Software as a Service (SaaS) Platform as a Service Infrastructure as a Service Cloud Infrastructures Cloud Providers Characteristics Management of Virtualized Resources Cloud OS | |
| During CS | CS1.1 | Cloud Computing, services | Introduction to Cloud Computing Origins and Motivation | T1: Ch1 T2: Ch1 |
| | CS 1.2 | Deployment models | Types of Clouds and Services Cloud Infrastructure and Deployment | |
| Post CS | LE1.1 | | | |

| | SS1.1 | | Merits and Demerits of CC | |
|--|--------|--|---|---------------------------------|
| | HW1.1 | | Make a list of Public, Private, Hybrid clouds available in the IT space | |
| | QZ1.1 | | | |
| Lab Reference | | | | |
| Contact Session 2 M2: Virtualization Techniques and Types Dockers | | | | |
| Time | Type | | Description | Text/Ref Book/external resource |
| Pre CS | RL2.1 | Virtualization | Importance of Virtualization in Cloud Computing What is Virtualization What does Virtualization do? Changes after Virtualization Virtualization Architecture | T1: Ch9 |
| | RL2.2 | Hypervisor | Hypervisor Hypervisor Design Goals How Hypervisor goals are achieved? Monolithic versus Microkernelized CPU Sharing Memory Sharing IO Sharing | |
| | RL2.3 | Types of Virtualization | Approaches for Virtualization Full Virtualization ParaVirtualization SKI Virtualization x86 Hardware Virtualization Advantages of Virtualization Issues to be aware of Virtualization Applications of Virtualization | |
| | RL_2_5 | Lab Demo | Check Virtualization Support | |
| | RL_2_6 | Lab Demo | Oracle Virtual Box | |
| | RL_2_7 | Lab Demo | Hyper-V | |
| | | | | |
| During CS | CS2.1 | Virtualization Types | Types of Virtualization Advantages of Virtualization Issues to be aware of Virtualization | T1: Ch9 |
| | CS2.2 | Managing Virtual Resources on the Cloud Introduction to NFV-VNF | Manage the resources for the SaaS, PaaS and IaaS models Dockers | |

| Post CS | LE2.1 | | Go through RL 2.5, 2.6, 2.7 and solve exercise in Lab sheet 1 | |
|---|--------|------------------------------|--|--|
| | SS2.1 | | Study: KVM, Xen, Hyper-V, VirtualBox | |
| | HW2.1 | | Exercise on Docker Container | |
| | QZ2.1 | | | |
| Lab Reference | | | | |
| Contact Session 3, 4 M3: Infrastructure as a Service Managing Virtual Resources on the Cloud | | | | |
| Time | Type | | Description | Text/Ref Book/external resource |
| Pre CS | RL3.1 | IaaS | Key concepts of IaaS Two primary facets that make IaaS special The value of IaaS | T1: Ch2 |
| | RL3.2 | AWS | Amazon Web Services AWS infrastructure services Amazon Elastic Compute Cloud (Amazon EC2) Infrastructure Services | |
| | RL3.3 | Openstack - CaseStudy | Openstack overview Openstack Components Nova, Swift, Horizon, Keystone, Cinder, Neutron, Glance Conceptual Architecture | http://www.slashroot.in/openstack-tutorial-getting-started-basics-building-your-own-cloud http://docs.openstack.org/ |
| | RL3.4 | Virtual Machine Provisioning | Virtual Machine Provisioning and Manageability Life Cycle VM Provisioning Process VM Provisioning using templates Examples - Vagrant, Heat(Orchestration Tool of openstack) | T2: Ch5 |
| | RL3.5 | Virtual Machine Migration | Virtual Machine Migration Services Cold/regular migration Live Migration Technique Live Migration Demo | |
| | RL3.6 | Lab Demo | AWS-InstanceCreation | |
| | RL3.7 | Lab Demo | AWS-S3-ObjStorage | |
| | RL3.8 | Lab Demo | OS-Openstack-Install-Setup | |
| | RL3.9 | Lab Demo | OS-InstanceCreation | |
| | RL3.10 | Lab Demo | OS-InstanceCreateWithVol | |

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|---|---------|-------------------------------------|--|---|
| | RL3.11 | Lab Demo | OS-Swift-ObjStorage | |
| | RL3.12 | Lab Demo | OS-LoadBalancer-Manual | |
| | RL3.13 | Lab Demo | OS-InstanceCreate-Heat-Provision | |
| | RL 3.14 | Lab Demo | OS-LoadBalancer-Heat-Provision | |
| | RL3.15 | Lab Demo | Vagrant-Provision-WebServer | |
| | RL3.16 | Lab Demo | Part1-Proxmox-Cluster-Provision-Migration | |
| | RL3.17 | Lab Demo | Part2-Proxmox-Cluster-Provision-Migration | |
| During CS | CS 3.1 | Infrastructure as a Service | Introduction to IaaS IaaS examples Reference Model of AWS Region Vs Availability zones | T1: Ch2 |
| | CS 3.2 | AWS - Storage and Database Services | Amazon S3, Amazon Glacier, Amazon EBS, AWS Import/Export Amazon RDS, Amazon DynamoDB, Amazon AWS Demo Amazon Cloud Services - CloudFront, Elastic Load Balancer, Elastic Block Storage | T1: Ch2 |
| | CS 3.3 | Openstack | Openstack overview and Components | http://docs.openstack.org/ |
| | CS 3.4 | VM Provisioning and Migration | Virtual Machine Provisioning Process VM Provisioning using templates, Examples - Vagrant VM Migrations Techniques | T2: Ch5 |
| Post CS | LE3.1 | | Install Openstack and carry out exercise on RL 3.9-3.17 | |
| | SS3.1 | | RL 3.6 - 3.17, Try using Openstack - http://trystack.org/ | |
| | HW3.1 | | Compare Openstack vs AWS (Similarities and Differences) | |
| | QZ3.1 | | | |
| Lab Reference | | | | |
| Contact Session 5 M4: Containers | | | | |
| Time | Type | | Description | Text/Ref Book/external resource |

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|---|-------|-----------------------------------|---|--|
| Pre CS | RL4.1 | SW Virtualization | Dockers How are Docker Containers different from a Virtual Machine? Docker Container Lifecycle Dockerfile | https://docs.docker.com/get-started/ more focus on 1: Orientation 2: Containers 3. Services |
| During CS | CS4.1 | Containers | Linux Containers - LXC and LXN | https://linuxcontainers.org/lxc/introduction/ https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux_atomic_host/7/html/overview_of_containers_in_red_hat_systems/introduction_to_linux_containers |
| | CS4.2 | Cloud and Container orchestration | Cloud orchestration technologies | https://www.ibm.com/developerworks/cloud/library/cloud-orchestration-technologies-trs/index.html https://www.digitalocean.com/community/tutorials/an-introduction-to-kubernetes |
| Post CS | LE4.1 | | | |
| | SS4.1 | | | |
| | HW4.1 | | | |
| | QZ4.1 | | | |
| Lab Reference | | | | |
| Contact Session 6: Review | | | | |
| Contact Session 7 M5: Platform as a Service and SaaS | | | | |
| Time | Type | | Description | Text/Ref Book/external resource |
| Pre CH | RL5.1 | | Dependency on IaaS and PaaS Introduction to PaaS Building blocks of PaaS Characteristics of PAAS Advantages and Risks | T1: Ch3 |
| | RL5.2 | | Paas Example: Windows Azure Windows Azure Runtime Environment Paas Vendors | |
| | RL5.3 | Introduction to SaaS | Dependency on IaaS and PaaS What is SaaS? Problems in traditional Model | |

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| | | | SaaS – How is it delivered | |
| | RL5.4 | SaaS – Architecture | SaaS – Architecture SaaS Models Business Model comparisons | T1: Ch4 |
| | RL5.5 | SaaS Advantages | SaaS Advantages SaaS User and Vendor Benefits (CS) SaaS - Applicability | |
| | RL5.6 | Lab Demo | Get Azure Account | |
| | RL5.7 | Lab Demo | Running Azure app locally | |
| | RL5.8 | Lab Demo | Deploying the local app to Azure | |
| | RL5.9 | Lab Demo | Determine which instance gets serves the request | |
| During CH | CS5.1 | Intro to PaaS | Introduction to PaaS PaaS examples 5 Principles of UI Design - AWS PaaS | T1: Ch3 |
| | CS5.2 | SaaS | Introduction to SaaS Pros and Cons of SaaS model | T1: Ch4 |
| Post CH | LE5.1 | | Try exercise on SS 5.1 | |
| | SS5.1 | | RL 5.5, 5.6 | |
| | HW5.1 | | | |
| | QZ5.1 | | | |
| Lab Reference | | | | |
| Contact Session 8 | | | | |
| M6: Capacity management and Scheduling in cloud computing | | | | |
| Time | Type | | Description | Text/Ref Book/external resource |
| Pre CH | RL 6.1 | Capacity Management and Scheduling | Managing Cloud - Introduction | T2: Ch6 |
| | RL 6.2 | VIM | Why a Virtual Infrastructure Manager? Extending the Benefits of Virtualization to Clusters Virtual Machine Management Model | T2: Ch6 |
| | RL 6.3 | OpenNebula | What is OpenNebula? The Benefits of OpenNebula Interoperability from the Cloud Provider perspective The Benefits for System Integrators (CS) The main features of OpenNebula Comparison with Other | |

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| | | | technologies (CS) | |
| | RL 6.4 | OpenNebula | OpenNebula Architecture Process separation Constructing/Management of a private cloud System Overview Complex Storage behind OpenNebula Networking for private clouds Users Management(CS) Preparing VMs for OpenNebula VM Description VM States overview Hybrid cloud Making an Amazon EC2 hybrid | |
| During CH | CS 6.1 | Capacity Management | Capacity management Distributed management of virtual machines | T2: Ch6 |
| | CS 6.2 | Scheduling | Reservation-based provisioning of virtualized resource Provisioning to meet SLA commitments | |
| Post CH | LE 6.1 | | | |
| | SS 6.1 | | Documentation of OpenNebula | |
| | HW 6.1 | | Install OpenNebula, Create instances and cluster | |
| | QZ 6.1 | | | |
| Lab Reference | | | | |
| Contact Session 9 M7: Issues and Challenges : Availability, Multi-Tenancy, Security and SLA | | | | |
| Time | Type | | Description | Text/Ref Book/external resource |
| Pre CH | RL 7.1 | Availability | High Availability Key aspects of SLA | T1: Ch6 |
| | RL 7.2 | Multi-Tenancy | Multitenancy – What is it? Pros and Cons Traditional Deployment Model Multitenancy – Introduction Multi-tenants Deployment Modes for Application Server Multi-tenants Deployment Modes in Data Centers | T1: Ch6 |
| | RL 7.3 | Security | Introduction to cloud security | T1: Ch 7 |

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| | | | Cloud Security Issues Loss of Control in the Cloud Multi-tenancy Issues in the Cloud Taxonomy of Fear Threat Model | T2: Ch 23 |
| During CH | CS 7.1 | Multi-Tenancy | Multi-Tenancy 4 levels of multi tenancy Top 5 cloud security threats | T1: Ch6 |
| | CS 7.2 | Security and SLA | who is responsible for managing security Service License Agreements: Lifecycle and Management Traditional approaches to SLO management Automated Policy based management Managing Clouds: Services and Infrastructure | T1: Ch6 T1: Ch 7 T1: Ch8 T2: Ch 23 T2: Ch16 |
| Post CH | LE 7.1 | | | |
| | SS 7.1 | | Study - NimSoft, Netchart | |
| | HW 7.1 | | | |
| | QZ 7.1 | | | |
| Lab Reference | | | | |
| Contact Session 10 M8: Distributed File System (DFS) and Hadoop | | | | |
| Time | Type | | Description | Text/Ref Book/external resource |
| Pre CH | RL 8.1 | Hadoop | Why Hadoop? Introduction to BIG DATA Hadoop Features Hadoop Framework Tools | https://hadoop.apache.org/docs/r1.2.1/hdfs_design.html |
| | RL 8.2 | Hadoop | Hadoop common Component MapReduce (Data Processing Framework) MapReduce Processing flow Architecture Overview Distributed Word Count Word Count Execution MarketRatings example and Program demo MapReduce Execution Details Fault Tolerance in MapReduce Challenges of Cloud Environment | |
| | RL 8.3 | Lab Demo | HadoopMapReduce-MarketRating | |
| | RL 8.4 | Lab Demo | WordCountingwithApacheP | |
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| During CH | CS 8.1 | DFS | Introduction to Distributed File System Case Study HDFS Setting started - Amazon EMR | https://hadoop.apache.org/docs/r1.2.1/hdfs_design.html |
| | CS 8.2 | Hadoop | Hadoop components and importance of MapReduce MapReduce Facts Amazon EMR - Plan and Configure clusters (# only for CSI) AMazon EMC - Manage Clusters (# only for CSI) | http://docs.aws.amazon.com/emr/latest/ManagementGuide/emr-what-is-emr.html |
| Post CH | LE 8.1 | | Install Hadoop and Carry out exercise on Word count and Market ratings | |
| | SS 8.1 | | Study - Hive, PIG, HBase of Hadoop | |
| | HW 8.1 | | | |
| | QZ 8.1 | | | |
| Lab Reference | | | | |

Contact Session 11: Review

Lab Details

| Lab No | Lab Objective | Lab Sheet/Capsule Access URL | Content Reference |
|--------|--|------------------------------|-------------------|
| 1 | <ul style="list-style-type: none"> Software(s) or Tool(s) required: Virtual Box, KVM on Ubuntu, Hyper V, Openstack, AWS, Salesforce, Proxmox or ConVirt, Hadoop Horton Sandbox System Requirements: Any System with Processor better or equal to i3 intel. Min 4GB RAM (Recommended 8GB or more) Download url: <ul style="list-style-type: none"> https://www.virtualbox.org/wiki/Downloads www.devstack.org https://aws.amazon.com/console/ https://www.proxmox.com/en/proxmox-ve https://www.convirture.com/products_opensource.php http://hortonworks.com/products/hortonworks-sandbox/ Mode of working (GUI based- Stand alone installer/ Client Server / Console based/ Browser based): All types Open source/ Freeware/ Proprietary: Opensource/Freeware Objective behind Labwork in this course: Understand and have hands on knowledge on technologies related to | | |

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|--|-----------------|--|--|
| | Cloud computing | | |
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Evaluation Scheme

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

| No | Name | Type | Duration | Weight | Day, Date, Session, Time |
|------|--|-----------------|----------|--------|--|
| EC-1 | Quizzes / Assignments/ Paper Presentation | To be announced | | 15% | September 10-20, 2020 |
| EC-2 | Mid-Semester Test | Closed Book | 2 hours | 35% | Sunday, 11/10/2020 (AN) 2 PM – 4 PM |
| EC-3 | Comprehensive Exam | Open Book | 3 hours | 50% | Sunday, 29/11/2020 (AN) 2 PM – 5 PM |

Note - Evaluation components can be tailored depending on the proposed model.

Important Information

Syllabus for Mid-Semester Test (Closed Book): Topics in Weeks 1-7

Syllabus for Comprehensive Exam (Open Book): All topics given in plan of study

Evaluation Guidelines:

1. EC-1 consists of either two Assignments or three Quizzes. Announcements regarding the same will be made in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
3. For Open Book exams: Use of prescribed and reference text books, in original (not photocopies) is permitted. Class notes/slides as reference material in filed or bound form is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam. The genuineness of the reason for absence in the Regular Exam shall be assessed prior to giving permission to appear for the Make-up Exam. Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.

Appendix

Course Plan

| Contact hour | Pre-contact hour prep | During Contact hour | Post-contact hour |
|--------------|-----------------------|---------------------|--------------------------|
| 1 | RL 1.1 | CS 1.1 | SS 1.1 |
| 2 | RL 1.2, 1.3 | CS 1.2 | HW 1.1 |
| 3 | RL 2.1, 2.2 | CS 2.1 | SS 2.1, RL 2.5, 2.6, 2.7 |
| 4 | RL 2.3 | CS 2.2 | HW 2.1, LE 2.1 |
| 5 | RL 3.1, RL 3.2 | CS 3.1 | RL 3.8, SS 3.1 |
| 6 | RL 3.3 | CS 3.2 | RL 3.6, 3.7 |
| 7 | RL 3.4 | CS 3.3 | RL 3.9 - 3.15 |
| 8 | RL 3.5 | CS 3.4 | RL 3.16 , 3.17 LE 3.1 |
| 9 | RL 4.1 | CS 4.1 | SS 4.1 |
| 10 | | CS 4.2 | LE 4.1 |
| 11 | | Review | |
| 12 | | Review | |
| 13 | RL 5.1, 5.2 | CS 5.1 | SS 5.1 |
| 14 | RL 5.3, 5.4, 5.5 | CS 5.2 | RL 5.6 - RL 5.9, LE 5.1 |
| 15 | RL 6.1, 6.2 | CS 6.1 | SS 6.1 |
| 16 | RL 6.3, 6.4 | CS 6.2 | HW 6.1 |
| 17 | RL 7.1, 7.2 | CS 7.1 | |
| 18 | RL 7.3 | CS 7.2 | SS 7.1 |
| 19 | RL 8.1 | CS 8.1 | SS 8.1 |
| 20 | RL 8.2 | CS 8.2 | RL 8.3, 8.4, LE 8.1 |
| 21 | | Review | |
| 22 | | Review | |