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	Second 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	Manage the resources for the SaaS, PaaS and IaaS models Dockers	

		NFV-VNF		
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	
	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
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 LXD	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/cl-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 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 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	T1: Ch6

			Server Multi-tenants Deployment Modes in Data Centers	
	RL 7.3	Security	Introduction to cloud security Cloud Security Issues Loss of Control in the Cloud Multi-tenancy Issues in the Cloud Taxonomy of Fear Threat Model	T1: Ch 7 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	WordCountingwithApachePig	
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	• Software(s) or Tool(s) required: Virtual Box, KVM on Ubuntu, Hyper V, Openstack, AWS, Salesforce, Proxmox or ConVirt, Hadoop Harton Sandbox • System Requirements: Any System with Processor better or equal to i3 intel. Min 4GB RAM (Recommended 8GB or more) • Download url: o https://www.virtualbox.org/wiki/Downloads o www.devstack.org o https://aws.amazon.com/console/ o https://www.proxmox.com/en/proxmox-ve o https://www.convirture.com/products_opensource.php o 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 Cloud computing		

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	Quiz-1		*	5%	February 1-15, 2021
	Quiz-2		*	5%	March 1-15, 2021
	Assignment		*	5%	April 1-15, 2021
EC-2	Mid-Semester Test	Closed Book	2 hours	35%	Sunday, 07/03/2021 (AN) 2 PM – 4 PM
EC-3	Comprehensive Exam	Open Book	3 hours	50%	Sunday, 02/05/2021 (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	