INSTRUCTION DIVISION
1st SEMESTER 2014-2015
Course Handout Part II

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course

Course No. : **CS / SS G527**
Course Title **: Cloud Computing**
Instructor-in-Charge**: Shan Sundar Balasubramaniam (email: sundarb)**
Instructors: Anuj Kumar

Course Website: **http://csis/faculty/sundarb/courses/cloud**

1. Scope and Objective:

The primary objective of the course is to introduce the student to cloud computing from architectural and design perspectives. As such the emphasis of the course would be on the underlying infrastructure and architecture of clouds, techniques for enabling services and the quality of such services, as well as issues in designing clouds. Specific research issues in performance, security, and management would also be addressed. Programming on the cloud would be encouraged but not taught in class. Students are expected to learn and understand tools and techniques for using, designing, and implementing clouds and services via assignments and a term project.

2. Text and References:

a.Text Book: NONE

b.References:

R1. Kai Hwang , Jack Dongarra , Geoffrey C. Fox *Distributed and Cloud Computing: From Parallel Processing to the Internet of Things*. Morgan Kauffman 2011.

R2. Jim Smith, Ravi Nair. *Virtual Machines: Versatile Platforms for Systems and Processes.* Morgan Kaufmann. 2005

AR. Additional references (papers) to be posted on the course website.

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3. Course Plan:

3a. Modules

Mod-ule	Theme	Learning Objectives
I	Introduction to Cloud Computing	• To understand the motivation for Cloud Computing. • To understand the underlying (distributed) computing model.
II	Cloud Architecture – Resources and Virtualization	• To understand how to leverage and provision computing resources at different levels of abstraction. • To understand virtualization techniques at different levels of abstraction. • To understand how to architect a cloud to suit different requirements
III	Programming for the Cloud and Application Models	• To understand the execution of applications on the cloud • To understand how to develop & deploy applications for the cloud and the relevant tools & technologies
IV	Services, Service Models, and QoS.	• To understand how to use the cloud to deliver Software as a Service. • To understand how to deliver computing Infrastructure (e.g. processors, storage, network) as a Services • To understand Quality of Service issues and QoS support mechanisms for Services on the Cloud
V	Cloud Management, Performance and Security Issues	• To understand how to manage a cloud platform and a services ecosystem • To understand performance issues and techniques to enable performance of a cloud at different levels of abstraction • To understand security issues specific to cloud computing and solutions to address them.

[Note: Module III will not be covered in class in detail. It is to be learnt primarily through assignments and project. End of Note.]

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3.b Lecture Schedule:

Lecture	Module	Topics	Readings
1	I	Evolution of Computing Systems – Mainframes to PCs to Networked Systems to Clouds. Spectrum of Parallel and Distributed Computers.	R1 Sec. 1.2
2		Spectrum of Parallel and Distributed Computers – Programmer's Perspective. Cloud Computing and Services – User's Perspective.	R1 Sec. 1.3.4 and 1.4.1
3		Parallel Computing: Performance: Speedup and Amdahl's Law. Concurrency and Parallelism: Multi-tasking, Multi-processing, and Multi-Threading.	NONE
4		Parallel Computing: Multiple Computational Spaces: Shared-Memory Systems vs. Distributed Systems, UMA vs. NUMA, Impact of Memory Hierarchy on Performance and Locality of References.	Any text book on Computer Architecture
5		Distributed Computing Models – Message Passing: Synchrony, Failures, and Buffering.	AR
6		Failures: Byzantine Failures: Byzantine Agreement: Upper Bound on faulty entities, Solutions and capabilities.	AR
7 - 8		Introduction to Computer Clusters: Structure of a cluster – components of a cluster: nodes, interconnect, and middleware. Design of a cluster: Single System Image, Design for availability, Fault-tolerance and Fault Recovery.	R1 Sec. 2.1 to 2.3
9		Computer Clusters: Task Management and Resource Management; Scheduling and Load Balancing.	R1 Sec. 2.4, AR
10 - 11	III	Distributed Programming:RPC/RMI, Message Passing. Distributed Locking. Programming on Clusters: MPI, Map-Reduce/Hadoop.	R1 1.4.3, AR

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12-13	II	Introduction to Virtualization. Different Levels of Abstraction and Virtualization. Mechanisms for Virtualization. Process VMs vs. System VMs, HLL VMs;	R2 Ch. 1, R1 Sec.3.1 to 3.2, AR
14-15		Instruction Set Virtualization: Interpretation and Binary Translation. Code Discovery and Dynamic Translation. Optimizations. Case Study.	R2 Ch. 2, AR
16-17		Process VMs: VM Implementation; Emulation of: Memory Architecture, Instruction Execution, and Exception Handling; OS Emulation; Code Cache Management. Case Study.	R2 Ch. 3, AR
18-19		System Virtualization : Virtualization of Processors, Memory, and I/O. Case Studies.	R2 Sec. 8.1 to 8.3, AR
20		System Virtualization: Performance Analysis and Enhancement. Case study.	R2 Sec. 8.5 to 8.6, AR
21-22		Virtualization of Multi-processor systems / Multi-core Processors.	R2. Sec. 9.1 to 9.3, R1. Sec. 3.3.5
23-24		Storage Systems and Storage Virtualization: Storage Devices, File Systems and Volumes, Storage Networks – NAS and SAN, Virtual Storage.	AR
25-26		Virtualized Networks and Virtual Clusters. Process Migration and VM Migration. Live Migration – Suspend and Resume.	R1 Sec. 3.4, R2 Sec. 10.2, AR
27		Virtualization in Data Centers and Clouds. Cloud OS.	R1 Sec. 3.5, AR
28	III	Handling Large Data: Big Data Issues; Programming and Storage Models: GFS/HDFS, NoSQL, Big Data Spreadsheets, etc.	AR
29-30	IV	Services on the Cloud. Software as a Service; SOA; REST; Web Services;	R1 Sec. 5.1, AR
31-32		Platform as a Service; Computing Infrastructure as a Service. Case Studies (EC2 and Azure).	AR
33-		Quality of Service – Models, Parameters, and Metrics. SLAs.	AR

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35-36	V	Resource Scaling and Capacity Management: Managing VMs Resource Provisioning.	AR
37-38		Data Centers and Cloud: Performance Measurement and Models. Application Performance on the Cloud – Performance Modeling and Enhancement Techniques	AR
39-40		Cloud-specific Security Issues and Challenges. Access Control and Privacy Issues. Process Isolation and Security	AR
41		Trust and Reputation on the Cloud.	R1 Sec. 4.5, AR
42		Energy Consumption Models and Energy-aware Data Centers and Clouds	AR

4. Evaluation

4. a. Evaluation Scheme:

Component		Weight	Date	Remarks
Assignments (3)		35%	1 to 3 weeks each (in Aug. and Sept.)	Take Home
Mid-Term Test		15%	To be scheduled. In Oct.	Open Book
Seminar		10%	To be scheduled bet. 20 Sep. and 1st Oct.	Individual
Term Project	Definition and Scoping	10%	Last Week of Sep. (to be handed in by email)	Teams of two; Take Home; Documents to be sent by email (where applicable); Interaction to be scheduled per team.
	Design & Progress	10%	1st week of Nov.	
	Results, Demo, & Report	20%	25th Nov.	

Note: There is no comprehensive examination for this course. **End of Note.**

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4. b. Make-up Policy:

- **No Make-up will be available for assignments, seminar, or term project.**
- **Prior Permission of the Instructor-in-Charge is usually required to get make-up for a test.**
- **A make-up test shall be granted only in genuine cases where - *in the Instructor's judgment* - the student would be physically unable to appear for the test. Instructor's decision in this matter would be final.**

4.c. Fairness Policy:

- **Students are expected to work on their own on assignments / presentation / project expect where explicitly instructed / permitted otherwise.**
- **When students are allowed to consult/discuss other students/teams such consultation/discussion should be explicitly acknowledged and reported to the instructor prior to evaluation.**
- **When students are expected to collaborate within a team:**
  - **individual contributions should be identified and documented in qualitative and quantitative terms.**
  - **Instructor may assess and mark each individual in a team separately.**
  - **The instructor's assessment of the contributions in this matter would be final.**

5. Consultation Hours: *(see course website)*

6. Notices: All notices concerning this course will be displayed on the course website only. If there is a need email would be used on short notice (12 hours) – only BITS Pilani email would be used.

Instructor –In- Charge

CS / SS G527

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