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BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

WORK INTEGRATED LEARNING PROGRAMMES

COURSE HANDOUT

Part A: Content Design

Course Title	Software Architectures
Course No(s)	SS ZG653 / SE* ZG651
Credit Units	5
Course Author	Nayan Khare
Version No	1.3
Date	

Course Objectives:

No	Course Objective
CO1	Provide an industry approach towards foundation of Software Architecture for professionals who want to understand this discipline.
CO2	Understand the various design and architectural aspects of the discipline and its building blocks to get familiar with the current practices.
CO3	Understand both enterprise and modern application architecture that leverages Cloud and Mobile technologies.

Text Books:

T1	Software Architecture in Practice, Third Edition, Len Bass, Paul Clements, Rick Kazman, Pearson 2013 ISBN:978-93-325-0230-7
T2	Essential Software Architecture, Second Edition, Ian Gorton, Springer 2011 ISBN:9783642191756

Reference Books:

R1	Software Modelling and Design, Hassan Gomaa, Cambridge University Press 2011, ISBN:9780521764148
R2	Microsoft Application Architecture Guide, Second Edition, Microsoft 2009, ISBN: 9780735627109 [Availability: Online Free]
R3	Enterprise Architecture at Work: Modelling, Communication and Analysis, Third Edition, Marc Lankhorst et al., Springer 2013, ISBN:9783642296505
R4	Developing Multi-tenant Applications for the Cloud on Microsoft Windows Azure, Third Edition, Microsoft 2012, ISBN:978-1-62114-023-8 [Availability: Online Free]
R5	Amazon Web Services – Architecting for the Cloud: Best Practices, January 2011, Jinesh Varia [Availability: Online Free]

	https://media.amazonwebservices.com/AWS_Cloud_Best_Practices.pdf
R6	Architecting Mobile Solutions for the Enterprise – Dino Esposito, 2012, Microsoft Press, ISBN: 978-0-7356-6303-2

Content Structure

Module No	List of Topic Title	Text/Ref Book/external resource
M1	Introduction to Software Architecture <ul style="list-style-type: none"> • What is Software Architecture? • Definitions of Software Architecture • Architecture Structure and Patterns • Good architecture • Importance of Software architecture • Contexts of Software architecture • Architecture competence 	T1 - 01, 02, 03, 24
		RL 1.2 A Brief History of Software Architecture RL 1.3 Introduction to the Styles, Views and Rational's 4+1 RL 2.1 Three structures
M2	Software Quality Attributes <ul style="list-style-type: none"> • Understanding Quality Attributes • Interoperability • Testability • Usability • Performance • Scalability • Modifiability • Security • Availability • Integration • Other Quality Attributes • Design Trade-Offs 	T1 - 04, 05, 06, 07, 08, 09, 10, 11, 12
		RL 3.1 Quality classes, Quality attribute, quality attribute scenario and architectural tactics RL 4.1 Usability and its tactics RL 4.2 Availability RL 5.1 Modifiability RL 5.2 Performance RL 6.1 Security RL 6.2 Testability RL 6.3 Interoperability
M3	Architecture requirements and design <ul style="list-style-type: none"> • ASR from Requirements documents • Stakeholder interviews • Identifying business goals • Building a Utility tree • Design strategy • Steps of Attribute-Driver design • Agile Architecture • Agile Methods • Example 	T1 - 15, 16, 17
		RL 19.1 Architecture and Requirements RL 19.2 Designing the Architecture RL 8.2 Introducing Agile methodology
M4	Documenting Software Architecture	T1 – 18

	<ul style="list-style-type: none"> • Benefits of Cloud based approach • Design Issues • Case Study: Developing Multitenant Applications for the Cloud • Case Study: Amazon Web Services – Cloud Architecture: Best Practices • Case Study – Mobile Architecture • Case Study – Patterns of Mobile Application Development 	RL 17.1 Introduction and Virtualization basic RL 17.2 IAAS and Data storage RL 18.1 Quality attribute revisited RL 18.2 Multi-Tenant Architecture, Micro Services, CAP Theorem
M8	Architecture – Management and Governance <ul style="list-style-type: none"> • Planning • Organizing • Measuring • Governance 	T1-22
		Recording not available
M9	Economic analysis of architectures <ul style="list-style-type: none"> • Decision-making context • Basis for economic analysis • CBAM 	T1-23
		Recording not available

Learning Outcomes:

No	Learning Outcomes
LO1	Acquire knowledge of software architecture discipline and interpret the various attributes that pertains to the domain of application development.
LO2	Analyse patterns used for modern application design relate it with new technology such as Cloud and mobile.
LO3	Examine application architecture from the perspective of quality attributes to revise an existing design or develop a new design or make review and make recommendations for a given design.
LO4	Illustrate the importance of requirements, documentation and able to write them
LO5	Measure and assess application design and contribute to design decision.

Part B: Contact Session Plan

Academic Term	
Course Title	Software Architectures
Course No	
Lead Instructor	

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 classroom 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

Time	Type	Description	Content Reference
Pre-CS			
During CS	CS 1	M1 Software architecture – definition, need for architecture, architecture role, structure and patterns, views, contexts. Discuss LE 1 (a), (b)	
Post-CS		RL 1.2 RL 1.3 RL 2.1 Complete LE 1 (a), (b)	
Lab Reference			

Contact Session 2

Time	Type	Description	Content Reference
Pre-CS		RL 3.1 RL 4.1 RL 4.2 RL 5.2	
During CS	CS 2	M2 Functionality and quality attributes, Design checklists and tactics for each Quality attributes, Attributes – Scalability, Availability, Integration, Performance, Usability Discuss LE 2	
Post-CS		RL 5.1 RL 6.1 RL 6.2 RL 6.3 Complete LE 2	

Lab Reference			
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Contact Session 3

Time	Type	Description	Content Reference
Pre-CS		RL 19.1 RL 19.2	
During CS	CS 3	M3 Building ASR: Requirements, Interviews, Business Goals, Build Utility tree, Attribute-Driven D method, Agile methodology LE 2 – Build ASR, Design interviews	
Post-CS		Complete LE 2	
Lab Reference			

Contact Session 4

Time	Type	Description	Content Reference
Pre-CS		RL 20.1 Recap of UML: RL 7.1 RL 7.2 RL 8.1	
During CS	CS 4	M4 Documenting Architecture Views, Choosing Views, Combining Views, Behaviour Discuss LE 3	
Post-CS		RL 8.3 Complete LE 3	
Lab Reference			

Contact Session 5

Time	Type	Description	Content Reference
Pre-CS		Case Study: Layer Guidelines - Presentation, Business, Data Layer, Service	
During CS	CS 5	M5 Architecture implementation, Testing, Reconstruction process, Raw view extraction,	

		Database construction, View fusion, Finding violations, Factors for evaluation, Trade off analysis, Lightweight evaluation	
Post-CS		Recap of CS 1 through CS 5	
Lab Reference			

Contact Session 6

Time	Type	Description	Content Reference
Pre-CS		RL 9.1 RL 12.1 RL 12.2	
During CS	CS 6	M6 Layered, Broker, MVC, Service Oriented Discuss LE 4, LE 5	
Post-CS		RL 9.2 RL 10.1 RL 10.2 LE 5	
Lab Reference			

Contact Session 7

Time	Type	Description	Content Reference
Pre-CS		RL 11.1	
During CS	CS 7	M6 Client server, Peer-to-Peer, Publish-subscribe, Shared data, Multi-tier	
Post-CS		RL 13.1 RL 13.2 RL 13.3 LE 5	
Lab Reference			

Contact Session 8

Time	Type	Description	Content Reference
Pre-CS		RL 17.1 RL 17.2 RL 18.1 RL 18.2	

During CS	CS 8	M7 Cloud Definitions, Service Models, Architecting for the Cloud, Benefits of Cloud based approach, Design Issues Discuss LE 6	
Post-CS			
Lab Reference			

Contact Session 9

Time	Type	Description	Content Reference
Pre-CS			
During CS	CS 9	M7 Case Study: Developing Multitenant Applications for the Cloud Case Study: Amazon Web Services – Cloud Architecture: Best Practices Case Study – Mobile Architecture Case Study – Patterns of Mobile Application Development	
Post-CS		Complete LE 6	
Lab Reference			

Contact Session 10

Time	Type	Description	Content Reference
Pre-CS			
During CS	CS 10	M8, M9 Architecture Management and Economic analysis – Decision making, CBAM	
Post-CS			
Lab Reference			

Contact Session 11: Review

Refer Appendix for detailed course plan

Learning Exercises and Case Studies:

Faculty needs to provide learning exercise, reading notes and case studies and include them in EC-1 evaluation which are primarily drawn from the tables below.

Detailed Plan for Learning Exercises:

The learning exercises is designed keeping in mind a simple approach to motivate the students to actively participate in completion of the assignment and fulfil learnings that is desired by the instructor.

Lab No	Lab Objective	Content Reference
LE1	<p>a. Consider you are a hardware architect and in charge of designing a new portable device (phone/tablet or a new innovation). Come up with the details of the hardware including the software it will run and capture the reason for your decisions of design and the rationale for the same. Hardware criteria could be amount of RAM, size of the device, battery life etc. Carry out the task individually and understand from each other their specific criteria for their corresponding design and discuss how an architecture serve as a basis for analysis and decision making process?</p> <p>b. Now that you have designed a new hardware in part (a), think of a creative software application that you plan to develop and to be made on run on the device that is designed. Bring in an analogy with software architecture from the above example? List the objective of the application and identify the features of the application and how is it supposed to work and if it requires any specific hardware capability like camera, gyroscope etc. and verify it with the hardware design above.</p> <p>[The created document should be preserved for subsequent exercises]</p>	<p>Part (a) After session 1</p> <p>Part (b) After session 2</p>
LE2	<p>From the document created as part of LE1, subject it all the quality attributes and identify the considerations over each other and record your observations regarding the decisions made e.g. performance criteria for the application. There could be decisions taken from perspective of failure of components – both hardware and software, performance, interoperability, security, cost etc. and assign priority of each attribute for the product that is being designed and give reasons for the priority. Again compare your priority with another individual and understand the thought process for the decisions taken and share your feedback and gain an understanding how the design decisions bring changes to the application design features e.g. some attributes may be ignored due to the cost and some attributes must be considered otherwise the application may not work as expected.</p>	<p>After session 2</p>
LE3	<p>With both the documents from LE1 and LE2 in place,</p>	<p>After session 3, 4, 5</p>

	create the architectural design for the system. Identify the notations for architecture design to be used like Use cases, Sequence Diagrams, Domain Model, Domain Class Diagrams etc. and determine how to go about producing a design document for the same. Also, have considerations on how much documentations should be produced. [Don't confuse the task with producing a User Guide for the hardware] .	
LE4	Design a unique client-server based application for the hardware that is designed in LE1 and make use of the design documentation produced in LE3. Keep in mind the hardware and software constraints as per your design with the help of document from LE2. Produce a detailed design with the help of document produced in LE3 involving the Application Layers – Layer Guidelines – Presentation, Business, Data Layer, and Service Layer.	After session 9, 10
LE5	Introspect all the layers mentioned in LE4 and identify the components that could be redesigned as Service to fit into the model of Service Oriented architecture. Adapt the application to REST based architecture once all the components have been identified and update the design to reflect the same.	After session 9, 10
LE6	Select a particular Cloud service provider and identify the service (preferably PaaS) and deployment model (preferably public) and make the required design changes to the application to map it to cloud based architecture and call out the changes having compared with LE4 and LE5.	After session 11, 12, 13, 14

Case Studies: Detailed Plan:

Case study No	Case Study Objective
1	Understand Application Layers – Layer Guidelines – Presentation, Business, Data Layer, Service
2	Understand how to develop Multitenant Applications for the Cloud
3	Understand Best Practices of Amazon Web Services Cloud Architecture
4	Case Study: Mobile Architecture, Patterns of Mobile Application Development

Evaluation Components

No	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Assignment/Quiz	Online Quiz -1 Quiz – 2 Assignment – 1		5% 5% 10%	To be announced
EC-2	Mid-Semester Exam	Closed Book	1.5 hours	30%	To be announced
EC-3	Comprehensive Exam	Open Book	2.5 hours	50%	To be announced

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

Important Information:

Syllabus for Mid-Semester Test (Closed Book): Topics in CS 1-5.

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

Evaluation Guidelines:

1. 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.
2. 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.
3. 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 Session	Pre-contact prep	Contact session	Post-contact sessions
1	NA	M1 Software architecture – definition, need for architecture, architecture role, structure and patterns, views, contexts.	RL 1.2 RL 1.3 RL 2.1 Complete LE 1 (a), (b)

		Discuss LE 1 (a), (b)	
2	RL 3.1 RL 4.1 RL 4.2 RL 5.2	M2 Functionality and quality attributes, Design checklists and tactics for each Quality attributes, Attributes – Scalability, Availability, Integration, Performance, Usability Discuss LE 2	RL 5.1 RL 6.1 RL 6.2 RL 6.3 Complete LE 2
3	RL 19.1 RL 19.2	M3 Building ASR: Requirements, Interviews, Business Goals, Build Utility tree, Attribute-Driver D method, Agile methodology LE 2 – Build ASR, Design interviews	Complete LE 2
4	RL 20.1 Recap of UML: RL 7.1 RL 7.2 RL 8.1	M4 Documenting Architecture Views, Choosing Views, Combining Views, Behaviour Discuss LE 3	RL 8.3 Complete LE 3
5	Case Study: Layer Guidelines - Presentation, Business, Data Layer, Service	M5 Architecture implementation, Testing, Reconstruction process, Raw view extraction, Database construction, View fusion, Finding violations, Factors for evaluation, Trade off analysis, Lightweight evaluation	Recap of CS 1 through CS 5
MID SEM EXAMINATIONS – CS 1 to CS 5			
6	RL 9.1 RL 12.1 RL 12.2	M6 Layered, Broker, MVC, Service Oriented Discuss LE 4, LE 5	RL 9.2 RL 10.1 RL 10.2 LE 5
7	RL 11.1	M6 Client server, Peer-to-Peer, Publish-subscribe, Shared data, Multi-tier	RL 13.1 RL 13.2 RL 13.3 LE 5
8	RL 17.1 RL 17.2 RL 18.1	M7 Cloud Definitions, Service Models, Architecting for	

	RL 18.2	the Cloud, Benefits of Cloud based approach, Design Issues Discuss LE 6	
9		M7 Case Study: Developing Multitenant Applications for the Cloud Case Study: Amazon Web Services – Cloud Architecture: Best Practices Case Study – Mobile Architecture Case Study – Patterns of Mobile Application Development	Complete LE 6
10		M8, M9 Architecture Management and Economic analysis – Decision making, CBAM	
11	Review		
END SEM EXAMINATIONS – CS 1 to CS 11			