

# UNIVERSITY OF DELHI

CNC-II/093/1(26)/2023-24/200

Dated: 21.09.2023

## NOTIFICATION

### Sub: Amendment to Ordinance V

[E.C Resolution No. 14-1/ (14-1-12) and 27-1 (27-1-14) dated 09.06.2023 and 25.08.2023]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

#### **Add the following:**

#### **Skill Enhancement Courses (SECs) Under UGCF-2022**

**Listed under Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University  
(with effect from Academic Year 2022-23)**

A student who pursues any undergraduate programme in the University and its Colleges is offered a pool of Skill Enhancement Courses. A list of such courses as passed by the Executive Council in its meeting dated 09.06.2023 and 25.08.2023 is as below:

- 1) Plant Tissue Culture
- 2) Application of Plant Tissue Culture
- 3) Exploring medicinal plants: from cultivations to applications
- 4) DNA barcoding of medicinal/ commercially important plants
- 5) Cultivation of Lac: an eco-friendly multiuse wonder product of nature
- 6) Lac Characterization and Processing
- 7) Drosophila and Zebrafish model organism in biological studies
- 8) Isolation and characterization of Plasmid DNA
- 9) Isolation, characterization and quality check of Genome DNA
- 10) Polymerase chain reaction (PCR) and its applications
- 11) CAD (Computer aided Jewellery Design-I)
- 12) CAD (Computer aided Jewellery Design-II)
- 13) CAD (Computer aided Jewellery Design-III)
- 14) CAD (Computer aided Jewellery Design-IV)
- 15) Harmonium -II- Study of Harmonium
- 16) Reading & Writing skills in Brahmi Scripts

- 17) Acting Skills in Sanskrit Dramaturgy
- 18) Script writing skills in Sanskrit Dramaturgy
- 19) Fundamentals of Indian Manuscriptology
- 20) Traditional Indian Gastronomy
- 21) E-Learning Tools and Techniques for Sanskrit
- 22) Practices in Horoscopes -I
- 23) Basics of Food Science and Nutrition
- 24) Basic Forensic science
- 25) Basic Laboratory Techniques
- 26) Public health, hygiene and nutrition
- 27) LaTeX Typesetting for Beginners
- 28) Mathematical Modeling with Excel
- 29) Financial Modeling with Excel
- 30) Network Flows
- 31) R-Shiny: Powerful Web Apps for Everyone
- 32) Spoken Persian: Elementary level

# LaTeX TYPESETTING FOR BEGINNERS

## CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
LaTeX Typesetting for Beginners	2	0	0	2	Class XII	NIL

**Learning Objectives:** The objective of this course is to introduce:

- LaTeX, a high-quality open-source typesetting software that produces professional prints and PDF files for research articles and books in all subjects, and languages.
- Typesetting in Indian languages using LaTeX by transliteration and ITRANS packages.

**Learning Outcomes:** After completion of the course the learner will be able to:

- Prepare a LaTeX document with title page including contents, references, and index.
- Understand the Indian language transliteration package (ITRANS-processor) for typesetting Sanskrit, Hindi, Punjabi, Malayalam, etc. using LaTeX.

### **UNIT-I: Getting Started with LaTeX (24 hours)**

Installing and using LaTeX for creating a first LaTeX document; Formatting text and understanding LaTeX commands and environments; Designing pages, Creating a book with chapters and table of contents, Creating and customizing lists, Including images, and creating tables with captions.

### **UNIT-II: Cross-References, Index, Bibliography and Large Documents (16 hours)**

Setting labels and references, Hyperlinks; Customizing the table of contents, Generating an index, Creating a bibliography; Writing basic math formulas and equations; Developing large documents by splitting the input and creating front/back matter.

### **UNIT-III: Typesetting in Indian Languages using LaTeX (20 hours)**

Transliteration symbols with illustrative examples of the Indian languages, such as Sanskrit, Hindi (Devanagari), Punjabi, and Malayalam; Creation of the transliterated document for typesetting in Devanagari (for Sanskrit, Hindi, and Marathi), Gurumukhi (for Punjabi), and Rachana (for Malayalam); ITRANS pre-processor package to convert English-encoded text into various Indian language script such as Gujarati, Bengali, Kannada, Tamil, Telugu, etc.

#### **Essential Readings**

1. Kottwitz, Stefan (2021). LaTeX Beginner's Guide (2nd ed.). Packet Publishing Ltd.
2. Nambudiripad, K.B.M. (2014). LaTeX for Beginners. Narosa Publishing House, Delhi.
3. <https://ctan.org/pkg/devanagari>; <https://www.ctan.org/pkg/gurmukhi-singh>
4. <https://ctan.org/tex-archive/language/indian/itrans>

#### **Suggested Reading**

- Lamport, Leslie (1994). LaTeX: A Document Preparation System, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint.

**Practical Exercises:** Getting started with free open-source software LaTeX for typesetting documents from chapter 1 of the text book [1]: LaTeX Beginner's Guide (2nd ed.) by Stefan Kottwitz for installing and using LaTeX. Learners are required to:

- Design a LaTeX document by choosing title, author, date, address, page dimensions, margins, adjust line spacing, add footnotes, and orientation.
- Create a document with bulleted lists, numbered lists, and definition lists. Furthermore, modify the document with compact and customized versions of such lists, including spacing adjustments and interrupting and resuming.
- Create tables, adding captions to tables, putting text into columns, spanning columns and rows, using LaTeX packages to auto-fit columns.
- Generate a document by customizing the table of contents, lists of figures and tables, producing an index pointing to relevant information for keywords and phrases.
- Typesetting fine-tune math expressions, align and number equations, and use various math symbols from the amsmath package in LaTeX.
- Generate a list of five books related to your field of interest under an automatically generated title 'Bibliography', using thebibliography command in LaTeX. Illustrate how these references are cited in the body of a document.
- Create a LaTeX file to manage large documents consisting of several LaTeX files by splitting the input, including front and back matter and a separate title page.
- Transliterate these six names: Aryabhata, Arthashastra, Bhaskaracharya, Chanakya, Ganita Bharati, and Shankaracharya, and write them in itemize form using Devanagari package in LaTeX. Also use the verbatim environment to display the LaTeX code.
- Typeset ten words of your choice using ITRANS pre-processor package in LaTeX to convert English-encoded text into any one Indian language script.

### **Teaching Plan (SEC Paper: LaTeX Typesetting for Beginners)**

**Week 1:** Installing and using LaTeX for creating a first LaTeX document. [1]: **Chapter 1.**

**Week 2:** Formatting text and understanding LaTeX commands and environments. [1]: **Chapter 2.**

**Week 3:** Designing pages, Creating a book with chapters and table of contents. [1]: **Chapter 3.**

**Week 4:** Creating and customizing lists. [1]: **Chapter 4.**

**Week 5:** Including images. [1]: **Chapter 5.**

**Week 6:** Creating tables with captions. [1]: **Chapter 6.**

**Week 7:** Setting labels and references, Hyperlinks. [1]: **Chapter 7.**

**Week 8:** Customizing the table of contents, Generating an index, Creating a bibliography. [1]: **Chapter 8.**

**Week 9:** Writing basic math formulas and equations. [1]: **Chapter 9.**

**Week 10:** Developing large documents by splitting the input and creating front/back matter. [1]: **Chapter 11.**

**Weeks 11, and 12:** Transliteration symbols with illustrative examples of the Indian languages, such as Sanskrit, Hindi (Devanagari), Punjabi, and Malayalam. [2]: **Chapter 9;** and **gurmukhi**

**Weeks 13, and 14:** Creation of transliterated document for typesetting in Devanagari (Sanskrit, Hindi and Marathi), Gurumukhi (Punjabi), and Rachana (Malayalam). [2]: **Chapter 10;** [3]: **Devanagari,** and **Gurmukhi.**

**Week 15:** ITRANS pre-processor package to convert English-encoded text into various Indian language script such as Gujarati, Bengali, Kannada, Tamil, Telugu, etc. [4]: **Itrans: Indian languages**

## MATHEMATICAL MODELING WITH EXCEL

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
<b>Mathematical Modeling with Excel</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>Class XII pass with Mathematics</b>	<b>NIL</b>

**Learning Objectives:** The objective of this course is to introduce:

- The importance and significance of assumptions behind a mathematical model.
- The long-term behavior of discrete dynamical systems numerically and graphically.
- Monte Carlo simulations with real-life examples.
- Linear programming, transportation, assignment and traveling salesman problems.

**Learning Outcomes:** After completion of the course the learner will be able to:

- Understand the purpose and process of mathematical modeling.
- Model different scenarios with linear discrete dynamical systems.
- Formulate and solve LP, transportation and assignment problems using Excel Solver.

#### **UNIT-I: Modeling with Proportionality and Geometric Similarity (20 hours)**

Definition, purpose, process, assumptions, and examples of mathematical modeling; Charts in excel using given data, Modeling with proportionality: Population growth, Radioactive decay, and Free-falling object; Fitting straight lines analytically, Geometric similarity, and Linearizable models.

#### **UNIT-II: Discrete-time Models (16 hours)**

Discrete dynamical system concepts and examples; Long-term behavior and equilibria, Discrete logistic equation, Linear predator-prey model, SIR model of epidemics, SIS model.

#### **UNIT-III: Simulations and Linear Optimization (24 hours)**

Monte Carlo simulation: Flipping a coin, Area under a curve, Car dealership contest, and the birthday problem; Formulation of linear programming, transportation and assignment problems and their solutions using Excel Solver tool; Traveling salesman problem.

#### **Essential Reading**

1. Albright, Brian, & Fox, William P. (2020). Mathematical Modeling with Excel (2nd ed.). CRC Press, Taylor & Francis Group.

#### **Suggested Reading**

- Giordano, Frank R., Fox, William P., & Horton, Steven B. (2014). A First Course in Mathematical Modeling (5th ed.). CENGAGE Learning India.

**Practical Exercises:** Practical work to be performed using Excel spreadsheets for the modeling of the following type of problems:

- The data given below measures shoe length (to the nearest quarter of an inch) and height (to the nearest half inch) of ten persons, to determine if there is a relationship between shoe length and height of a person. Graph Height vs. Shoe Length and fit a straight line to the data. How well does this model fit the data?

Shoe Length	9	10	10.5	11	11.5	11.75	12	12.5	12.75	13
Height	62	64	64.5	69	70	73	72	75	74	77

- The table below contains the total length and weight of 10 black bears. Graph weight vs. length, fit different linearizable models to the data, and select the one that best fits the data. Explain.

Length	139	138	139	120.5	149	141	150	166	180	129.5
Weight	110	60	90	60	85	95	85	155	220	105

- The table below contains data on the population of foxes in a forest over a period of several years. Fit a discrete logistic equation to the data. How well does the model fit the data?

$n$	0	1	2	3	4	5	6	7	8	9	10
$a_n$	50	85	110	130	175	200	215	221	228	232	234

- Consider a disease such as the common cold where a person is *not* immune once they are 'healed.' Once healed, a person becomes susceptible again. Such a disease could be modeled with an SIS model. Implement your model in an Excel worksheet to describe the spread of the common cold through a population of 1,000 where initially 4 people have the cold and assuming that the cold lasts an average of 2 weeks (use  $\alpha = 0.00167$ ). What do you observe?
- Random number generation in Excel and then use it to simulate area under a given curve.
- An automobile repair company performs paint-less dent removal from hail damaged cars and trucks. Each vehicle must be processed in both the body assembly shop and the finishing shop. In the body shop it takes 0.5 man-hours to repair a car and 0.5 man-hours to repair a truck. There are 25 body shop man-hours available per day. In the finishing shop it takes 0.4 man-hours to finish a car and 0.6 man-hours to finish a truck. There are 24 finishing man hours available per day. Each car contributes Rs. 20000 to overall profit, and each truck contributes Rs. 22500 to overall profit. Find number of cars & trucks the company can service a day to maximize overall profit, using Solver.

### Teaching Plan (SEC Paper: Mathematical Modeling with Excel)

**Week 1:** Definition, purpose, process, assumptions, and examples of mathematical modeling; [1]:Chapter 1.

**Week 2:** Charts in excel using given data. [1]: Chapter 2 (Sections 2.1, and 2.2).

**Week 3:** Modeling with proportionality: Population growth, Radioactive decay, and Free-falling object. [1]: Chapter 2 (Section 2.3).

**Weeks 4 and 5:** Fitting straight lines analytically, Geometric similarity, and Linearizable models. [1]: Chapter 2 (Sections 2.4 to 2.6).

**Weeks 6, and 7:** Discrete dynamical system concepts and examples; Long-term behavior and equilibria, Discrete logistic equation. [1]: Chapter 4 (Sections 4.1 to 4.3).

**Weeks 8, and 9:** Linear predator-prey model, SIR model of epidemics, and SIS model. [1]: Chapter 4 (Sections 4.4, and 4.6).

**Weeks 10, and 11:** Monte Carlo simulation: Flipping a coin, Area under a curve, Car dealership contest, and the birthday problem. [1]: Chapter 6 (Section 6.2), and Section 6.3 (Example 6.3.2 and Exercise 6.3.4 only).

**Weeks 12 to 14:** Formulation of linear programming, transportation and assignment problems and their solutions using Excel Solver tool. [1]: Chapter 7 (Sections 7.2 to 7.4).

**Week 15:** Traveling salesman problem. [1]: Chapter 8 (Section 8.8).

## FINANCIAL MODELING WITH EXCEL

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
<b>Financial Modeling with Excel</b>	2	0	0	2	Class XII	NIL

**Learning Objectives:** The objective of this course is to:

- Build financial models using Excel functions to solve some real-life financial problems.
- Acquire practical skills and knowledge that are useful for investment banking.

**Learning Outcomes:** After completion of the course the learner will be able to:

- Compute present value and future value of a cashflow or annuity.
- Create loans and amortization tables, and find price, yield, and duration of a bond.
- Draw option payoff diagrams and option strategy diagrams.
- Find option price using Black-Scholes, and binomial models.

#### **UNIT-I: Time Value of Money (28 hours)**

Building good financial models, Interest rates, Future value, Present value, Annuity, Perpetuity, Present value of an annuity, Present value of a perpetuity, Present value of non-annuity cash flows; Net present value (NPV), Internal rate of return (IRR), NPV vs IRR; Loans and amortization tables, Interest-only loan, An equal amortization term loan, Mortgage; Effective interest rates, Cost of a mortgage, Continuous compounding and discounting.

#### **UNIT-II: Bond Pricing and Duration (12 hours)**

Characteristics of bonds, Zero-coupon bond, Bond valuation, Yield to maturity, Yield curve and forward rates; Macaulay duration, Modified duration, and convexity.

#### **UNIT-III: Options, Black-Scholes, and Binomial Models (20 hours)**

Call and put options, Option strategies, Put-call parity, Black-Scholes formulae for prices of call and put options; Binomial option pricing model, and two-period binomial model.

#### **Essential Readings**

1. Benninga, Simon & Mofkadi, Tal (2018). Principles of Finance with Excel (3rd ed.). Oxford University Press, New York.
2. Sengupta, Chandan (2004). Financial Modeling using Excel and VBA. John Wiley.

#### **Suggested Readings**

- Day, Alastair L. (2015). Mastering Financial Mathematics in Microsoft Excel (3rd ed.). Pearson Education Ltd.
- Luenberger, David G. (2014). Investment Science (2nd ed.). Oxford University Press.

**Practical Exercises:** Review of Excel spreadsheets concepts including functions and graphs from [1]: Part Five Excel Skills. Practical work to be performed using Excel spreadsheets for the modeling of the following type of problems:

1. Calculating future value, present value, and present value of an annuity. Use of Excel functions **FV, PV, NPV, and PMT**. [1]: Chapter 2, Exercises 1,3,5, and 7 pages 46-47.
2. Calculating net-present value (NPV) and internal rate of return (IRR). NPV vs IRR. Use of Excel functions **NPV** and **IRR**. [1]: Chapter 3, Exercises 1 to 3 pages 99-100.
3. Creating loan and amortization table. Use of Excel functions **IPMT** and **PPMT**. [1]: Chapter 4, Exercises 1 to 3 pages 132-133.
4. Computing effective annual interest rate (EAIR), using function **IRR**, and **XIRR** (for dates, not evenly spaced). [1]: Chapter 5, Exercises 1, 4, 7, and 9 pages 169-171.
5. Calculating bond price and yield to maturity (YTM) of a bond. Use of Excel functions **PRICE, YIELD, IRR, and XIRR** (for non-periodic cash flows). [2]: Models 2, and 3 pages 276-279.
6. Computing duration, modified duration, and convexity of a bond. Use of Excel functions **DURATION**, and **MDURATION**. [2]: Models 4, and 5 pages 280-284.
7. Computing payoffs of call and put options, and draw profit diagrams in Excel. [1]: Chapter 17, Exercises 1 to 4 pages 572-574.
8. Studying and comparing option strategies: Bear spread, Bull spread, and Butterfly spread, and draw corresponding profit diagrams in Excel. [1]: Chapter 17, Exercises 18, 19, and 21 pages 581-583.
9. Using Black-Scholes formulae to find prices of call and put options. [1]: Chapter 19, Exercises 1 to 4 page 626.
10. Using binomial model to find prices of call and put options, and Excel tree diagram. [1]: Chapter 20, Exercises 3 to 5 page 653.

### **Teaching Plan (SEC Paper: Financial Modeling with Excel)**

**Week 1:** Excel Skills, Building good financial models.

[1]: Review of Excel basics and functions from Chapters 21 to 23, and Chapter 1(Section 1.4).

**Week 2:** Interest rates, Future value. [1]: Chapter 2 (Section 2.1).

**Weeks 3, and 4:** Present value, Annuity, Perpetuity, Present value of an annuity, Present value of a perpetuity, Present value of non-annuity cash flows. [1]: Chapter 2 (Section 2.2).

**Week 5:** Net present value (NPV), Internal rate of return (IRR), NPV vs IRR.[1]: Chapter 3 (3.1 to 3.3).

**Week 6:** Loans and amortization tables, Interest-only loan, An equal amortization term loan, Mortgage. [1]: Chapter 4 (Sections 4.2 to 4.5).

**Week 7:** Effective interest rates, Cost of a mortgage, Continuous compounding and discounting. [1]: Chapter 5 (Sections 5.1, 5.2, and 5.7).

**Weeks 8 to 10:** Characteristics of bonds, Zero-coupon bond, Bond valuation, Yield, Yield curve and forward rates; Macaulay duration, Modified duration, and convexity. [2]: Chapter 10.

**Weeks 11 to 13:** Call and put options, Option strategies, Put-call parity.

[1]: Chapter 17, and Chapter 18 (Section 18.3, and Exercises 4 to 6, page 602).

**Week 14:** Black-Scholes formulae for prices of call and put options. [1]: Chapter 19 (Section 19.1).

**Week 15:** Binomial option pricing model, Two-period binomial model. [1]: Chapter 20 (20.1 to 20.3).



## NETWORK FLOWS

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
<b>Network Flows</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>Class XII</b>	<b>NIL</b>

**Learning Objectives:** The objective of this course is to:

- Introduce the transportation and assignment problems as network models.
- Learn more about network optimization models and describe the characteristics of various network flow problems.
- Understand the critical path method (CPM) designed to assist in the planning, scheduling, and control of projects.

**Learning Outcomes:** After completion of the course the learner will be able to:

- Formulate and solve transportation and assignment problems using Excel.
- Understand the network flow problem of types - shortest-path problem, minimum spanning tree problem, maximum flow, and minimum cost flow problems, and their optimum solutions using Excel spreadsheet.
- Apply the critical path method (CPM) of time-cost trade-offs for project management.

#### **UNIT-I: Transportation and Assignment Problems (20 hours)**

Network representation of the transportation and assignment problems, Formulate transportation and assignment problems, and solve using Excel.

#### **UNIT-II: Network Optimization Models (24 hours)**

Terminology of networks; Formulate and use Excel to solve shortest-path, minimum spanning tree, maximum flow, and minimum cost flow problems; Critical path method (CPM) of time-cost trade-offs using Excel spreadsheet.

#### **UNIT-III: Case Studies (16 hours)**

Shipping wood to market, Project pickings, Money in motion, Steps to success.

#### **Essential Reading**

1. Hillier, Frederick S., & Lieberman, Gerald J. (2021). Introduction to Operations Research, (11th ed.). McGraw-Hill Education.

#### **Suggested Readings**

- Ragsdale, Cliff T. (2022). Spreadsheet Modeling and Decision Analysis: A Practical Introduction to Business Analytics (9<sup>th</sup> ed.). CENGAGE Learning.
- Taha, Hamdy A. (2017). Operations Research: An Introduction (10th ed.). Pearson Education Limited.

**Practical Exercises:** Use Excel spreadsheet to solve transportation, and assignment problems, shortest-path problem, maximum flow problem, minimum cost flow problem, and CPM calculations of following type of exercises from the chapters 9 and 10 of [1].

- 9.1-1, 9.3-1, Case 9.1 (Shipping Wood to Market), and Case 9.3 (Project Pickings).
- 10.3-2, 10.3-6, 10.5-3, 10.6-5, 10.8-1, Case 10.1 (Money in motion), and Case 10.3 (Steps to success).

### **Teaching Plan (SEC Paper: Network Flows)**

**Weeks 1 to 5:** Network representation of the transportation and assignment problems, Formulate transportation and assignment problems, and solve using Excel.

[1]: Chapter 9 (Sections 9.1, and 9.3).

**Weeks 6, and 7:** Terminology of networks, Formulate and use Excel to solve Shortest-path problem.

[1]: Chapter 10 (Sections 10.2, and 10.3).

**Week 8:** The minimum spanning tree problem. [1]: Chapter 10 (Section 10.4).

**Weeks 9, and 10:** Formulate maximum flow, and minimum cost flow problems and solve using Excel.

[1]: Chapter 10 [Sections 10.5, and 10.6 (including special cases fit into the network format of the minimum cost flow problems, pages 388-390)].

**Week 11:** Critical path method (CPM) of time-cost trade-offs using Excel spreadsheet.

[1]: Chapter 10 (Section 10.8).

**Week 12:** Shipping wood to market. [1]: Chapter 9 (Case 9.1).

**Week 13:** Project pickings. [1]: Chapter 9 (**Case 9.3**).

**Week 14:** Money in motion. [1]: Chapter 10 (Case 10.1).

**Week 15:** Steps to success. [1]: Chapter 10 (**Case 10.3**).

## R-SHINY: POWERFUL WEB APPS FOR EVERYONE

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
R-Shiny: Powerful Web Apps for Everyone	2	0	0	2	Class XII	NIL

**Learning Objectives:** The objective of this course is to:

- Build interactive web applications for charts, tables, graphs, and maps using R Shiny.
- Create, develop, and deploy Shiny web applications using reactive components.
- Customize the appearance of Shiny web apps using Shiny in R Markdown.

**Learning Outcomes:** After completion of the course the learner will be able to:

- Understand the fundamentals of Shiny and develop interactive web applications.
- Understand reactive programming concepts and building reactive web applications.
- Learn R Markdown and deploy Shiny apps locally and to the web with flexdashboard.

#### **UNIT-I: Introduction to Shiny and Basic User Interface (UI) components (20 hours)**

What is Shiny? How Shiny works with R; Create Shiny app directory and file, Adding UI controls, and behaviour; Building the UI using the fluidPage(), Input, and Output functions, and deploy Shiny apps locally using server function.

#### **UNIT-II: Reactive Programming in Shiny (20 hours)**

Basic reactivity: The server function and creating reactive outputs using Shiny's render functions, Reactive programming, Reactive graph, and reactive expressions.

#### **UNIT-III: Shiny in R Markdown (20 hours)**

R Markdown: Installation, Basics, Shiny with flexdashboard, Building Shiny documents by adding the option 'runtime: shiny' to the YAML metadata; Deploy Shiny apps to the web, Embedded Shiny apps, and Shiny widgets.

#### **Essential Readings**

1. Wickham, Hadley (2021). Mastering Shiny: Building Interactive Apps, Reports, and Dashboards Powered by R. O'Reilly Media. (<https://mastering-shiny.org/>)
2. <https://shiny.rstudio.com/tutorial/>
3. Xie, Yihui, Allaire, J.J, & Golemund, Garrett (2019). R Markdown: The Definitive Guide. CRC Press, Taylor & Francis Group. (<https://bookdown.org/yihui/rmarkdown/>)

#### **Suggested Reading**

- Granjon, David (2022). Outstanding User Interfaces with Shiny. CRC Press.

**Practical Exercises:** Practice exercises from first three chapters of Hadley’s Mastering Shiny.

### **Teaching Plan (SEC Paper: R-Shiny: Powerful Web Apps for Everyone)**

**Weeks 1, and 2:** What is Shiny? How Shiny works with R; Create Shiny app directory and file, Adding UI controls, and behaviour. [1]: Preface, and Chapter 1.

[2]: Welcome to Shiny: **Lesson1**, and **getting started**

**Weeks 3 to 5:** Basic UI: Building the UI using the fluidPage(), Input, and Output functions, and deploy Shiny apps locally using server function. [1]: Chapter 2

[2]: Build a UI and control widgets: **Lesson2**, and **Lesson3**

[2]: **User Interface and server function**

**Weeks 6 to 8:** Basic reactivity: The server function and creating reactive outputs using Shiny's render functions. [1]: Chapter 3 (pages 27-30); [2]: Reactive output: **Lesson4**

[2]: **Reactive Flow**, and **Reactive Elements**

**Weeks 9, and 10:** Reactive programming, Reactive graph, and reactive expressions.

[1]: Chapter 3 (pages 30-35).

[2]: Reactive expressions: **Lesson6**

**Weeks 11, and 12:** R Markdown: Installation, Basics, Shiny with flexdashboard.

[3]: Chapter 1, Chapter 2 (p. 5-8, and section 2.8.2, p. 42-45), Chapter 5 (Section 5.3, p. 131-135).

**Weeks 13 to 15:** Building Shiny documents by adding the option ‘runtime: shiny’ to the YAML metadata; Deploy Shiny apps to the web, Embedded Shiny apps, and Shiny widgets.

[3]: Chapter 19 (Sections 19.1 to 19.4, pages 283-293); [2]: Share Shiny Apps: **Lesson7**