University of Mumbai

Honours/Minor Degree Programs Booklet

(with effect from 2022-2023)

Faculty of Science and Technology

University of Mumbai

Syllabus for Approval

Title of Course	Honours and Minor Degree Programs

Eligibility	1. Third year underfraduate engineering student from semester V satisfying following eligibility criteria can opt for Honours and Minor Degree Programs
	  A. Students with no backlog in semester I, II, and III
	  B. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above
	  C. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above
	2. It is optional for students to take Honours/Minor degree program.

Ordinances / Regulations (if any)	
Passing Marks	40%
No. of years/Semesters:	Semesters - 4
Level:	U.G.
Pattern:	Semester
Status:	New
To be implemented from Academic Year :	From the academic year 2022-23

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology
University of Mumbai

Honours and Minor Degree Programs
in
Engineering and Technology

1.   Introduction:

As per the AICTE's Approval Process Handbook-2020-21: Chapter VII- clause 7.3.2 (Page 99-101), all branches of Engineering and Technology shall offer Elective Courses in the EMERGING AREAS viz., Artificial Intelligence (AI),

Internet of Things (IoT), Blockchain, Robotics, Quantum Computing, Data Sciences, Cyber Security, 3D Printing and Design, Augmented Reality/ Virtual Reality (AR/VR), as specified in Annexure 1 of the Approval Process Handbook.

a) Under Graduate Degree Courses in EMERGING AREAS shall be allowed as specialization from the same Department. The minimum additional Credits for such Courses shall be in the range of 18- 20 and the same shall be mentioned in the degree, as specialization in that particular area. For example, doing extra credits for Robotics in Mechanical Engineering shall earn B.E./ B.Tech. (Hons.) Mechanical Engineering with specialization in Robotics

b) Minor specialization in EMERGING AREAS in Under Graduate Degree Courses may be allowed where a student of another Department shall take the minimum additional Credits in the range of 18-20 and get a

degree with minor from another Department.

It is also made very clear by AICTE that areas in which Minor Degree/Honours may be offered are numerous. It is up to the Universities with the help of their Academic Board/Council to decide whether Minor Degree/Hons. is to be offered or not in any particular area, which is not mentioned above. AICTE approval is not required for offering Minor Degree/Hons. in any such area, however the criteria that "Minor Degree or Hons. will cumulatively require additional 18 to 20 credits in the
specified area in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e. 160 credits)"

2.   Proposed Honours and Minor Degree:

Honours and Minor degree program is introduced in order to facilitate the students to choose additionally the specialized courses in the emerging areas of their choice and build their competence in such domains. Based on AICTE guidelines, the Faculty of Science and Technology has proposed to offer following Honours/ Minor degree program corresponding to each engineering program:

Table 1: Honours / Minor Degree Programs

Sr. No	Honours/Minor degree programs
1	Infrastructure Engineering
2	Smart Cities
3	Waterways Transport Engineering

4	Professional Practices in Structural Engineering
5	Green Technology and Sustainability Engineering
6	Infrastructure Policies & Regulations
7	Artificial Intelligence and Machine Learning
8	Blockchain
9	Cyber Security
10	Virtual and Augmented Reality
11	Data Science
12	Internet of Things (IoT)
13	Waste Technology
14	Electric Vehicles
15	Microgrid Technologies
16	Robotics
17	3D Printing
18	Industrial Automation

Note: The Honours and Minor degree programs selection for each of the engineering programs offered in University of Mumbai is as given in Table 2.

3. Honours and Minor Degree Eligibility Criteria for Students:

In view of the above-mentioned guidelines issued by AICTE in APH 2020-21 for offering Honours and Minor degree in the various engineering programs, the following recommendations are proposed on the eligibility criteria for students opting for same;

i) **Eligibility criteria for opting the Honours/ Minor Degree program:**
  a. **Students with no backlog in semester I, II, and III**
  b. **The CGPI (based on semester I, II, and III) of the students must be 6.75 and above**
  c. **For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above**

ii) Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.

iii) However, it is optional for students to take Honours/Minor degree program.

iv) The Honours/ Minor degree program can be opted only during regular engineering studies

v) The student shall complete the Honours/Minor degree program in stipulated four semesters only.

4. Honours and Minor Degree Program Scheme and Structure:

Honours and Minor degree program be offered from academic year 2022-23 onwards along with Rev 2019 'C' scheme syllabus.

Honours and Minor credit courses will be offered from Semester V onwards to Semester VIII

5. Eligibility criteria for Department/Institute to offer Honours/Minor degree:

As the intention of offering the Honours degree program is to facilitate the advanced learners to build their competence in emerging areas with additional in-depth course work, it becomes very essential to ensure availability of such expert faculties and infrastructure with the departments and institutes. **The proposed modality of approval is self-assessment and declaration basis.** Institute can assess on following points before offering Honours/Minor degrees,

1. The Honours Degree program out of 18 programs listed in Table-1 can only be offered by an institute having the regular degree program running as specified in Table 2 column B.

2. Availability of Faculty expertise in domains of Honours/Minor degree programs
   a. Regular faculty on institute role who has completed PhD/Masters in same domain. OR
   b. Regular faculty on institute role who is doing research either sponsored by government agencies or industries or trusts.
      OR
   c. Regular faculty on institute role who has successfully completed certificate course in same domain and able to deliver the expectations of specialisation in emerging areas.

3. Availability of laboratory infrastructure/facilities in domains of Honours /Minor degree
   a. Established centre of excellence in same domain.
      OR
   b. Built research facilities to facilitate research in emerging areas
      OR
   c. Minimum facility is already developed to conduct hands on experience in chosen domains of Hons and Minor degrees.

Institute shall submit declaration of availability of expertise of faculty members and laboratory facilities to offer Hons/Minor degree to University well in advance (i.e before announcement of admission) for same to the Academic Authorities.

The verification of declaration of institute shall be done by LIC committees visiting for affiliation purpose or academic audit purpose.

6. Examination and Evaluation of Honours/Minor Degree Courses:

In current scenario First Year and Final Year of engineering examinations, assessments and result declaration are entirely done by University, while as in Second and Third Year question papers are delivered by University, assessment and results preparation and declaration after approval from university is done by Institute on behalf of University following all ordinances and regulations of

university. Hons/Minor degrees courses will be offered in Third and Final Year of engineering as specialisation in emerging areas.

By keeping in mind availability of expertise of faculty with particular Institute only, proposed following modalities of Examination and Evaluation,

a. The continuous assessment and End Sem. Examination (ESE) evaluation shall follow the same pattern as adopted for corresponding semester stated by the University.

b. Question paper will be set and delivered to institutes by University for all Hons/Minor degree

c. End semester Assessment will be done as per the laid down practices by following all applicable ordinances and regulations of university

d. Hons/Minor degree courses can be treated as Audit type of courses, wherein passing marks set will be 40. If any student scored equal or more than passing marks in particular course can be declared as pass.

e. Grading of courses offered under Hons/Minor degree shall be avoided and also not included in overall CUMMULATIVE GRADE POINT AVERAGE, to bring parity with all students admitted for the basic program.

f. Hons/Minor degree shall be conferred in addition to basic degree only after successfully completion of all courses

g. University can make provision for entering pass or fail in course offered under Hons/Minor degree on portal.

7.   Award of Honours / Minor Degree:

The students successfully completing the Honours / Minor Degree shall be awarded with the degree designated as: "B. E. in ………(regular) Engineering with Honours/Minor in ……..
(specialization)"

Example 1: Students s successfully completing BE in Computer Engineering with specialization (Honours) in Cyber Security shall get a degree as "B.E. in Computer Engineering (Honours- Cyber Security) "

Example 2: Students successfully completing BE in Computer Engineering with specialization (Minor) in Electric Vehicles shall get a degree as "B.E. in Computer Engineering (Minor - Electric Vehicles)"

Template for Honours degree Program Syllabus Scheme

<table>
<tr>
<td colspan="11">University of Mumbai
Honours in --------------
(With effect from 2022-23)</td>
</tr>
<tr>
<td rowspan="2">Year & Sem</td>
<td rowspan="2">Course Code and Course Title</td>
<td colspan="3">Teaching Scheme Hours / Week</td>
<td colspan="5">Examination Scheme and Marks</td>
<td>Credit Scheme</td>
</tr>
<tr>
<td>Theory</td>
<td>Seminar /Tutorial</td>
<td>Pract.</td>
<td>Internal Assess ment</td>
<td>End Sem. Exam</td>
<td>Ter m Work</td>
<td>Oral</td>
<td>Total</td>
<td>Credits</td>
</tr>
<tr>
<td rowspan="2">TE Sem. V</td>
<td>HXXC501: Subject 1</td>
<td>04</td>
<td>--</td>
<td>--</td>
<td>20</td>
<td>80</td>
<td>--</td>
<td>--</td>
<td>100</td>
<td>04</td>
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<td>-</td>
<td>100</td>
<td>04</td>
</tr>
<tr>
<td colspan="11">Total Credits = 04</td>
</tr>
<tr>
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</tr>
<tr>
<td rowspan="2">TE Sem. VI</td>
<td>HXXC601: Subject 2</td>
<td>04</td>
<td>--</td>
<td>--</td>
<td>20</td>
<td>80</td>
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</tr>
<tr>
<td colspan="11">Total Credits = 04</td>
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<tr>
<td rowspan="3">BE Sem. VII</td>
<td>HXXC701: Subject 3</td>
<td>04</td>
<td>--</td>
<td>--</td>
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<tr>
<td>HXXSBL701: Lab-1</td>
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<td>--</td>
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<tr>
<td colspan="11">Total Credits = 06</td>
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<tr>
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</tr>
<tr>
<td rowspan="2">BE Sem.VIII</td>
<td>HXXC801: Subject 4</td>
<td>04</td>
<td>-</td>
<td>--</td>
<td>20</td>
<td>80</td>
<td>--</td>
<td>--</td>
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</tr>
<tr>
<td colspan="11">Total Credits = 04</td>
</tr>
<tr>
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</tr>
<tr>
<td colspan="11">Total Credits for Semesters V,VI, VII &VIII = 04+04+06+04 = 18</td>
</tr>
<tr>
<td colspan="11">Reference: https://www.aicte-india.org/sites/default/files/APH%202020_21.pdf (page 99-101)</td>
</tr>
</table>

Honours and Minor Degree Programs

Mapping with Engineering/Technology Programs in University of Mumbai

Honour's/Minors degree program is being introduced by the Faculty of Science and Technology of University of Mumbai in order to facilitate the students to choose additionally the specialized courses in the emerging areas of their choice and build their competence in such domains. As per AICTE guidelines, Honours/Minors degree program to be chosen by eligible students (based on certain criteria given in manual) studying in third year of various Engineering program's are elaborated in following table to bring clarity to all stakeholders including students, faculty members and institutions. **Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.**

Table 2: Honours and Minor Degree Program Mapping with Engineering Programs

	Honours / Minor Degree Programs	Programs who can offer this Honours Degree Program	Programs who can offer this as Minor Degree program
Row	Column A	Column B	Column C
11	Data Science	1 Computer Engineering 2 Electronics and Telecomm. Engineering 3 Electronics Engineering 4 Information Technology 5 Electronics and Computer Science 6 Mechanical Engineering 7 Production Engineering 8 Automobile Engineering 9 Computer Science and Engineering (Internet of Things & Cyber Security including Blockchain) 10 Cyber Security 11 Computer Science and Engineering (Artificial Intelligence & Machine Learning) 12 Internet of Things 13 Artificial Intelligence & Machine Learning 14 Electrical Engineering 15 Computer Science and Design	1. Civil Engineering 2. Civil and Infrastructure Engineering 3. Mechatronics Engineering 4. Printing and Packaging Technology 5. Chemical Engineering 6. Instrumentation Engineering

Self-assessment and Declaration form for starting Honours/Minor Programs under University of Mumbai

Name of Institute:		
Honours / Minor Program:		
Do you have regular program to offer Honours Program?		**Yes/No**
If Yes,		
Availability of **Regular Engineering Programs** (as specified in Table 2 column B of Honours and Minor Degree Program Manual Part-1)	**Following regular programs exists in Institute to offer Honours Program mentioned above,** 1. 2. 3.	
Do you have availability of Faculty expertise as per criteria mentioned in manual to offer Honours Program?		**Yes/No**
If Yes, (Strike through whichever is not applicable)		
1.	**Regular faculty** on institute role who is doing research either sponsored by government agencies or industries or trusts.	**Yes** **No**
2.	**Regular faculty** on institute role who had completed either Phd or Masters in same domain of Honours Program.	**Yes** **No**
3.	Regular faculty on institute role who has successfully completed **certificate course** in same domain of Honours Program	**Yes** **No**
Do you have availability of laboratory facilities as per criteria mentioned in manual to offer Honours Program?		**Yes/No**
If Yes, (Strike through whichever is not applicable)		
1.	**Availability of** Established **Centre of Excellence** (**CoE**) in same domain of Honours Program	**Yes** **No**
2.	**Availability of Research Facilities built to** facilitate research in same domain of Honours Program.	**Yes** **No**
3.	**Availability of Minimum facility** to conduct hands on experience in same domain of Honours Program	**Yes** **No**

This is to certify that Departments offering honours programs is assessed and found that at least one of the eligibility norms in each of the three eligibility criteria has been found fulfilling. Hence forwarded application for starting Honours program in " .... " to University of Mumbai.

Head of Institute sign and seal
(Enclosure: Supporting documents of fulfilling criteria's)

UNIVERSITY OF MUMBAI
Honours/Minor Degree Programs
(with effect from 2022-2023)

Note: Course code format used in the document

1. Course Code: HXXC-Z01: (example- HEVC-501) H stands for Honours/ Minor course
   XX : Abbrevation of Program code: eg. For Electric Vehicles- it is 'EV' C- Theory Course
   Z for semester. For sem 5 -> 501

2. Skill Based Lab Code: HXXSBL-Z01: (example- HEVSBL-701) H stands for Honours/ Minor course
   XX : Abbrevation of Program code: eg. For Electric Vehicles- it is 'EV' SBL- Theory Course
   Z for semester. For sem 7 -> 701

University of Mumbai

Syllabus for

Honours/Minor Degree Program

In

Data Science

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2022-2023)

<table>
<tr><th colspan="11">University of Mumbai
Data Science
(With effect from 2022-23)</th></tr>
<tr><th rowspan="2">Year & Sem</th><th rowspan="2">Course Code & Course Title</th><th colspan="3">Teaching Scheme Hrs / Week</th><th colspan="5">Examination Scheme and Marks</th><th>Credit Scheme</th></tr>
<tr><th>Theory</th><th>Seminar / Tutorial</th><th>Practical</th><th>Internal Assessment</th><th>End Sem Exam</th><th>Term Work</th><th>Oral</th><th>Total</th><th>Credits</th></tr>
<tr><td>TE Sem V</td><td>HDSC501: Mathematics for Data Science</td><td>04</td><td>--</td><td>--</td><td>20</td><td>80</td><td>--</td><td>--</td><td>100</td><td>04</td></tr>
<tr><td></td><td>Total</td><td>04</td><td>-</td><td>--</td><td>100</td><td>-</td><td>-</td><td>-</td><td>100</td><td>04</td></tr>
<tr><td colspan="11" align="right">Total Credits = 04</td></tr>
<tr><td colspan="11"></td></tr>
<tr><td>TE Sem VI</td><td>HDSC601: Statistical Learning for Data Science</td><td>04</td><td>--</td><td>--</td><td>20</td><td>80</td><td>--</td><td>--</td><td>100</td><td>04</td></tr>
<tr><td></td><td>Total</td><td>04</td><td>-</td><td>-</td><td>100</td><td>-</td><td>-</td><td>-</td><td>100</td><td>04</td></tr>
<tr><td colspan="11" align="right">Total Credits = 04</td></tr>
<tr><td colspan="11"></td></tr>
<tr><td>BE Sem VII</td><td>HDSC701: Data Science for Health and Social Care</td><td>04</td><td>--</td><td>--</td><td>20</td><td>80</td><td>--</td><td>--</td><td>100</td><td>04</td></tr>
<tr><td></td><td>HDSSBL701: Data Science for Health and Social Care: Lab</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>50</td><td>50</td><td>100</td><td>02</td></tr>
<tr><td></td><td>Total</td><td>04</td><td>-</td><td>04</td><td colspan="2">100</td><td>50</td><td>50</td><td>200</td><td>06</td></tr>
<tr><td colspan="11" align="right">Total Credits = 06</td></tr>
<tr><td colspan="11"></td></tr>
<tr><td>BE Sem VIII</td><td>HDSC801: Text, Web and Social Media Analytics</td><td>04</td><td>-</td><td>--</td><td>20</td><td>80</td><td>--</td><td>--</td><td>100</td><td>04</td></tr>
<tr><td></td><td>Total</td><td>04</td><td>-</td><td>-</td><td>100</td><td>-</td><td>-</td><td>-</td><td>100</td><td>04</td></tr>
<tr><td colspan="11" align="right">Total Credits = 04</td></tr>
<tr><td colspan="11"></td></tr>
<tr><td colspan="11" align="center">Total Credits for Semesters V, VI, VII &VIII = 04+04+06+04 = 18</td></tr>
</table>

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSC501	Mathematics for Data Science	04	--	--	04	--	--	04

<div align="center">

Data Science: Sem V

</div>

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
HDSC501	Mathematics for Data Science	20	20	20	80	03	--	--	100

Course Prerequisites:	
1	Applied Mathematics, Discrete Mathematics
Course Objectives:	
1	To build an intuitive understanding of Mathematics and relating it to Data Analytics.
2	To provide a strong foundation for probabilistic and statistical analysis mostly used in varied applications in Engineering.
3	To focus on exploring the data with the help of graphical representation and drawing conclusions.
4	To explore optimization and dimensionality reduction techniques.
Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Use linear algebra concepts to model, solve, and analyze real-world problems.
2	Apply probability distributions and sampling distributions to various business problems.
3	Select an appropriate graph representation for the given data analysis.
4	Apply exploratory data analysis to some real data sets and provide interpretations via relevant visualization
5	Analyze various optimization techniques for data analysis.
6	Describe Dimension Reduction Algorithms in analytics

Module		Topics	Hours.
1.0		**Linear Algebra**	05
	1.1	Vectors and Matrices, Solving Linear equations, The four Fundamental Subspaces, Eigenvalues and Eigen Vectors, The Singular Value Decomposition (SVD).	
2.0		**Probability and Statistics**	09
	2.1	Introduction, Random Variables and their probability Distribution, Random Sampling, Sample Characteristics and their Distributions, Chi-Square, t-, and F-Distributions: Exact Sampling Distributions, Sampling from a Bivariate Normal Distribution, The Central Limit Theorem.	

3.0		Introduction to Graphs	10
	3.1	Quantitative vs. Qualitative data, Types of Quantitative data: Continuous data, Discrete data, Types of Qualitative data: Categorical data, Binary data, Ordinary data, Plotting	

		data using Bar graph, Pie chart, Histogram, Stem and Leaf plot, Dot plot, Scatter plot, Time-series graph, Exponential graph, Logarithmic graph, Trigonometric graph, Frequency distribution graph.	
4.0		**Exploratory Data Analysis**	09
	4.1	Need of exploratory data analysis, cleaning and preparing data, Feature engineering, Missing values, understand dataset through various plots and graphs, draw conclusions, deciding appropriate machine learning models.	
5.0		**Optimization Techniques**	10
	5.1	Types of optimization-Constrained and Unconstrained optimization, Methods of Optimization-Numerical Optimization, Bracketing Methods-Bisection Method, False Position Method, Newton's Method, Steepest Descent Method, Penalty Function Method.	
6.0		**Dimension Reduction Algorithms**	05
	6.1	Introduction to Dimension Reduction Algorithms, Linear Dimensionality Reduction: Principal component analysis, Factor Analysis, Linear discriminant analysis.	
	6.2	Non-Linear Dimensionality Reduction: Multidimensional Scaling, Isometric Feature Mapping. Minimal polynomial	
		Total	48

Text Books:
1 Linear Algebra for Everyone,
2 Gilbert Strang, Wellesley Cambridge Press.
3 An Introduction to Probability and Statistics, Vijay Rohatgi, Wiley Publication
4 An introduction to Optimization, Second Edition, Wiley-Edwin Chong, Stainslaw Zak.
5 Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge
   University Press.
6 Exploratory Data Analysis, John Tukey, Princeton University and Bell Laboratories.

References:

1 Introduction to Linear Algebra, Gilbert Strang.
2 Advanced Engineering Mathematics, Erwin Kreyszig
3 Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar. Foundations of Machine Learning. MIT Press,
   2018.
4 Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms.
   Cambridge University Press, 2014
5 Last updated on Sep 9, 2018.
6 Mathematics and Programming for Machine Learning with R, William B. Claster, CRC Press,2020

Useful Links:

1 https://math.mit.edu/~gs/linearalgebra/
2 https://www.coursera.org/learn/probability-theory-statistics
3 https://nptel.ac.in/courses/111/105/111105090/
4 https://onlinecourses.nptel.ac.in/noc21_ma01/preview
5 https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/

Assessment:

Internal Assessment: (20)

1 Assessment consists of two class tests of 20 marks each.
2 The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when
additional 40% syllabus is completed.

3   Duration of each test shall be one hour.

End Semester Theory Examination: (80)

1   Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2   **Question No: 01** will be **compulsory** and based on the entire syllabus wherein 4 to 5 sub-questions will be
    asked.
3   Remaining questions will be mixed in nature and randomly selected from all the modules.
4   Weightage of each module will be proportional to number of respective lecture hours as mentioned in the
    syllabus.
5   **Total 04 questions** need to be solved.

Data Science: Sem VI							
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSC601	Statistical Learning for Data Science	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
HDSC601	Statistical Learning for Data Science	20	20	20	80	03	--	--	100

Course Prerequisites:	
1	Engineering Mathematics, Probability and Statistics

Course Objectives:	
1	To understand basic statistical foundations for roles of Data Scientist.
2	To develop problem-solving skills.
3	To infer about the population parameters using sample data and perform hypothesis testing.
4	To understand importance and techniques of predicting a relationship between data and determine the goodness of model fit.

Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Develop various visualizations of the data in hand.
2	Analyze a real-world problem and solve it with the knowledge gained from sampling and probability distributions.
3	Analyze large data sets and perform data analysis to extract meaningful insights.
4	Develop and test a hypothesis about the population parameters to draw meaningful conclusions.
5	Fit a regression model to data and use it for prediction.

Module No.		Topics	Hours.
1.0		**Introduction**	08
	1.1	**Data and Statistics**: Elements, Variables, and Observations, Scales of Measurement, Categorical and Quantitative Data, Cross-Sectional and Time Series Data, Descriptive Statistics, Statistical Inference, Descriptive Statistics: Tabular and Graphical Summarizing Categorical Data, Summarizing Quantitative Data, Cross Tabulations and Scatter Diagram.	
	1.2	**Descriptive Statistics: Numerical Measures**: Measures of Location, Measures of Variability, Measures of Distribution Shape, Relative Location, and	

		Detecting Outliers, Box Plot, Measures of Association Between Two Variables	

2.0		**Probability**	**08**
	2.1	**Probability :** Experiments, Counting Rules, and Assigning Probabilities, Events and Their Probabilities, Complement of an Event, Addition Law Independent Events, Multiplication Law, Baye's theorem	
	2.2	**Discrete Probability Distributions** Random Variables, Discrete Probability Distributions, Expected Value and Variance, Binomial Probability Distribution, Poisson Probability Distribution	
	2.3	**Continuous Probability Distributions:** Uniform Probability Distribution, Normal Curve, Standard Normal Probability Distribution, Computing Probabilities for Any Normal Probability Distribution	
3.0		**Sampling and Sampling Distributions**	05
	3.1	Sampling from a Finite Population, Sampling from an Infinite Population, Other Sampling Methods, Stratified Random Sampling, Cluster Sampling, Systematic Sampling, Convenience Sampling, Judgment Sampling	
	3.2	Interval Estimation: Population Mean: Known, Population Mean: Unknown, Determining the Sample Size, Population Proportion	
4.0		**Hypothesis Tests**	05
	4.1	Developing Null and Alternative Hypotheses, Type I and Type II Errors, Population Mean: Known Population Mean: Unknown Inference About Means and Proportions with Two Populations-Inferences About Population Variances, Inferences About a Population Variance, Inferences About Two Population Variances	
	4.2	Tests of Goodness of Fit and Independence, Goodness of Fit Test: A Multinomial Population, Test of Independence	
5.0		**Regression**	08
	5.1	**Simple Linear Regression:** Simple Linear Regression Model, Regression Model and Regression Equation, Estimated Regression Equation, Least Squares Method, Coefficient of Determination, Correlation Coefficient, Model Assumptions, testing for Significance, Using the Estimated Regression Equation for Estimation and Prediction Residual Analysis: Validating Model Assumptions, Residual Analysis: Outliers and Influential Observations	
	5.2	**Multiple Regression:** Multiple Regression Model, Least Squares Method, Multiple Coefficient of Determination, Model Assumptions, Testing for Significance, Categorical Independent Variables, Residual Analysis	
6.0		**Time Series Analysis and Forecasting**	05

	6.1	Time Series Patterns, Forecast Accuracy, Moving Averages and Exponential Smoothing, Trend Projection, Seasonality and Trend and Time Series Decomposition	
	6.2	**Nonparametric Methods** Sign Test, Wilcoxon Signed-Rank Test, Mann-Whitney-Wilcoxon Test, Kruskal- Wallis Test, Rank Correlation	
		Total	**48**

Text Books:

1 https://static1.squarespace.com/static/5ff2adbe3fe4fe33db902812/t/6009dd9fa7bc363aa822d2c7/1611259312432/ISLR+Seventh+Printing.pdf
2 Data Science from Scratch, FIRST PRINCIPLES WITH PYTHON, O'Reilly, Joel Grus,
3 Data Science from Scratch (oreillystatic.com)
4 Practical Time Series Analysis, Prediction with statistics and Machine Learning, O'Reilly, Aileen
   Nielsen [DOWNLOAD] O'Reilly Practical Time Series Analysis PDF (lunaticai.com)
5 R for data science: Import, Tidy, Transform, Visualize, And Model Data, O'Reilly , Garrett Grolemund,
   Hadley Wickham
6 Python for Data Analysis, 2nd Edition, O'Reilly Media, Wes McKinney.
7 https://static1.squarespace.com/static/5ff2adbe3fe4fe33db902812/t/6009dd9fa7bc363aa822d2c7/1611259312432/ISLR+Seventh+Printing.pdf

References:

1 Data Science for Dummies Paperback, Wiley Publications, Lillian Pierson
2 Storytelling with Data: A Data Visualization, Guide for Business Professionals, Wiley Publications,
   Cole Nussbaumer Knaflic
3 Probability and Statistics for Engineering and the Sciences, Cengage Publications Jay L. Devore.

Assessment:

Internal Assessment: (20)

1 Assessment consists of two class tests of 20 marks each.
2 The first-class test is to be conducted when approx. 40% syllabus is completed and second-class
   test when additional 40% syllabus is completed.
3 Duration of each test shall be one hour.

End Semester Theory Examination: (80)

1 Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2 **Question No: 01** will be **compulsory** and based on the entire syllabus wherein 4 to 5 sub-questions
   will be asked.
3 Remaining questions will be mixed in nature and randomly selected from all the modules.
4 Weightage of each module will be proportional to number of respective lecture hours as mentioned
   in the syllabus.
5 **Total 04 questions** need to be solved.

Data Science: Sem VII							
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSC701	Data Science for Health and Social Care	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration	Term Work	Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
HDSC701	Data Science for Health and Social Care	20	20	20	80	03	--	--	100

Course Prerequisites:
Artificial Intelligence, Machine Learning

Course Objectives: The course aims	
1	To gain perspective of Data Science for Health and Social Care.
2	To understand different techniques of Biomedical Image Analysis.
3	To learn NLP techniques for processing Clinical text.
4	To understand the role of social media analytics for Healthcare data .
5	To learn advanced analytics techniques for Healthcare Data.
6	To investigate the current scope, potential, limitations, and implications of data science and its applications for healthcare.

Course Outcomes:	
After successful completion of the course, the student will be able to:	
1	Identify sources and structure of healthcare data.
2	Apply structured lifecycle approach for handling Healthcare data science projects.
3	Analyze the data, create models, and identify insights from Healthcare data.
4	Apply various data analysis and visualization techniques for Healthcare and social media data.
5	Apply various algorithms and develop models for Healthcare data science projects.
6	To Provide data science solutions for solving problems of Health and Social Care.

Module		Topics	Hours.
1.0		**Data Science for Healthcare**	05
	1.1	Introduction, Healthcare Data Sources and Data Analytics for Healthcare, Applications and Practical Systems for Healthcare.	
	1.2	Electronic Health Records(EHR), Components of EHR, Benefits of EHR, Barriers to Adopting EHR, Challenges of using EHR data, Phenotyping Algorithms	
2.0		**Biomedical Image Analysis**	06
	2.1	Biomedical Imaging Modalities, Object detection ,Image segmentation, Image Registration, Feature Extraction	
	2.2	Mining of Sensor data in Healthcare, Challenges in Healthcare Data Analysis	
	2.3	Biomedical Signal Analysis, Genomic Data Analysis for Personalized Medicine.	
3.0		**Data Science and Natural Language Processing for Clinical Text**	06

	3.1	NLP, Mining information from Clinical Text, Information Extraction, Rule Based Approaches, Pattern based algorithms, Machine LearningAlgorithms.	
	3.2	Clinical Text Corpora and evaluation metrics, challenges in processing clinical reports, Clinical Applications.	
4.0		**Social Media Analytics for Healthcare**	06
	4.1	Social Media analysis for detection and tracking of Infectious Disease outbreaks.	
	4.2	Outbreak detection, Social Media Analysis for Public Health Research, Analysis of Social Media Use in Healthcare.	
5.0		**Advanced Data Analytics for Healthcare**	08
	5.1	Review of Clinical Prediction Models, Temporal Data Mining for Healthcare Data	
	5.2	Visual Analytics for Healthcare Data, Information Retrieval for Healthcare- Data Publishing Methods in Healthcare.	
6.0		**Data Science Practical Systems for Healthcare**	08
	6.1	Data Analytics for Pervasive Health, Fraud Detection in Healthcare	
	6.2	Data Analytics for Pharmaceutical discoveries, Clinical Decision Support Systems	
	6.3	Computer-Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data.	
		Total	48

Textbooks:

1 Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2015.
2 Hui Yang and Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.

References:

1 Madsen, L. B. (2015). Data-driven healthcare: how analytics and BI are transforming the industry. Wiley India Private Limited

2 Strome, T. L., & Liefer, A. (2013). Healthcare analytics for quality and performance improvement.
Hoboken, NJ, USA: Wiley

3 McNeill, D., & Davenport, T. H. (2013). Analytics in Healthcare and the Life Sciences: Strategies,
Implementation Methods, and Best Practices. Pearson Education.

4 Rachel Schutt and Cathy O'Neil, "Doing Data Science", O'Reilly Media

5 Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media

6 EMC Education Services,"Data Science and Big Data Analytics",Wiley

Assessment:

Internal Assessment: (20)

1 Assessment consists of two class tests of 20 marks each.
2 The first-class test is to be conducted when approx. 40% syllabus is completed and second-class
test when additional 40% syllabus is completed.
3 Duration of each test shall be one hour.

End Semester Theory Examination: (80)

1 Question paper will comprise of **total 06** questions, each carrying **20 marks**.

2   **Question No: 01** will be **compulsory** and based on the entire syllabus wherein 4 to 5 sub-questions will be asked.
3   Remaining questions will be mixed in nature and randomly selected from all the modules.
4   Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5   **Total 04 questions** need to be solved.

Data Science: Sem VIII								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSC801	Text, Web and Social Media Analytics	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
HDSC801	Text, Web and Social Media Analytics	20	20	20	80	03	--	--	100

Course Prerequisites:
Python, Data Mining

Course Objectives: The course aims

1	To have a strong foundation on text, web and social media analytics.
2	To understand the complexities of extracting the text from different data sources and analysing it.
3	To enable students to solve complex real-world problems using sentiment analysis and Recommendation systems.

Course Outcomes:

After successful completion of the course, the student will be able to:

1	Extract Information from the text and perform data pre-processing
2	Apply clustering and classification algorithms on textual data and perform prediction.
3	Apply various web mining techniques to perform mining, searching and spamming of web data.
4	Provide solutions to the emerging problems with social media using behaviour analytics and Recommendation systems.
5	Apply machine learning techniques to perform Sentiment Analysis on data from social media.

Module No.		Topics	Hours.
1.0		**Introduction**	06
	1.1	**Introduction to Text Mining:** Introduction, Algorithms for Text Mining, Future Directions	
	1.2	**Information Extraction from Text**: Named Entity Recognition, Relation Extraction, Unsupervised Information Extraction	
	1.3	**Text Representation:** tokenization, stemming, stop words, NER, N-gram modelling	
2.0		Clustering and Classification	10

	2.1	**Text Clustering**: Feature Selection and Transformation Methods, distance based Clustering Algorithms, Word and Phrase based Clustering, Probabilistic document Clustering	
	2.2	**Text Classification**: Feature Selection, Decision tree Classifiers, Rule-based Classifiers, Probabilistic based Classifiers, Proximity based Classifiers.	
	2.3	**Text Modelling:** Bayesian Networks, Hidden Markovian Models, Markov random Fields, Conditional Random Fields	
3.0		**Web-Mining:**	05
	3.1	**Introduction to Web-Mining:** Inverted indices and Compression, Latent Semantic Indexing, Web Search,	
	3.2	**Meta Search:** Using Similarity Scores, Rank Positons	
	3.3	**Web Spamming**: Content Spamming, Link Spamming, hiding Techniques, and Combating Spam	
4.0		**Web Usage Mining:**	**05**
	4.1	Data Collection and Pre-processing, Sources and types of Data, Data Modelling, Session and Visitor Analysis, Cluster Analysis and Visitor segmentation, Association and Correlation Analysis, Analysis of Sequential and Navigational Patterns, Classification and Prediction based on Web User Transactions.	
5.0		**Social Media Mining**:	**05**
	5.1	Introduction, Challenges, Types of social Network Graphs	
	5.2	Mining Social Media: Influence and Homophily, Behaviour Analytics, Recommendation in Social Media: Challenges, Classical recommendation Algorithms, Recommendation using Social Context, Evaluating recommendations.	
6.0		**Opinion Mining and Sentiment Analysis**:	**08**
	6.1	The problem of opinion mining,	
	6.2	**Document Sentiment Classification**: Supervised, Unsupervised	
	6.3	**Opinion Lexicon Expansion:** Dictionary based, Corpus based	
	6.4	**Opinion Spam Detection**: Supervised Learning, Abnormal Behaviours, Group Spam Detection.	
		Total	**48**

Textbooks:

1 Daniel Jurafsky and James H. Martin, "Speech and Language Processing," 3rd edition, 2020
2 Charu. C. Aggarwal, Cheng Xiang Zhai, Mining Text Data, Springer Science and Business Media,

2012.

3   BingLiu, "Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data", Springer, Second Edition, 2011.

4   Reza Zafarani, Mohammad Ali Abbasiand Huan Liu, "Social Media Mining- An Introduction",
    Cambridge
    University Press, 2014

Assessment:

Internal Assessment: (20)

1   Assessment consists of two class tests of 20 marks each.
2   The first-class test is to be conducted when approx. 40% syllabus is completed and second-class
    test when additional 40% syllabus is completed.
3   Duration of each test shall be one hour.

End Semester Theory Examination: (80)

1   Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2   **Question No: 01** will be **compulsory** and based on the entire syllabus wherein 4 to 5 sub-questions
    will be asked.
3   Remaining questions will be mixed in nature and randomly selected from all the modules.
4   Weightage of each module will be proportional to number of respective lecture hours as mentioned
    in the syllabus.
5   **Total 04 questions** need to be solved.

Data Science: Sem VII							
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HDSSBL701	Data Science for Health and Social Care: Lab	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration	Term Work	Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
HDSSBL701	Data Science for Health and Social Care: Lab						50	50	100

Course Prerequisites:
Python
Course Outcomes:
After successful completion of the course, the student will be able to:
1	Students will be able to, Identify sources of data, suggest methods for collecting, sharing and analyzing Healthcare data.
2	Students will be able to Clean, integrate and transform healthcare data.
3	Students will be able to apply various data analysis and visualization techniques on healthcare data.
4	Students will be able to apply various algorithms and develop models for healthcare data Analytics.
5	Students will be able to implement data science solutions for solving healthcare problems.

Suggested Experiments:	
Sr. No.	Name of the Experiment
	Introduction
1	Clean, Integrate and Transform Electronic Healthcare Records.
2	Apply various data analysis and visualization techniques on EHR.
3	Bio Medical Image Preprocessing, Segmentation.
4	Bio Medical Image Analytics.
5	Text Analytics for Clinical Text Data.
6	Diagnose disease risk from Patient data.
7	Social Media Analytics for outbreak prediction/ Drug review analytics.
8	Visual Analytics for Healthcare Data.

9	Implement an innovative Data Science application based on Healthcare Data.
10	Documentation and Presentation of Mini Project.

Useful Links:

1 http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=MachineLearning
2 http://www.cse.wustl.edu/~kilian/cse517a2010/
3 https://datarade.ai/data-categories/electronic-health-record-ehr-data
4 https://www.cms.gov/Medicare/E-Health/EHealthRecords
5 https://onlinecourses.nptel.ac.in/noc20_ee40

Term Work:

1 Term work should consist of 8 experiments and a Mini Project.
2 The final certification and acceptance of term work ensures satisfactory performance of laboratory

work and minimum passing marks in term work.
3 Total 25 Marks (Experiments: 10-Marks, Mini Project-10 Marks, Attendance Theory & Practical: 05-

marks)

Oral & Practical exam

1 Based on the entire syllabus of **AI ML for Healthcare**