University of Mumbai

AAMS_UGS/ICD/2022-23/86

CIRCULAR:-

<u>**Sub:- (Artificial Intelligence and Data Science) (CBCS).**</u>

<u>**Ref:- RB/MU-2022/CR-207/Edn-5/899, dated 18th August, 2022**</u>

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No.UG/194 of 2019-20 dated 16th February, 2020 relating to the Syllabus & Ordinances of M. Tech. (Chemical Engineering) (CBCGS), M. Tech. (Artificial Intelligence) and M.Tech. (Transportation Engineering).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Computer Engineering at its meeting held on 18th November, 2021 <u>vide</u> item No. 2 and subsequently passed by the Board of Deans at its online meeting held on 2nd May, 2022 <u>vide</u> item No. 6.5 (N) have been accepted by the Academic Council at its meeting held on 17th May, 2022 <u>vide</u> item No. 6.8 (N) and subsequently approved by the Management Council at its meeting held on 25th May, 2022 <u>vide</u> item No. 4 and that in accordance therewith, in exercise of the powers conferred upon the Management Council under Section 74(4) of the Maharashtra Public Universities Act, 2016 (Mah. Act No. VI of 2017) for the amendment of **adding new branch for (Artificial Intelligence and Data Science) (CBCS).** from the academic year 2022-23. and to read as under:-

<u>**Amendment of O. 5134 relating to the adding new branch for (Artificial Intelligence and Data Science) (CBCS).**</u>

Existing O. 5134:-

Any person who has passed an examination for the Degree of Bachelor of Engineering of this University or the degree of Bachelor of Engineering of any other University recognized as equivalent to the Bachelor of Engineering degree of the University is deemed eligible for admission to the Masters degree course in Engineering in the specific branch in which he/she has taken the degree of Bachelor of Engineering of a related branch as listed below :-

Master of Engineering	Bachelor of Engineering
1. Civil Engineering with (i) Environmental Engineering Subjects (ii) Hydraulics Engineering Subjects (iii) Water Resource Engineering Subjects	a. Civil Engineering OR b. Environmental Engineering OR c. Construction Engineering OR d. Water Management
1.Civil Engineering with (iv) Structural Engineering Subjects (v) Construction Management Subjects (vi) Goo-technical Engineering Subjects (vii)Traffic and Transportation Engineering Subjects	a. Civil Engineering OR b. Construction Engineering OR c. Structural Engineering
1.Civil Engineering - Construction Engineering and Management	a. Civil Engineering OR b. Construction Engineering

2.Mechanical Engineering with (i) Machine Design Subjects (ii) Automobile Engineering Subjects (iii) CAD/ CAM & Robotics subjects	a. Mechanical Engineering OR b. Automobile engineering OR c. Production Engineering OR d. Aerospace / Aeronautical Engineering
2.Mechanical Engineering with (iv) Fluid Pumping Machine Subjects (v) Internal Combustion Engineering Subject (vi) Thermal Engineering Subjects (vii) Heat Power subjects (viii) Energy Engineering subjects	a. Mechanical Engineering OR b. Automobile Engineering OR c. Aerospace / Aeronautical Engineering
2.Mechanical Engineering with (ix) Manufacturing systems Engineering subjects (x) Production Engineering subjects	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Industrial Engineering OR e. Machine Tool Engineering OR f. Metallurgical Engineering
2.Mechanical Engineering i) Energy System & Management ii) Product Design & Development	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Aerospace Engineering
3. Production Engineering	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Industrial Engineering OR e. Machine Tool Engineering OR f. Metallurgical Engineering
4. Electrical Engineering with (i) Control Systems Engineering Subjects (ii) Power Systems Engineering Subjects (iii) Power Electronics and Drives	a. Electrical Engineering OR b. Electronics Engineering OR c. Instrumentation Engineering OR d. Power Electronics OR e. Electronics and Power OR f. Industrial Electronics OR g. Electronics and Telecommunication Engineering
4. Electrical Engineering - Power Plant Engineering & Energy Management	a. Electrical Engineering OR b. Electronics & Power OR c. Power Engineering OR d. Instrumentation Engineering

5. Electronics Engineering
 	
**6. Electronics & Telecommunication
    Engineering**
	a. Electrical Engineering Or
	b. Electronics Engineering OR
	c. Electronics and Telecommunication
	    Engineering OR
	d. Instrumentation Engineering OR
	e. Computer Engineering OR
	f. Power Engineering OR
	g. Biomedical Engineering OR
	h. Information Technology

7. Instrumentation Engineering	a. Electrical Engineering OR b. Electronics engineering OR

8. Instrumentation & Control Engineering	c. Instrumentation Engineering OR d. Power Electronics OR e. Biomedical Engineering OR f. Mechanical Engineering OR g. Chemical Engineering.
9. Computer Engineering	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics and Telecommunication Engineering OR e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics
10. Information Technology **11. Information Technology in Information Security** **12. Information Technology in Information and Cyber warfare** **13. Information Technology in AI and Robotics**	All Branches of the Bachelor of Engineering/ Technology degree courses
14. Biomedical Engineering	a. Biomedical Engineering OR b. Computer Engineering OR c. Instrumentation Engineering OR d. Electronics Engineering OR e. Electronics and Telecommunication Engineering OR f. Electrical Engineering OR g. Information Technology OR h. Electronics and Power Engineering OR i. Electrical and Electronics Engineering OR j. Power Electronics
15. Chemical Engineering	a. Chemical Engineering OR b. Chemical Technology OR c. Petrochemical Engineering OR d. Petroleum Engineering OR e. Biotechnology
16. Signal Processing	a. Electrical Engineering OR b. Electronics Engineering OR c. Electronics & Telecommunication Engineering OR d. Instrumentation Engineering OR e. Computer Engineering OR f. Power Electronics OR g. Biomedical Engineering
17. Packing Technology	a. B.E. (Printing & Packing Technology) OR b. B.E. (Printing Technology) OR c. B.E. (Packing Technology) OR d. B.E. (Mechanical Engineering) OR e. B.E. (Chemical Engineering) OR f. B.E. (Plastic Engineering) OR g. B.E. (Polymers Engineering) OR h. B.E. (Food Technology) OR i. B.E. (Bio-Technology)

18. Advance Communication & Information System	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics & Telecommunication Engineering Or e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics
19. Artificial Intelligence	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics & Telecommunication Engineering Or e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics

Notwithstanding what is stated above, candidate who have passed the Section A and section B examination conducted by the (1) The Institution of Engineers (India), Kolkota 700020 and (2) Institution of Electronics and Telecommunication Engineers (India), New Delhi, is deemed eligible for admission to the Master of Engineering degree course in the specific branch in which they have passed Section A and Section B examination of a related branch as listed above.

And,

Any person who has passed an examination for the Degree of Bachelor of Engineering of this University or the degree of Bachelor of Engineering/ Bachelor of Technology of any other University recognized as equivalent to the Bachelor of Engineering degree of this University is deemed eligible for admission to the Master degree course in Engineering\Technology in the specific branch in which he/she has taken the degree of Bachelor of Engineering / Bachelor of Technology of a related branch as listed below :-

Master of Engineering	**Bachelor of Engineering**
1. Computer Engineering	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics and Tele-Communication Engineering OR e. Instrumentation Engineering f. Information Technology g. Power Electronics
2. Chemical Engineering	a. Chemical Engineering OR b. Chemical Technology OR c. Petrochemical Engineering OR d. Petroleum Engineering OR e. Biotechnology
3. Artificial Intelligence	a. Computer Engineering OR b. Electrical engineering OR c. Electronics Engineering OR d. Electronics and Tele-Communication OR e. Instrumentation Engineering f. Information Technology g. Power Electronics
4. Transportation Engineering	a. Civil Engineering OR b. Construction Engineering OR c. Structural Engineering

Amended O. 5134:-

Any person who has passed an examination for the Degree of Bachelor of Engineering of this University or the degree of Bachelor of Engineering of any other University recognized as equivalent to the Bachelor of Engineering degree of the University is deemed eligible for admission to the Masters degree course in Engineering in the specific branch in which he/she has taken the degree of Bachelor of Engineering of a related branch as listed below :-

Master of Engineering	Bachelor of Engineering
1. Civil Engineering with (i) Environmental Engineering Subjects (ii) Hydraulics Engineering Subjects (iii) Water Resource Engineering Subjects	a. Civil Engineering OR b. Environmental Engineering OR c. Construction Engineering OR d. Water Management
1.Civil Engineering with (iv) Structural Engineering Subjects (v) Construction Management Subjects (vi) Goo-technical Engineering Subjects (vii) Traffic and Transportation Engineering Subjects	a. Civil Engineering OR b. Construction Engineering OR c. Structural Engineering
1.Civil Engineering - Construction Engineering and Management	a. Civil Engineering OR b. Construction Engineering
2.Mechanical Engineering with (i) Machine Design Subjects (ii) Automobile Engineering Subjects (iii) CAD/ CAM & Robotics subjects	a. Mechanical Engineering OR b. Automobile engineering OR c. Production Engineering OR d. Aerospace / Aeronautical Engineering
2.Mechanical Engineering with (iv) Fluid Pumping Machine Subjects (v) Internal Combustion Engineering Subject (vi) Thermal Engineering Subjects (vii) Heat Power subjects (viii) Energy Engineering subjects	a. Mechanical Engineering OR b. Automobile Engineering OR c. Aerospace / Aeronautical Engineering
2.Mechanical Engineering with (ix) Manufacturing systems Engineering subjects (x) Production Engineering subjects	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Industrial Engineering OR e. Machine Tool Engineering OR f. Metallurgical Engineering
2.Mechanical Engineering i) Energy System & Management ii) Product Design & Development	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Aerospace Engineering

3. Production Engineering	a. Mechanical Engineering OR b. Automobile Engineering OR c. Production Engineering OR d. Industrial Engineering OR e. Machine Tool Engineering OR f. Metallurgical Engineering
4. Electrical Engineering with (i) Control Systems Engineering Subjects (ii) Power Systems Engineering Subjects (iii) Power Electronics and Drives	a. Electrical Engineering OR b. Electronics Engineering OR c. Instrumentation Engineering OR d. Power Electronics OR e. Electronics and Power OR f. Industrial Electronics OR g. Electronics and Telecommunication Engineering
(iv) Electrical Engineering - Power Plant Engineering & Energy Management	a. Electrical Engineering OR b. Electronics & Power OR c. Power Engineering OR d. Instrumentation Engineering
5. Electronics Engineering **6. Electronics & Telecommunication Engineering**	a. Electrical Engineering Or b. Electronics Engineering OR c. Electronics and Telecommunication Engineering OR d. Instrumentation Engineering OR e. Computer Engineering OR f. Power Engineering OR g. Biomedical Engineering OR h. Information Technology
7. Instrumentation Engineering **8. Instrumentation & Control Engineering**	a. Electrical Engineering OR b. Electronics engineering OR c. Instrumentation Engineering OR d. Power Electronics OR e. Biomedical Engineering OR f. Mechanical Engineering OR g. Chemical Engineering
9. Computer Engineering	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics and Telecommunication Engineering OR e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics
10. Information Technology **11. Information Technology in Information Security** **12. Information Technology in Information and Cyber warfare** **13. Information Technology in AI and Robotics**	All Branches of the Bachelor of Engineering/ Technology degree courses

14. Biomedical Engineering	a. Biomedical Engineering OR b. Computer Engineering OR c. Instrumentation Engineering OR d. Electronics Engineering OR e. Electronics and Telecommunication Engineering OR f. Electrical Engineering OR g. Information Technology OR h. Electronics and Power Engineering OR i. Electrical and Electronics Engineering OR j. Power Electronics
15. Chemical Engineering	a. Chemical Engineering OR b. Chemical Technology OR c. Petrochemical Engineering OR d. Petroleum Engineering OR e. Biotechnology
16. Signal Processing	a. Electrical Engineering OR b. Electronics Engineering OR c. Electronics & Telecommunication Engineering OR d. Instrumentation Engineering OR e. Computer Engineering OR f. Power Electronics OR g. Biomedical Engineering
17. Packing Technology	a. B.E. (Printing & Packing Technology)OR b. B.E. (Printing Technology) OR c. B.E. (Packing Technology) OR d. B.E. (Mechanical Engineering) OR e. B.E. (Chemical Engineering) OR f. B.E. (Plastic Engineering) OR g. B.E. (Polymers Engineering) OR h. B.E. (Food Technology) OR i. B.E. (Bio-Technology)
18. Advance Communication & Information System	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics & Telecommunication Engineering Or e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics
19. Artificial Intelligence	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics & Telecommunication Engineering Or e. Instrumentation Engineering OR f. Information Technology OR g. Power Electronics
20. Artificial Intelligence and Data Science	All Branches of the Bachelor of Engineering/ Technology degree courses

Notwithstanding, what is stated above, candidate who have passed the Section A and section B examination conducted by the (1) The Institution of Engineers (India), Kolkota 700020 and (2) Institution of Electronics and Telecommunication Engineers (India), New Delhi, is deemed eligible for admission to the Master of Engineering degree course in the specific branch in which they have passed Section A and Section B examination of a related branch as listed above.

And,

Any person who has passed an examination for the Degree of Bachelor of Engineering of this University or the degree of Bachelor of Engineering/ Bachelor of Technology of any other University recognized as equivalent to the Bachelor of Engineering degree of this University is deemed eligible for admission to the Master degree course in Engineering\Technology in the specific branch in which he/she has taken the degree of Bachelor of Engineering / Bachelor of Technology of a related branch as listed below :-

Master of Engineering	Bachelor of Engineering
1. Computer Engineering	a. Computer Engineering OR b. Electrical Engineering OR c. Electronics Engineering OR d. Electronics and Tele-Communication Engineering OR e. Instrumentation Engineering f. Information Technology g. Power Electronics
2. Chemical Engineering	a. Chemical Engineering OR b. Chemical Technology OR c. Petrochemical Engineering OR d. Petroleum Engineering OR e. Biotechnology
3. Artificial Intelligence	a. Computer Engineering OR b. Electrical engineering OR c. Electronics Engineering OR d. Electronics and Tele-Communication OR e. Instrumentation Engineering f. Information Technology g. Power Electronics
4. Transportation Engineering	a. Civil Engineering OR b. Construction Engineering OR c. Structural Engineering

(The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
20th August, 2022

(Dr. Vinod Patil)
I/c. REGISTRAR

To

The Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head University Departments in Faculty of Science & Technology.

A.C/6.8 (R) /17/05/2022
M.C/4/25/05/2022

****

No. AAMS_UGS/ICD/ 2022-23/86-A

20th August, 2022

Copy forwarded with Compliments for information to:-
1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Computer Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Vinod Patil)
I/c. REGISTRAR

UNIVERSITY OF MUMBAI

Syllabus
for the
M. E. (Artificial Intelligence and Data Science)

First year & Second Year (Sem. I to IV)

(CBCS)

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

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	M.E. (Artificial Intelligence and Data Science)
2	Eligibility for Admission	All Branches of the Bachelor of Engineering / Technology degree courses
3	Passing Marks	45%
4	Ordinances / Regulations (if any)	
5	No. of Years / Semesters	4 Semesters
6	Level	P.G./U.G./Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	With effect from Academic Year: 2022-2023

Dr. Sunil Bhirud
Chairman,
Adhoc Board of Studies,
Computer Engineering,
Faculty of Science and
Technology University of
Mumbai

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

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology
University of Mumbai

UNIVERSITY OF MUMBAI

Syllabus
for the
M. E. (Artificial Intelligence and Data Science)

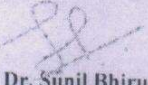## First year & Second Year (Sem. I to IV)

(CBCS)

(Introduce As per AICTE guidelines with effect from the academic year 2022–2023)
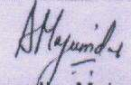
UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**M.E. (Artificial Intelligence and Data Science)**
2	Eligibility for Admission	All Branches of the Bachelor of Engineering / Technology degree courses
3	Passing Marks	45%
4	Ordinances / Regulations (if any)	
5	No. of Years / Semesters	4 Semesters
6	Level	**P.G.**/U.G./Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / **Semester** (Strike out which is not applicable)
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Dr. Sunil Bhirud
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Faculty of Science and
Technology University of
Mumbai

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

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology
University of Mumbai

From the Associate Dean's Desk:

The era of digitalization has changed and is changing the way we produce, communicate and even the way cities work. Artificial Intelligence and Data Science (AI & DS) is considered to be the next remarkable technological development, alike the past industrial revolutions and the current digital revolution. The scope of the AI & DS market seems promising with opportunities in diverse sectors such as the healthcare, security, retail, agriculture, automotive, manufacturing, and finance. In fact, it is estimated that AI& DS will transform the labor market by creating more a million new job opportunities related to this field. Also, the increasing amount of digital data and the growing consumer preference for smart devices is resulting into multi-fold rise in the demand for engineers with proficiency in AI & DS. This Masters programme in Artificial Intelligence & Data Science will open the doors to gain skills for developing of a wide range of applications with efficiency, accuracy and reduced risk.

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology and developed curriculum accordingly. In addition to outcome-based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes, Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System was implemented for First Year Master of Engineering from the academic year 2016-2017 and subsequently the system has been carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science & Technology,
Member - Board of Deans, Academic Council and
Senate, University of Mumbai, Mumbai

Preamble:

University of Mumbai feels that it is desirable to provide specialized Masters programme in Artificial Intelligence and Data Science (AI & DS) to address the needs of the industry, which today requires more specialized resource in each field.

The objective of the programme is to give students a deeper understanding of technology and how to apply logic to create Artificial Intelligence and Data Science (AI & DS) and teach them to create and programme unique projects for the Artificial Intelligence & Data Science fields. Many skills may be developed during this master's program thatcould lead to high-paying jobs and career advancements in the future. Students may develop critical-thinking and technology skills that help them excel in their career field, and they may also learn crucial problem-solving abilities.

The Master of Engineering, M. E. in Artificial Intelligence and Data Science (AI & DS) programme is offered to students who are interested in advanced earning and research in any area of Artificial Intelligence, Machine Learning and Business Intelligence, etc. Applicants to this programme are expected to have a background in Computer Science and Engineering / Information Technology / Electronics Engineering / Electronics and Telecommunication Engineering / Electrical Engineering / Instrumentation Engineering/ Power Electronics as per the guidelines of eligibility.

The programme is a 72-credit post-graduate degree programme, which is spread over 4 semesters for a full-time student. About two-thirds of the credits involve course work, and the remaining consists of project work. The emphasis is on conducting original research and writing a thesis individually. The programme is flexible enough to allow a student to specialize in any topic of interest by taking elective(optional) courses and working on a research project in that area.

Faculty of Technology, University of Mumbai has taken a lead in incorporating philosophy of Choice Based Education in the process of curriculum development.

Dr. Sunil G Bhirud, Chairman, Board of Studies in Computer Engineering (BoS CE),UoM

Dr Subhash Shinde, Member, BoS CE

Dr Sunita R Patil, Member, BoS CE

Dr Sawarkar, Member, BoS CE

Dr Leena Ragha, Member, BoS CE

Dr Satish Ket, Member, BoS CE

Dr Dayanand Ingale, Member, BoS CE

Dr Meera Narvekar, Member, BoS CE

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)
(With Effect from 2022 – 23)

University of Mumbai
Semester – I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDSC101	Statistical learning for Artificial Intelligence & Data Science	04	-	-	04	-	-	04
MEAIDSC102	Foundation of Artificial Intelligence & Data Science	04	-	-	04	-	-	04
MEAIDSC103	Deep Neural Network Design	04	-	-	04	-	-	04
MEAIDSDLO-I	Department Level Optional Course–I#	04	-	-	04	-	-	04
ILO-I	Institute Level Optional Course– I*	03	-	-	03	-	-	03
MEAIDSL101	Computational Intelligence Lab	-	02	-	-	01	-	01
MEAIDSL102	DLOC Lab-1	-	02	-	-	01	-	01
Total		**19**	**04**	**-**	**19**	**02**	**-**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral / Pract	Total
		Internal			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
MEAIDSC101	Statistical learning for Artificial Intelligence & Data Science	20	20	20	80	03	-	-	100
MEAIDSC102	Foundation of Artificial Intelligence & Data Science	20	20	20	80	03	-	-	100
MEAIDSC103	Deep Neural Network Design	20	20	20	80	03	-	-	100
MEAIDSDLO-I	Department Level Optional Course–I#	20	20	20	80	03	-	-	100
ILO-I	Institute Level Optional Course– I*	20	20	20	80	03	-	-	100
MEAIDSL101	Computational Intelligence Lab	-	-	-	-	-	25	25	50
MEAIDSL102	DLOC Lab-1	-	-	-	-	-	25	25	50
Total		**100**	**100**	**100**	**400**	**-**	**50**	**50**	**600**

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)
(With Effect from 2022 – 23)

University of Mumbai

Semester – I

Department Level Optional Course–I#	
Course Code	**Course Name**
MEAIDSDLO1011	Natural Language Processing
MEAIDSDLO1012	Knowledge Representation and Reasoning
MEAIDSDLO1013	Pattern Recognition
MEAIDSDLO1014	Blockchain and Decentralized Finance
MEAIDSDLO1015	Game Theory for AI & DS

Institute Level Optional Course–I*	
Course Code	**Course Name**
ILO1011	Product Life cycle Management
ILO1012	Reliability Engineering
ILO1013	Management Information System
ILO1014	Design of Experiments
ILO1015	Operation Research
ILO1016	Cyber Security and Laws
ILO1017	Disaster Management &Mitigation Measures
ILO1018	Energy Audit and Management

Department Level Optional Course (DLO): Every student is required to take one Department Elective Course for Semester I and Semester II. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

* **Institute Level Optional Course (ILO):** Every student is required to take one Institute Elective Course for Semester I and Semester II, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)
(With Effect from 2022 – 23)

University of Mumbai

Semester – II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDSC201	Applied Data Science	04	-	-	04	-	-	04
MEAIDSC202	Data Handling & Visualization	04	-	-	04	-	-	04
MEAIDSC203	AI and DS Applications	04	-	-	04	-	-	04
MEAIDSDLO-II	Department Level Optional Course–II#	04	-	-	04	-	-	04
ILO-II	Institute Level Optional Course–II*	03	-	-	03	-	-	03
MEAIDSL201	Data Handling & Visualization Lab	-	02	-		01	-	01
MEAIDSL202	DLOC Lab – 2	-	02	-		01	-	01
	Total	**19**	**04**	**-**	**19**	**02**	**-**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral / Pract	Total
		Internal			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
MEAIDSC201	Applied Data Science	20	20	20	80	03	-	-	100
MEAIDSC202	Data Handling & Visualization	20	20	20	80	03	-	-	100
MEAIDSC203	AI and DS Applications	20	20	20	80	03	-	-	100
MEAIDSDLO-II	Department Level Optional Course–II#	20	20	20	80	03	-	-	100
ILO-II	Institute Level Optional Course–II*	20	20	20	80	03	-	-	100
MEAIDSL201	Data Handling & Visualization Lab	-	-	-	-	-	25	25	50
MEAIDSL202	DLOC Lab-2	-	-	-	-	-	25	25	50
	Total	**100**	**100**	**100**	**400**	**-**	**50**	**50**	**600**

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)
(With Effect from 2022 – 23)

University of Mumbai

Semester – II

Department Level Optional Course–II#	
Course Code	**Course Name**
MEAIDSDLO2021	Social Network Analysis
MEAIDSDLO2022	GPU Architecture and Programming
MEAIDSDLO2023	Robotics Process Automation
MEAIDSDLO2024	Bio- inspired Computing and Bioinformatics
MEAIDSDLO2025	Security and AI

Institute Level Optional Course – II*	
Course Code	**Course Name**
ILO2021	Project Management
ILO2022	Finance Management
ILO2023	Entrepreneurship Development and Management
ILO2024	Human Resource Management
ILO2025	Professional Ethics and CSR
ILO2026	Research Methodology
ILO2027	IPR and Patenting
ILO2028	Digital Business Management
ILO2029	Environmental Management

PROGRAM STRUCTURE FOR M.E. (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)
(With Effect from 2022 – 23)

University of Mumbai

Semester-III

CourseCode	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDSS301	Seminar: State -of-the- art research topics	----	06	--	---	03	--	03
MEAIDSS301	Dissertation-I	----	24	--	---	12	--	12
	Total	**----**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Oral / Pract	Total
		Test 1	Test 2	Avg					
MEAIDSS301	Seminar: State -of-the- art research topics	---	---	---	---	---	50	50	100
MEAIDSS301	Dissertation-I	---	---	---	---	---	100	---	100
	Total	**---**	**---**	**---**	**----**	**---**	**150**	**50**	**200**

Semester - IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDSD401	Dissertation-II	--	30	--	---	15	--	15
	Total	**--**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Oral / Pract	Total
		Test 1	Test 2	Avg					
MEAIDSD401	Dissertation-II	---	---	---	---	---	100	100	200
	Total	**---**	**---**	**---**	**----**	**---**	**100**	**100**	**200**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDSC 101	Statistical Learning for Artificial Intelligence & Data Science	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Applied Mathematics

Course Objectives:
1. To describe the role of mathematics in AI, ML and Data Science
2. To explain the concept of vectors and matrices and apply them in machine learning.
3. To evaluate various AI techniques using dimension reduction, optimization and probability.
4. To apply mathematical knowledge gained in the field of AI, Machine Learning and Data Science to solve real life problems.

Course Outcomes:
1. Apply linear algebra problems and concepts to AI, ML and Data Science
2. Analyze dimensionality reduction techniques for building AI models
3. Build approximations to functions using calculus and to determine their accuracy.
4. Develop optimization and modeling approach for real-time problems.
5. Use mathematical tools for the development of statistical procedures

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction & Linear Algebra	**1.1 Role of mathematics in AI, ML & Data Science** **1.2 Linear Algebra:** Vectors, Vector spaces and subspaces, basis and dimensions, linear transformation, four fundamental subspaces	6
2.	Matrix Theory & Decomposition Algorithms	**2.1 Matrix Theory:** Norms and spaces, eigen values and eigenvectors, Special Matrices and their properties, least squared approximation and minimum normed solutions **2.2 Singular Value Decomposition** Properties and applications, low rank approximations, Gram Schmidt process, polar decomposition	10

3.	Dimensions Reduction Algorithms & Graphs	**3.1 Dimension Reduction Algorithms**: Linear, nonlinear, Principal component analysis (PCA), linear discriminant analysis (LDA), minimal polynomial and Jordan canonical form, Multidimensional Scaling, Isometric Feature Mapping. **3.2 Graphs:** 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	10
4.	Calculus	**4.1 Calculus:** Basic concepts of calculus: partial derivatives, gradient, directional derivatives, Jacobean, hessian, convex sets, convex functions and its properties	6
5.	Evaluation & Optimization	**5.1 Algorithmic Performance Evaluation:** Confusion matrix; Precision; Recall; Specificity; ROC Curve; AUC; Lift. **5.2 Optimization Types:** Unconstrained and Constrained optimization, Numerical optimization techniques for constrained and unconstrained optimization, Multivariate optimization with equality and inequality constraint. **5.3 Methods:** Newton's method, Steepest descent method, Penalty function method, Bracketing Methods-Bisection Method, False Position Method	8
6.	Probability, Statistics & Support Vector Machines	**6.1 Probability:** conditional probability, Bayes' theorem, independence, theorem of total probability, expectation and variance, joint distributions and covariance, Random Variables and their probability Distribution, **6.2 Statistics:** Random Sampling, Sample Characteristics and Distributions, Chi-Square, t and F Distributions: Exact Sampling Distributions, Sampling from a Bivariate Normal Distribution, The Central Limit Theorem. **6.3 Support Vector Machine**	12

		Introduction to SVM, Error minimizing LPP	

Books Recommended:
  Text Books:
  1. Strang, Gilbert. Linear Algebra for Everyone. Cambridge University Press, 2020
  2. Chong, Edwin KP, and Stanislaw H. Zak. An introduction to optimization. John Wiley & Sons, 2004.
  3. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, Foundations of Machine Learning. MIT Press, 2018.
  4. J. S. Rosenthal, A First Look at Rigorous Probability Theory (Second Edition). Singapore: World Scientific Publishing, 2006.
  5. Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press.

  Reference Books:
  1. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, 2014
  2. William B. Claster, Mathematics and Programming for Machine Learning with R, CRC Press, 2020.
  3. W. Cheney, Analysis for Applied Mathematics. New York: Springer Science, Business Medias, 2001.
  4. S. Axler, Linear Algebra Done Right (Third Edition). Springer International Publishing, 2015.
  5. J. Nocedal and S. J. Wright, Numerical Optimization. New York: Springer Science+Business Media, 2006.

Useful Links:
  1. https://www.w3schools.com/r/default.asp
  2. https://www.tutorialspoint.com/r/r_environment_setup.htm
  3. https://math.mit.edu/~gs/linearalgebra/
  4. https://www.coursera.org/learn/probability-theory-statistics
  5. https://nptel.ac.in/courses/111/105/111105090/
  6. https://onlinecourses.nptel.ac.in/noc21_ma01/preview
  7. https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/
  8. https://www.w3schools.com/r/default.asp

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS C102	Foundations of Artificial Intelligence and Data Science	04	--	--	04	--	--	04
		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Data Structures & Algorithms, Fundamentals of Mathematics

Course Objectives:
1. To explain AI and Soft Computing techniques and their difference from conventional techniques.
2. To describe the fundamentals of data science to apply in real-world problems.
3. To illustrate the need and concept of hybrid soft computing algorithms.
4. To apply mathematical knowledge gained in the field of AI, Machine Learning and Data Science to solve real life problems

Course Outcomes:
1. Apply the various characteristics and concepts of Artificial Intelligence.
2. Apply the elements of Data Science and its components
3. Analyze various soft computing Approaches
4. Demonstrate knowledge of significance testing and outline the conditions for a particular test.
5. Analyze optimization techniques for improvising performance
6. Design Expert system.

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction To Artificial Intelligence	1.1 Introduction to Artificial Intelligence, Components of AI Program, Foundations of AI, Sub-areas of AI; 1.2 Applications of AI, Current trends in AI; 1.3 Introduction to AI related fields like Natural Language Processing(NLP), Expert Systems, Computer Vision, Robotics, speech recognition	04
2.	Problem Solving	2.1 Informed Search Methods: Greedy best first search ,A* Search , Inadmissible heuristics and weighted A*, Memory bounded heuristic Search 2.2 Local Search and Optimization Problems Hill-climbing search, Simulated annealing, Local beam search, Tabu Search, Genetic	10

		Algorithms, Ant Colony Optimization. 2.3 Adversarial Search: Games, Optimal strategies, The Mini-Max algorithm , Alpha-Beta Pruning	
3.	Soft Computing	3.1 Introduction to Soft computing, comparison with hard computing 3.2 Neural Network: Perceptron training algorithm, Linear separability , Widrow & Hebb's learning rule/Delta rule, ADALINE, MADALINE, Introduction of MLP, different activation functions, Error back propagation algorithm, derivation of EBPA, limitation, characteristics and application of EBPA. Self-Organized:SOM (Kohonen Maps) Recurrent: Simple Recurrent Network, Hopfield Network .Stochastic: Boltzmann machines, RBM. 3.3 Fuzzy Logic: Fuzzy set theory and relations, Features of membership functions, fuzzy reasoning, fuzzy inference systems, defuzzification methods, Design of fuzzy logic controller. 3.4 Introduction to expert system, design of an expert system	12
4.	Artificial Neural Network & Genetic Algorithm	4.1 Components of Data Science: Statistical Inference, Populations and Samples, Modeling 4.2 Exploratory Data Analysis, Philosophy of EDA, Data Science Process, 4.3 Data Science Analytics and Algorithms 4.4 Structured thinking for solving data science problems.	05
5.	Expert Systems	Exploratory Data Analysis: Elements of Structured Data, Rectangular Data, Estimates of Location, Estimates of Variability, Exploring the Data Distribution, Exploring Binary and Categorical Data, Correlation, Exploring Two or More Variables Random Sampling and Sample Bias, Selection Bias, Sampling Distribution of a Statistic, The Bootstrap, Confidence Intervals, Distributions: Normal, Long tailed, Student's t-distribution, Binomial, Poisson & related distribution	14
6.	Statistics And Significance Testing	A/B Testing, Hypothesis Tests, Resampling, Statistical significance and p-values, Testing: t-Tests, Multiple tests, Degree of freedom, ANOVA, Multi-Arm Bandit Algorithm	7

Self-Learning (optional)

1. NPTEL :: Computer Science and Engineering - Artificial Intelligence: Search Methods for Problem Solving :https://nptel.ac.in/courses/106/106/106106126/

Books Recommended:

Text Books:

1. Russell, Stuart, and Peter Norvig. "Artificial intelligence: a modern approach." (2002).
2. Bruce, Peter, and Andrew Bruce. Practical statistics for data scientists: 50 essential concepts. " O'Reilly Media, Inc.", 2017.
3. John Tukey." Exploratory Data Analysis", Princeton University and Bell Laboratories.
4. S.N. Sivanandam & S.N. Deepa, "Principles of Soft Computing, Wiley Publications", 2nd Edition, 2011.
5. S, Rajasekaran & G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications", PHI Publication, 1st Edition, 2009.

Reference Books:

1. G. Brassard, P. Bratley, Fundamental of Algorithms, PHI Publication.
2. S. Basu, Design Methods and Analysis of Algorithms, PHI Publication.
3. Elaine Rich and Kevin Knight ―Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008
4. Rajasekaran, Sanguthevar, and GA Vijayalakshmi Pai. Neural networks, fuzzy logic and genetic algorithm: synthesis and applications (with cd). PHI Learning Pvt. Ltd., 2003.
5. Agresti, Alan, and Christine Franklin. The art and science of learning from data. Vol. 2. Upper Saddle River, NJ: Prentice Hall, 2007.
6. Bhargava, Aditya. Grokking Algorithms: An illustrated guide for programmers and other curious people. Simon and Schuster, 2016.

Useful Links:

1. https://www.coursera.org/specializations/mathematics-for-data-science
2. https://www.coursera.org/learn/datasciencemathskills
3. https://nptel.ac.in/courses/106/101/106101060/

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS C103	Deep Neural Network Design	04	--	--	04	--	--	04

	Examination Scheme						
	Theory Examination			TW	Pract	Oral	
	Internal Assessment		End Sem Exam				
	Test 1	Test 2	Avg				
	20	20	20	80	--	--	--

Prerequisites:
1. Engineering Mathematics
2. Machine Learning Concepts
3. Python Programming
4. Probability

Course Objectives:
1. To explain the fundamental techniques and principles of Neural Networks.
2. To design convolutional networks for handwriting and object classification from images or video.
3. To create recurrent neural networks with attention mechanism.

Course Outcomes:
1. Build deep learning models to train them with real-world datasets.
2. Design convolutional networks for various applications
3. Create RNN with attention mechanisms for natural language classification, generation, and translation.
4. Evaluate the performance of different deep learning models.
5. Apply regularization, training optimization, and hyperparameter selection on deep models.
6. Analyze a deep learning model's for hardware scalability.

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction to Neural Networks	1.1 Introduction to Neural Network, 1.2 Supervised Learning with Neural Networks, Multilayer Perceptron and Backpropagation. Binary Classification and Logistic Regression, 1.3 Deep Neural Networks, Deep forward network, Regularization for Deep learning	6
2.	Optimization Parameters	2.1 Practical Aspects of Deep Learning- Bias / Variance, Regularization, Normalizing inputs, Weight Initialization for Deep Networks, Optimization for Training Deep models. 2.2 Optimization algorithms- Mini-batch gradient descent, Gradient descent with	10

		momentum, Adam optimization algorithm, 2.3 Hyperparameter tuning- Using an appropriate scale to pick hyperparameters, Normalizing activations in a network, SoftMax Regression, Batch Normalization	
3.	Convolutional Neural Networks	3.1 Basics of CNN: Edge Detection, Padding, Strided Convolutions, One Layer of a Convolutional Network, Pooling Layers 3.2 Deep convolutional models- ResNets, Networks in Networks and 1x1 Convolutions, Inception Network, Comparison of U-Net and V-Net 3.3 Convolutional Implementation of Sliding Windows, Bounding Box Predictions, Intersection Over Union, Non-max Suppression, Anchor Boxes	11
4.	Recurrent Neural Networks	44.1 Recurrent Neural Network Model, Back propagation through time, Different types of RNNs, Recurrent and recursive nets. 4.2 Vanishing gradients with RNNs, Gated Recurrent Unit (GRU),Long Short-Term Memory (LSTM) 4.3 Representation learning using Auto encoders, types of auto encoders, Wave Net Auto encoders	12
5.	Sequence models and Reinforcement Learning	5.1 Basic Models, Picking the most likely sentence, Beam Search, Refinements to Beam Search, Error analysis in beam search 5.2 Reinforcement Learning, Generative learning using GANs	8
6.	Modular Neural Networks	6.1 Introduction to Modular Neural Network (MNN) 6.2 MNN Design stages and MNN Architectures	5

Self-Learning (optional)

1. Deep Learning Specialization by DeepLearning.AI in Coursera.

2. Deep Learning by NPTEL (https://nptel.ac.in/courses/106/105/106105215/)

Books Recommended:
Text Books:
1. Charu, C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Spinger, 2018.
2. Khan, Salman, et al. "A guide to convolutional neural networks for computer vision." Synthesis Lectures on Computer Vision 8.1 (2018): 1-207.
3. Medsker, Larry, and Lakhmi C. Jain, eds. Recurrent neural networks: design and applications. CRC press, 1999.
4. Murre, Jacob MJ. Learning and categorization in modular neural networks. Psychology Press, 2014.

Reference Books:
1. Chollet, Francois. "The limitations of deep learning." Deep Learning With Python (2017).
2. Patterson, Josh, and Adam Gibson. Deep learning: A practitioner's approach. " O'Reilly Media, Inc.", 2017.
3. Zhou et al "Deep learning for Medical image analysis" Elsevier 2018.

Useful Links:
1. https://www.sciencedirect.com/science/article/abs/pii/S0925231208005444
2. https://www.tensorflow.org/tutorials/images/classification
3. https://colab.research.google.com/github/Hvass-Labs/TensorFlow-Tutorials/blob/master/20_Natural_Language_Processing.ipynb

Suggested List of Experiments:
1. Image classification using CNN
2. Connected handwriting recognition using LSTM
3. Face recognition using Modular NN for images with missing features
4. Audio Music Information Retrieval (MIR), using RNN

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO1011	Natural Language Processing	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Artificial Intelligence
2. Theory of Computer Science

Course Objectives:
1. To explain theoretical concepts of Natural Language Processing
2. To define statistical operations on text data.
3. To develop skills for research or industry application of Natural Language Processing.
4. To discuss Neural Networks for NLP tasks.

Course Outcomes:
1. To identify stages of NLP for a given task.
2. To perform word level analysis using different NLP models.
3. To design a parser to understand the structure of a sentence.
4. To resolve ambiguities at word and sentence level.
5. To develop a NN based model to perform NLP tasks.
6. Evaluate different NLP models for applications

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction to NLP	1.1 Levels of NLP, Ambiguity in Natural language, stages in NLP, challenges of NLP 1.2 Empirical Laws: Heap's Law, Zipf's Law, Type-Token Ratio 1.3 Representation of Words, Linguistic and Statistical Properties of Words (Corpus, Tokens, Part of Speech, Stemming, Lemmatization, Segmentation)	04
2.	Word Level Analysis	2.1 Regular Expression, Text Normalization 2.2 NLP and probability - Join and Conditional Probability, Chain Rule, Markov Assumption 2.3 Language Models - Bigram language model, Smoothing 2.4 N -gram Language Model 2.5 Representing word as vector: Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector	10

		2.6 Vector models: Word Embeddings, Bag of Words, Word2vec	
3.	Syntactic parsing	3.1 Words and Word Classes-Part-of Speech Tagging. 3.2 Syntactic Analysis: Context-free Grammar-Grammar rules for English, Treebanks 3.3 Normal Forms for grammar, Dependency Grammar – Syntactic Parsing, Ambiguity, 3.4 Efficient parsing for context-free grammars (CFGs). 3.5 Statistical parsing and probabilistic CFGs (PCFGs), 3.6 Probabilistic CYK, Neural shift-reduce dependency parsing	**08**
4.	Semantics and Discourse Analysis	4.1 Meaning Representation 4.2 Lexical Semantics 4.3 Ambiguity- Word Sense Disambiguation 4.4 Discourse segmentation, Coherence – Reference Phenomena 4.5 Anaphora Resolution using Hobbs and Centering Algorithm 4.6 Compositional semantics. Semantic Role Labeling and Semantic 　　　Parsing	**08**
5.	Neural Networks for NLP	5.1 Multi-Layer Perceptron, Activation Function, Gradient Descent 5.2 Sequence Modeling, Recurrent Neural Networks 5.3 Gated Recurrent Unit, Long-Short Term Memory Networks, 　　1-D Convolutional Layer 5.4 Language Model using RNN, Forward Pass, Backward Pass	**10**
6.	Applications of Natural Language Processing	6.1 Statistical Machine Translation, Neural Machine Translation, 6.2 Text Categorization and Clustering 6.3 Topic Modelling and Document Summarization 6.4 Social network Analysis and Sentiment Analysis 6.5 Question and Answer systems, ChatBoat 6.6 Spell checker , Text similarity checking	**12**

Books Recommended:
  Text Books:
    1. Jurafsky, Daniel, and James H. Martin. "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition."
    2. Manning, Christopher, and Hinrich Schutze. Foundations of statistical natural language processing. MIT press, 1999.
    3. Allen, James F., et al. "Toward conversational human-computer interaction." AI magazine 22.4 (2001): 27-27
    4. Charniak, Eugene. Statistical language learning. MIT press, 1996.

  Reference Books:
    1. Kumar, Satish. Neural networks: a classroom approach. Tata McGraw-Hill Education, 2004.
    2. Simon Haykin, "Neural Networks, A Comprehensive Foundation", 2nd Edition, Addison Wesley Longman, 2001.
    3. Bishop, Christopher M. "Pattern recognition." Machine learning 128.9 (2006).
    4. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
    5. Daniel M Bikel and Imed Zitouni ― Multilingual natural language processing applications‖ Pearson, 2013

Useful Links:
    1. http://cse24-iiith.virtual-labs.ac.in/#
    2. http://www.cse.iitb.ac.in/~cs626-449

Suggested List of Experiments:

    1. Write a program to perform tokenization, filtration and script validation of English and Hindi Text
    2. Write a program to identify stop words, stem and lemma of English and Hindi Text
    3. Write a program to generate n-gram (bigram,trigram,etc) of English and Hindi Text
    4. Write a program to identify word frequency and generate word cloud of English and Hindi Text
    5. Write a program to identify Part of Speech of English and Hindi Text
    6. Write a program Get word definition, examples, synonyms, antonyms using English WordNet
    7. Write a program to generate parse tree from text and extract noun and verb phrase of English Text
    8. Write a program to generate name entity (NER) from English and Hindi Text
    9. Write a program to generate feature vector of text using Bag of Words and TF-IDF
    10. Write a program to generate word embedding of the text using Word2Vec
    11. Write a program to demonstrate use of various text similarity prediction algorithms
    12. Mini Project based on Application mentioned in Module 6.

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO1012	Knowledge Representat-ion and Reasoning	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1.   Artificial Intelligence System
2.   Discrete Structures and Graph Theory

Course Objectives:
1.   To explain the basic concepts of knowledge base representation and reasoning.
2.   To discuss various representation formalisms and associated reasoning approaches.
3.   To demonstrate various types of knowledge representations and reasoning in the AI System.

Course Outcomes:
1.   Explain the basics of knowledge base representation, logic and inferences.
2.   Design representations of the knowledge, a key to intelligence.
3.   Integrate various representation formalisms and associated reasoning approaches
4.   Develop various types of knowledge representations and reasoning in the AI System.

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction	1.1 Knowledge base Reasoning 1.2 Basics of Knowledge Representation	4
2.	Logic and Inferences	2.1 Introduction to formal logic and higher order logic 2.2 Descriptive logic, 2.2 Forward Chaining, Backward Chaining and Deductive Retrieval 2.3 Horn Clause and SLD resolution 2.4 Reasoning with Horn Clause	10
3.	Concept and Languages	3.1 The conceptual domain: The ontological Base 3.2 Reification 3.3 RDF and Semantic Web 3.4 Conceptual Dependency Theory 3.5 Conceptual Analysis	10
4.	Structure knowledge representation	4.1 Hierarchies in Domain 4.2 The Schema 4.3 Frame, The Semantic Net 4.4 Inheritance in taxonomy	12

		4.5 Formal Concept analysis 4.6 Conceptual graph	
5.	Classification of knowledge Representation	5.1 Temporal Representation and Reasoning 5.2 Spatial Representation and Reasoning 5.3 Graph structures for Knowledge Representation	**8**
6.	Reasoning	6.1 Reasoning under Uncertainty - Default Reasoning Qualitative Reasoning, Probabilistic Reasoning 6.2 Case Based Reasoning 6.3 Probabilistic Reasoning 6.4 Analogical Reasoning	**8**

Self-Learning (optional)

1 NPTEL course for "Artificial Intelligence: Knowledge Representation and Reasoning" by Deepak Khemani
2 Knowledge Graphs: Data Models, Knowledge Acquisition, Inference and Applications by Stanford University

Books Recommended:
Text Books:
1 Khemani, Deepak. A first course in artificial intelligence. McGraw-Hill Education, 2013.
2 Porter, Bruce, Vladimir Lifschitz, and Frank Van Harmelen, eds. Handbook of knowledge representation. Elsevier, 2008.
3 Krümpelmann, Patrick, Tim Janus, and Gabriele Kern-Isberner. "Angerona-A Multiagent Framework for Logic Based Agents with application to Secrecy Preservation."
Reference Books:
1 Patterson, Dan. Introduction to artificial intelligence and expert systems. Prentice-Hall, Inc., 1990.
2 Hitzler, Pascal, Markus Krotzsch, and Sebastian Rudolph. Foundations of semantic web technologies. Chapman and Hall/CRC, 2009.
3 Antoniou, Grigoris, and Frank Van Harmelen. A semantic web primer. MIT press, 2004.

Useful Links:

1 https://nptel.ac.in/courses/106/106/106106140/
2 https://web.stanford.edu/class/cs520/
3 http://lucylabs.gatech.edu/kbai/fall-2021/
4 https://www.cc.gatech.edu/classes/AY2013/cs7601_spring/papers/Markman+Knowledge+Representation+Chapter+1.pdf

Suggested List of Experiments:
1 Design Knowledge base for particular case study using OWL/RDF and perform knowledge retrieval using query SPARQL.
2 Perform Comparative analysis for various tools and techniques available in semantic

technologies such as Neo4j, Protege etc.

   3 Study of various Graph Query Languages: Graph QL, Open Cypher, Gremlin and SPARQL

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO1013	Pattern Recognition	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Artificial Intelligence
2. Image Processing
3. Fundamentals of probability and linear algebra

Course Objectives:
1. To discuss the basic concept of Pattern recognition
2. To describe different approaches of pattern recognition
3. To discuss various pattern classification techniques
4. To summarize on recent advances and applications in pattern recognition

Course Outcomes:
1. Explain basics of Pattern recognition
2. Illustrate feature generation and selection approaches
3. Analyze various type of pattern recognition techniques
4. Evaluate statistical and structural pattern recognition mechanisms
5. Identify and apply various pattern recognition and classification approaches to solve the problems
6. Examine recent advances in pattern recognition confined to various applications

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction	1.1 Pattern recognition system, pattern recognition design cycle, learning and adaptation, Features, Clustering vs. Classification 1.2 Structural and Syntactic Pattern Recognition	4
2.	Feature Selection and Feature Generation	2.1 Feature Selection: Data normalization, Feature Selection Based on Statistical Hypothesis Testing, Class Separability Measures, Feature Subset Selection, Optimal Feature Generation, Neural Networks and feature Generation/Selection 2.2 Data Transformation and Dimensionality Reduction: Basis Vectors and Images, The Karhunen-Loeve Transform, Independent Component Analysis, Fisher discriminant	14

		analysis, Nonnegative Matrix Factorization, Nonlinear Dimensionality Reduction (Kernel PCA, Graph based methods), Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT) 2.3 Regional Features, Features for Shape and Size Characterization, Fractals, Typical Features for Speech and Audio Classification	
3.	Classification	3.1 Classification with/without features, Gaussian model, Minimax classification 3.2 Rule based classification, Ensemble classification 3.3 Parametric classification: Gaussian discriminant analysis, Linear discriminant analysis, Quadratic discriminant analysis 3.4 Nonparametric classification: Histogram classification, KNN classification, Kernel classification, 3.5 Function-Approximation classification: Support vector classification, Neural networks, Rank based classification 3.6 Context dependent classification: Markov Chain Models, The Viterbi Algorithm, Channel Equalization, Hidden Markov Models 3.7 Error Estimation, classification accuracy assessment	**16**
4.	Clustering	4.1 Clustering Basic Concepts 4.2 Distance (Proximity) Measures: Kolmogorov, Bhattacharyya, Entropy, Jeffreys' Divergence, Mahalanobis 4.3 Clustering Algorithms: Sequential and Hierarchical algorithms, Fuzzy clustering algorithm, Graph based algorithm 4.4 Cluster validity measures	**6**
5.	Template Matching	5.1 Introduction, Measures Based on Optimal Path Searching Techniques, Measures Based on Correlations, 5.2 Deformable Template Models, Template Matching Using Dynamic Time Warping and Edit Distance	**6**
6.	Pattern Recognition Applications	6.1 Patterns and Feature Extraction with Examples 6.2 Pattern Recognition Applications: Document Analysis, Human chromosomes recognition, Satellite image analysis, Emotion recognition, Medical image analysis, Speech recognition	**6**

Self-Learning (optional)

1. http://in.mathworks.com/discovery/pattern-recognition.html
2. Pattern Recognition Course on the Web (by Richard O. Duda)

Books Recommended:

Text Books:

1. Theodoridis, Sergios. "Konstantinos koutroumbas." Pattern recognition (2003).
2. Schalkoff, Robert J. "Pattern recognition." Wiley Encyclopedia of Computer Science and Engineering (2007).
3. Bishop, Christopher M. Pattern Recognition and Machine Learning by Christopher M. Bishop. Springer Science+ Business Media, LLC, 2006.
4. Devroye, Luc, László Györfi, and Gábor Lugosi. A probabilistic theory of pattern recognition. Vol. 31. Springer Science & Business Media, 2013.

Reference Books:

1. Maji, Pradipta, et al., eds. Pattern Recognition and Machine Intelligence: 5th international conference, premi 2013, kolkata, india, december 10-14, 2013. proceedings. Vol. 8251. Springer, 2013.
2. Stork, David G., and Elad Yom-Tov. Computer manual in MATLAB to accompany pattern classification. Wiley-Interscience, 2004.
3. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", PHI, ISBN978- 81-203-4091-6
4. Chen, Chi Hau, ed. Handbook of pattern recognition and computer vision. World Scientific, 2015.

Useful Links:

1. eMedia at NPTEL : http://nptel.ac.in/courses/106108057/33
2. http://cgm.cs.mcgill.ca/~godfried/teaching/pr-web.html

Suggested List of Experiments:

1. Design based Problems (DP)/Open Ended Problem:
   A. Design a system to recognize the individual Devanagari alphabets written by human.
   B. Analyze the performance and accuracy of the system developed in Problem A.
   C. Discuss the issues regarding use of multiple training sets with the classifiers.
2. Design and develop recognition system for medical Diagnosis
3. Survey the different application areas of pattern recognition. Choose one of the areas and make the survey of current research issues into that area

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO1014	Blockchain and Decentralized Finance	04	--	--	04	--	--	04

			Examination Scheme					
		Theory Examination				TW	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Data Structure and Algorithm
2. Cryptography and Network Security

Course Objectives:
1. To explain a broad overview of the essential concepts of blockchain technology.
2. To describe Bitcoin and Ethereum protocol for developing applications.
3. To explain different types of blockchain and consensus algorithms.
4. To discuss decentralized nature of blockchain in various sectors

Course Outcomes:
1. Explain the types, benefits, and limitation of blockchain
2. Summarize the blockchain decentralization and cryptography concepts.
3. Describe and deploy the smart contracts.
4. Identify Bitcoin features and its alternative options.
5. Evaluate the performance of decentralized system using blockchain in financial sector.

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction to Blockchain	Distributed systems, History of blockchain, Introduction to blockchain, Types of blockchain, CAP theorem and blockchain, Benefits and limitations of blockchain	8
2.	Blockchain Algorithms	The consensus problem - Asynchronous Byzantine Agreement - AAP protocol and its analysis - Nakamoto Consensus on permission-less, nameless, peer-to-peer network - Abstract Models for BLOCKCHAIN - GARAY model - RLA Model - Proof of Work (PoW) as random oracle - formal treatment of consistency, liveness and fairness - Proof of Stake (PoS) based Chains - Hybrid models (PoW + PoS)	12
3.	Cryptographic basics for Cryptocurrency	A short overview of Hashing, signature schemes, encryption schemes and elliptic curve cryptography	8
4.	Ethereum	Ethereum Virtual Machine (EVM) - Wallets	8

		for Ethereum - Solidity - Smart Contracts - some attacks on smart contracts	
5.	Bitcoin	Wallet - Blocks - Merkley Tree - hardness of mining - transaction verifiability - anonymity - forks - double spending - mathematical analysis of properties of Bitcoin	**8**
6.	Decentralized Finance (DeFi)	Concept, Benefits and Risks Associated with DeFi, Centralized vs Decentralized finance, DeFi Projects, DeFi future trends.	**8**

Self-Learning (optional)

1. **Case Studies** Uses of Blockchain in E-Governance, Land Registration, Medical formation Systems, and others

Books Recommended:
Text Books:
1. Mai, Elettra. "Connections between stock market and bitcoin market." (2019).
2. Swan, Melanie. Blockchain: Blueprint for a new economy. " O'Reilly Media, Inc.", 2015.

Reference Books:
1. Bashir, Imran,Mastering blockchain, Packt Publishing Ltd, 2017.
2. Kaushik, Anshul, Block Chain & Crypto Currencies., KHANNA PUBLISHING HOUSE.
3. Laurence, Tiana. Blockchain for dummies. John Wiley & Sons, 2019.
4. Swan, Melanie. Blockchain: Blueprint for a new economy. " O'Reilly Media, Inc.", 2015.

Useful Links:
1. https://nptel.ac.in/courses/106/105/106105184/
2. Blockchain Specialization Offered by University at Buffalo, the state university of New York - https://www.coursera.org/specializations/blockchain

3. Bitcoin and Cryptocurrency Technologies offered by Princeton University- https://www.coursera.org/learn/cryptocurrency
4. https://developer.ibm.com/patterns/create-and-deploy-block chain-network- usingfabric-sdk-java/
5. https://medium.com/search?q=decentralized%20exchange

Suggested List of Experiments:
1. Create different types of Blockchain bitcoin wallet.
2. Set up an environment for Ethereum on Windows and Linux
3. Create smart contracts using solidity.
4. Implement smart contract to send ether to another contract/address.
5. Implement smart contract for deposit and withdrawals money from digital bank.
6. Install & setup Ethereum wallet and send/receive ether.

<u>**Internal Assessment:**</u>

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO1015	Game Theory for AI & DS	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Probability and graph theory concepts.
2. Knowledge of Artificial intelligence and foundations of data science.

Course Objectives:
1. To discuss how human behavior can be modeled using game theory principles for AI.
2. To describe the various ways that game theory aids various learning mechanisms.
3. To demonstrate use of game theory to produce novel and accurate data for data science problems.

Course Outcomes:
1. Explain behavioral game theory for AI domain.
2. Discuss the concepts of game theory for learning techniques in AI.
3. Use game theory principles to deal with data in the context of data science.
4. Model modern problems in AI and DS using game theory.
5. Develop game-theory solutions for AI and DS.

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction to Game Theory	Cooperative vs Non-Cooperative Games, Symmetric vs Asymmetric Games, Perfect vs Imperfect Information Games, Simultaneous vs Sequential Games, Zero-Sum vs Non-Zero-Sum Games, Nash Equilibrium, Inverse Game Theory Two-person cooperative games without transferable payoffs, N-Person cooperative games, Decisions under risk and uncertainty, Decisions in conflicts against p-intelligent players, Utility theory	08
2.	Multi-agent AI systems	Agent Architectures and Hierarchical control, multi-agent framework, Representation of Games, Computing strategies with perfect information, Planning under certanty, partially observable multi agent reasoning, Reasoning under uncertainty, Group decision making,	10

		Mechanism design, Learning Belief networks, Ontologies and Knowledge-based systems.	
3.	Imitation and Reinforcement Learning	Imitation and Reinforcement Learning, Multi-agent Reinforcement learning, Markov Decision process, Deep Q-learning, Imitation learning with Dagger algorithm, multi-arm bandits, Monte Carlo methods, Temporal Difference Learning, Policy Gradient methods. Case Study: Personalized Web Services	10
4.	Behavioral Game Theory	Behavioral game theory: Dictator, Ultimatum and trust games, Mixed strategy equilibrium, Bargaining, Dominant solvable games, Coordination games, Signaling and reputation.	08
5.	Learning Reinforcement	Types of Learning Reinforcement, Belief, Imitation, stochastic game theory, evolutionary games and Markov games for multi-agent reinforcement learning, Economic Reasoning and Artificial Intelligence.	08
6.	Game Theory for Data Science	Game Theory for data science: Mechanisms for verifiable and unverifiable information, non-parametric mechanisms, prediction markets, decentralized machine learning.	08

Self-Learning (Optional)

1. https://www.coursera.org/learn/game-theory-1
2. https://www.edx.org/learn/game-theory
3. https://www.classcentral.com/course/game-theory-1-308

Books Recommended:
Text Books:
1. Camerer, Colin F, "Behavioral game theory: Experiments in strategic interaction", Princeton university press, 2011.
2. Faltings, Boi, and Goran Radanovic. "Game theory for data science: Eliciting truthful information." Synthesis Lectures on Artificial Intelligence and Machine Learning 11.2 (2017): 1-151.
3. Maňas, M., "Games and Economic Decisions", SNTL, Praha, 1998 2. Morris, P., "Introduction to Game Theory", Springer Verlag, New York, 1994
4. Poole, David L., and Alan K. Mackworth. Artificial Intelligence: foundations of computational agents. Cambridge University Press, 2010.
5. Andrea Lonza, "Reinforcement Learning Algorithms with Python", Packt Publishing.

Reference Books:
1. Sutton, Richard S., and Andrew G. Barto, "Reinforcement learning: An introduction" , MIT press, 2018.

2. Navin K Manaswi, "Generative Adversarial Networks with Industrial Use Cases", BPB.
3. Shoham, Yoav, and Kevin Leyton-Brown, "Multiagent systems: Algorithmic, game-theoretic, and logical foundations", Cambridge University Press, 2008.
4. Schwartz, Howard M, " Multi-agent machine learning: A reinforcement approach", John Wiley & Sons, 2014.
5. Peter Vrancx, "Decentralized Reinforcement Learning in Markov Games", VUB Press, 2010.

Useful Links:
1. Game Theory in Artificial Intelligence
   https://towardsdatascience.com/game-theory-in-artificial-intelligence-57a7937e1b88
2. Game Theory important for Data Scientists
   https://www.projectpro.io/article/is-game-theory-important-for-data-scientists/139
3. Game Theory
   https://www.investopedia.com/terms/g/gametheory.asp
4. Introduction to Experimental Game Theory
   https://econweb.ucsd.edu/~vcrawfor/CrawJET02.pdf

Suggested List of Experiments:
1. Implementation of Constant Sum, Zero Sum, and Non-Zero Sum Games concept.
2. Implementation of Simultaneous Move Games and Sequential Move Games.
3. Implementation of Number of pure strategy Nash equilibria game.

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO1011	Product Life Cycle Management	03	--	--	03	--	--	03

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developinga product
4. To familiarize the students with Virtual Product Development

Course Outcomes:
1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility studyand PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moldings, machining,sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining andmanufacturing plant

Module	Detailed Content	Total Hrs
01	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selectionand implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, 050Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their	09

	Use in the Design Process	
03	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	**05**
04	For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	**05**
05	Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	**05**
06	Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	**05**

Books Recommended:
  Reference Books:

1. John, Stark. "Product Lifecycle Management: Paradigm for 21st Century Product Realisation." L.: Springer (2004).
2. Giudice, Fabio, Guido La Rosa, and Antonino Risitano. Product design for the environment: a life cycle approach. CRC press, 2006
3. Saaksvuori, Antti, and Anselmi Immonen. Product lifecycle management. Springer Science & Business Media, 2008.
4. Grieves, Michael. Product lifecycle management: driving the next generation of lean thinking: driving the next generation of lean thinking: driving the next generation of lean thinking. McGraw Hill Professional, 2005.

<u>**Internal Assessment:**</u>

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

<u>**End Semester Theory Examination:**</u>
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weight age of each module will be proportional to number of respective lecture hours as mention in the syllabus**
1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO1012	Reliability Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
ILO1012	Reliability Engineering	20	20	20	80	--	--	--

4. Only 4 questions need to be solved.
5. In the question paper, weight age of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Objectives:
1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Course Outcomes:
1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Total Hrs
1.	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis	08
2.	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
3.	System Reliability System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
4.	Reliability Improvement Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-	08

	set method, Success Path method, Decomposition method	
5.	Maintainability and Availability System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
6.	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Reference Books:
1. Srinath, L. S. Reliability engineering. New Delhi, Delhi: Affiliated East-West Press, 1991.
2. Charles, E. Ebeling. "Reliability and maintainability engineering." (2000).
3. Dhillon, B. S. "Medical equipment reliability: A review, analysis methods and improvement strategies." International Journal of Reliability, Quality and Safety Engineering 18.04 (2011): 391-403.
4. Rate, Constant Failure. "Course Code Course Name Credits ILO7012 Reliability Engineering 03 Objectives."
5. Kapur, K. C., and L. R. Lamberson. "Reliability in Engineering Design John Wiley & Sons." Inc., New York (1977).
6. Spiegel, Murray R., John J. Schiller, and R. Alu Srinivasan. Probability and statistics. New York: Mcgraw-hill, 2009.

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weight age of each module will be proportional to number of respective lecture hours as mention in the syllabus**

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO1013	Management Information System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
ILO1013	Management Information System	20	20	20	80	--	--	--

Course Objectives:
1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various
   technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Course Outcomes:
1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Total Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, and Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	04
02	Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence(BI):Managers and Decision Making ,BI for Data analysis And Presenting Results	07
03	Information Security .Threat to IS ,and Security Controls	07
04	Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce– B2BB2C. Mobile commerce	07
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	06
06	Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development Life cycle models.	08

Books Recommended:
  Reference Books:

  1   Rainer, R. Kelly, Brad Prince, and Hugh J. Watson, "Management Information
       Systems: Concepts and Applications", John Wiley & Sons Incorporated, 2017
  2   Laudon, Kenneth C, "Management information systems: Managing the digital
       firm", Pearson Education India, 2007
  3   Boddy, David, Albert Boonstra, and Graham Kennedy," Managing information
       systems: Strategy and organisation", Pearson Education, 2008

<u>**Internal Assessment:**</u>

 Assessment consists of two tests out of which one should be a compulsory class test (on
 minimum 02 modules) and the other can be either a class test or assignment on real-
 world problems or course related projects.

<u>**End Semester Theory Examination:**</u>

Some guidelines for setting up the question paper. Minimum 80% syllabus should
be covered in question papers of end semester examination. **In question paper
weight age of each module will be proportional to number of respective
lecture hours as mention in the syllabus**

  1   Question paper will comprise of total 6 questions
  2   All questions carry equal marks.
  3   Questions will be mixed in nature (for example, suppose Q2 has part (a) from
       module 3, then Q2 part (b) will be from any module other than module 3).
  4   Only 4 questions need to be solved.
  5   In the question paper, weight age of each module will be proportional to the
       number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO1014	Design of Experiments	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination						
		Internal Assessment		End Sem Exam	TW	Pract	Oral	
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1   To understand the issues and principles of Design of Experiments (DOE)
2   To list the guidelines for designing experiments
3   To become familiar with methodologies that can be used in conjunction with experimental designsfor robustness and optimization

Course Outcomes:
1   Plan data collection, to turn data into information and to make decisions that lead to appropriateaction
2   Apply the methods taught to real life situations
3   Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Total Hrs
01	Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack off it.	08
03	The 2^2 Design, the 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, blocking in the 2^k Factorial Design, Split-Plot Designs.	07
04	The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	07
05	Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	07
06	Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	04

Reference Books:

1   Myers, Raymond H., Douglas C. Montgomery, and Christine M. Anderson-Cook. Response surface methodology: process and product optimization using designed experiments. John Wiley & Sons, 2016.
2   Montgomery, Douglas C. Design and analysis of experiments. John wiley & sons, 2017.
3   Box, George EP, J. Stuart Hunter, and William Gordon Hunter. Statistics for experimenters: design, innovation, and discovery. Vol. 2. New York: Wiley-Interscience, 2005.
4   Diamond, William J. Practical experiment designs: for engineers and scientists. John Wiley & Sons, 2001.
5.   Dean, Angela, Daniel Voss, and Danel Draguljić. Design and analysis of experiments. Vol. 1. New York: Springer, 1999
6.   Ross, Phillip J. Taguchi techniques for quality engineering: loss function, orthogonal experiments, parameter and tolerance design. 1996.

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weight age of each module will be proportional to number of respective lecture hours as mention in the syllabus**

1   Question paper will comprise of total 6 questions
2   All questions carry equal marks.
3   Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4   Only 4 questions need to be solved.
5   In the question paper, weight age of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO1015	Operations Research	03	--	--	03	--	--	03

		Examination Scheme						
ILO1015	Operations Research	Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	03	--	--

Course Objectives:
1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Course Outcomes:
1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measure

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem.Finding basic	14

	feasible solutions – Northwest corner rule, least cost method and Vogel'sapproximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem,Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and mMachines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer ProgrammingProblem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique.Introduction to Decomposition algorithms.	
02	**Queuing models**: queuing systems and structures, single server and multi-servermodels, Poisson input, exponential service, constant rate service, finite and infinite Population	**05**
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	**05**
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamicprogramming approach for Priority Management employment smoothening, capital budgeting, Stage Coach / Shortest Path, cargo loading and Reliability problems.	**05**
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	**05**
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	**05**

Reference Books:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice",John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill,2002.
4. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut
5. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Internal Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is eithera class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weight age of each module will be proportionalto number of respective lecture hours as mention in the syllabus**

1. Question paper will comprise of total six questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weight age of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO1016	Cyber Security and Laws	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
ILO1016	Cyber Security and Laws	20	20	20	80	03	--	--

Course Objectives:
1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Course Outcomes:
1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafé and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyber line** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6

04	**The Concept of Cyberspace** E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of CyberLaw, The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange LawRelating to Electronic Banking, The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Reference Books:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes by Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
6. Kennetch J. Knapp, Cyber Security &Global Information Assurance Information SciencePublishing.
7. William Stallings, Cryptography and Network Security, Pearson Publication
8. Websites for more information is available on: The Information Technology ACT, 2008- TIFR:https://www.tifrh.res.in
9. Website for more information A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals- 33538

Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test and the other is eithera class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportionalto number of respective lecture hours as mention in the syllabus**

1. Question paper will comprise of total six questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).

4. Only 4 questions need to be solved.
5. In the question paper, weight age of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO1017	Disaster Management and Mitigation Measures	03	--	--	03	--	--	03

		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. To understand physics and various types of disaster occurring around the world.
2. To identify extent and damaging capacity of a disaster.
3. To study and understand the means of losses and methods to overcome/minimize it.
4. To understand role of individual and various organization during and after disaster.
5. To understand application of GIS in the field of disaster management.
6. To understand the emergency government response structures before, during and after disaster.

Course Outcomes: Learner will be able to…
1. Get to know natural as well as manmade disaster and their extent and possible effects on theeconomy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Total Hrs
1	**Introduction** Definition of Disaster, hazard, global and Indian scenario, general perspective,importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
2	**Natural Disaster and Manmade disasters:** **Natural Disaster:** Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions,Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sealevel rise, ozone depletion **Manmade Disasters:** Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changinglifestyle of human beings in frequent occurrences of manmade disasters.	09
3	**Disaster Management, Policy and Administration** Disaster Management, Policy and Administration Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. **Policy and administration:**	06

		Importance and principles of disaster management policies, command and co- ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
4	**Institutional Framework for Disaster Management in India:** Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.		06
5	**Financing Relief Measures:** Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.		09
6	**Preventive and Mitigation Measures:** Pre-disaster, during disaster and post-disaster measures in some events in general Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.		06

Reference Books:

1. Singh, Ram Babu, ed. Natural hazards and disaster management: vulnerability and mitigation. Rawat Publications, 2006.
2. Dagur, O. S. Disaster Management: An Appraisal of Institutional Mechanisms in India. Centre for Land Warfare Studies, 2011.
3. Coppola, Damon P. Introduction to international disaster management. Elsevier, 2006.
4. Pinkowski, Jack, ed. Disaster management handbook. CRC press, 2008.
5. Dasgupta, Rajdeep. Disaster management and rehabilitation. Mittal Publications, 2007.
6. Concepts and Techniques of GIS–C.P. LoAlbert, K.W.Yonng–Prentice Hall(India)Publications.
7. 'Disaster Management'by Harsh K. Gupta, Universities Press Publications

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO1018	Energy Audit and Management	03	--	--	03	--	--	03

		Examination Scheme			
		Theory Examination		TW	Pract
		Internal Assessment	End Sem Exam		
		Test 1	Test 2	Avg	

Test 1	Test 2	Avg	End Sem Exam	TW	Pract	Oral
20	20	20	80	--	--	--

Course Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures
6. To identify and describe present state of energy security and its importance.

Module	Detailed Contents	Total Hrs
1	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
2	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment(ROI), Internal rate of return (IRR)	08

3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Powerfactor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors,daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors,motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savingsopportunities.	10
5	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	4
6	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	3

Reference Books:
1. Doty, Steve, and Wayne C. Turner. Energy management handbook. Crc Press, 2004
2. Tyagi, Amit Kumar, ed. Handbook on energy audits and management. Teri, 2003
3. Smith, Craig B., and Kelly E. Parmenter. Energy, management, principles: Applications, benefits, savings. Elsevier, 2013
4. Patrick, Dale R., et al. Energy conservation guidebook. CRC Press, 2020
5. Thumann, Albert, and William J. Younger. Handbook of energy audits. The Fairmont Press, Inc., 2008
6. www.energymanagertraining.com;www.bee-india.nic.in
7. Stokes, Geoffrey, ed. Handbook of electrical installation practice. John Wiley & Sons, 2008.
8. Designing with light: Lighting Handbook ,By Anil Valia, Lighting System

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDSL 101	Computational Intelligence Laboratory	--	02	--	---	01	--	01
		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		---	---	---	---	25	25	50

Description of Lab: Based on MEAIDSC101, MEAIDSC102 and MEAIDSC103 contents.

Lab Title	Detailed Content	No of Hours
Matrix Theory and Applications	Demonstrate the use matrix theory in computer graphics application such as 2D/3D 2D modeling transformations or any other suitable application.	2
Dimension Reduction	Demonstrate the use Principal component analysis (PCA) and Linear Discriminant Analysis (LDA) in Face Recognition/ Health Monitoring or any other application.	4
Optimization Methods	Demonstrate the use of Newton's method/Steepest descent method/Penalty function method/Bracketing Methods in any real-life application may be using Sequential linear programming (SLP)/ Deciding or Finding the Search Direction or any other technique.	4
Probability and Statistics	Implementation of any business application such as : - Mutual Fund Sales - Lottery - Managing risk in the Investments. - To demonstrate the use of random variables and probability theory.	2
Foundation of DS	Exploratory Data Analysis	2
Soft Computing	Fuzzy Logic/ Fuzzy Genetic Algorithm based application such as Washing Machine or Fuzzy rule-based controller.	4
ANN and GA	ANN: Implementation of Linear and Nonlinear application and generalization.	4
ANN and GA	GA: Genetic Algorithm based application such as Travelling Salesman Problem or Timetable generation problem.	4

Internal Assessment:
Laboratory Project: Weightage for Laboratory Project should be 40% in Final Assessment ofLaboratory Work.

End Semester Examination :
Practical/Oral examination is to be conducted by pair of internaland external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS L102	DLOC Lab 1	--	02	--	---	01	--	01

		Examination Scheme						
		Theory Examination						
MEAIDS L102	DLOC Lab 1	Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		---	---	---	---	25	25	50

Description of Lab: Lab should be based on Department level Elective course opted by students:

Lab Title	Suggested List of Experiments for DLOC Lab1
MEAIDSDLO1011 **Natural Language Processing**	1. Write a program to perform tokenization, filtration and script validation of English and Hindi Text 2. Write a program to identify stop words, stem and lemma of English and Hindi Text 3. Write a program to generate n-gram (bigram, trigram, etc) of English and Hindi Text 4. Write a program to identify Part of Speech of English and Hindi Text 5. Write a program Get word definition, examples, synonyms, antonyms using English WordNet 6. Write a program to generate parse tree from text and extract noun and verb phrase of English Text 7. Write a program to generate name entity (NER) from English and Hindi Text 8. Write a program to generate feature vector of text using Bag of Words and TF-IDF 9. Write a program to demonstrate use of various text similarity prediction algorithms. 10. Mini Project based on Applications mentioned in Module 6 of MEAIDSDLO1011 course
MEAIDSDLO1012 **Knowledge Representation and Reasoning**	1. Design Knowledge base for particular case study using OWL/RDF and perform knowledge retrieval using query SPARQL. 2. Perform Comparative analysis for various tools and techniques available in semantic technologies such as Neo4j, Protege etc. 3. Study of various Graph Query Languages: GraphQL, OpenCypher, Gremlin and SPARQL
MEAIDSDLO1013	1. Design based Problems (DP)/Open Ended Problem:

Pattern Recognition	Design a system to recognize the individual Devanagari alphabets written by human. i. Analyse the performance and accuracy of the system developed in Problem A. ii. Discuss the issues regarding use of multiple training sets with the classifiers. 2. Design and develop recognition system for medical Diagnosis 3. Survey the different application areas of pattern recognition. Choose one of the areas and make the survey of current research issues into that area
MEAIDSDLO1014 **Blockchain and Decentralized Finance**	1. Create different types of Blockchain bitcoin wallet. 2. Set up an environment for Ethereum on Windows and Linux 3. Create smart contracts using solidity. 4. Implement smart contract to send ether to another contract/address 5. Implement smart contract for deposit and withdrawals money from digital bank. 6. Install & setup Ethereum wallet and send/receive ether.
MEAIDSDLO1015 **Game Theory for AI & DS**	1. Implementation of Constant Sum, Zero Sum, and Non-Zero Sum Games concept. 2. Implementation of Simultaneous Move Games and Sequential Move Games. 3. Implementation of Number of pure strategy Nash equilibria game

Internal Assessment:

Laboratory Project: Weightage for Laboratory Project should be 40% in Final Assessment ofLaboratory Work.

End Semester Examination :
Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS C201	Applied Data Science	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
MEAIDS C201	Applied Data Science	20	20	20	80	--	--	--

Prerequisites:
1. Basic Mathematics, Basic Probability and Statistics, Machine Learning Algorithms, data mining and warehousing

Course Objectives:
1. To exemplify Students to the basic principles of Applied Data Science
2. To prepare students with operational models and building blocks of data science.
3. To Use and Outline various tools and different case studies for decision making.
4. To infer data science tools and techniques in bioinformatics field
5. To construct the web analytics concepts
6. To support and develop some real-world applications of Data Science with critical analysis.

Course Outcomes:
1. Understand the basics of Applied Data Science
2. Illustrate use cases based on the operational models and knowledge acquired.
3. Analyze and apply tools for designing various use cases.
4. Apply tools of data science in the field of Bioinformatics.
5. Design the system in line with web analytics
6. To design and evaluate analytics with reference to real world applications

Unit No	Unit Title	Sub Topics	Total Hrs
1	Introduction to Applied Data Science	Data Science Principles, Data Science Workflows or Pipelines, Data Science and Global Mega Trends, Collaboration in Data Science, Interdisciplinary in Data Science, programming principles for data science	8
2	Data Scientist and Data Products	The Data Scientist's Set of Skills and Qualities, Operational Models for Advanced Analytics, Data-Driven Use Cases, Service Design, The Gap Toward	8

		Data Product Design, Bridging the Gap (Then and Now), The Essential Building Block of a Data Product	
3	Data Science for Decision Making	Decision making tools: Regression analysis and its applications; use of regression output in forecasting; promotional planning and optimal pricing; multivariate analysis (unsupervised learning) cluster analysis; factor analysis decision trees; elastic nets and random forests. Case studies: supply chain management, fraud analytics, manufacturing.	10
4	Data Science in Bioinformatics	Relevance of Data Science in Bioinformatics. Why Data Science in Biology and Healthcare? Visualization tools for biological and bioinformatics datasets. Data handling and Transformations of data from the perspective of Bioinformatics.	10
5	Web Analytics and Mining	Web Analytics, Text Mining, Web Mining, and practical application domains, Metrics of web sites, their content, user behavior, and reporting, Analysis of text including content extraction, String matching, Clustering, Classification, and Recommendation systems, Application : Social Web Mining	8
6	Critical Data Analytics	Critically analyze real-world problems, possibilities and limitations of analytics applications	8

Books Recommended:

Text Books:

1. Stadelmann, Thilo, et al. "Applied Data Science-Lessons Learned for the Data-Driven Business." (2018).
2. Grus, Joel. "Data science from scratch: first principles with python". O'Reilly Media, 2019.
3. Parnell, Gregory S., et al "Handbook of decision analysis". Vol. 6. John Wiley & Sons, 2013.
4. Arthur M. Lesk, "Introduction to Bioinformatics." 978-986-6929-12-0 (2008).
5. Croissant, Yves, and Giovanni Millo. "Panel data econometrics with R". John Wiley & Sons, 2018.

6.   Kaushik, Avinash. "Web analytics 2.0: The art of online accountability and science of customer centricity". John Wiley & Sons, 2009.

Reference Books:
1.   Provost, Foster, and Tom Fawcett. "Data Science for Business: What you need to know about data mining and data-analytic thinking". " O'Reilly Media, Inc.", 2013.
2.   Croissant, Yves, and Giovanni Millo. "Panel data econometrics with R". John Wiley & Sons, 2018.
3.   Fox, John, and Sanford Weisberg. "An R companion to applied regression". Sage publications, 2018.

Useful Links:
1.   NPTEL: https://nptel.ac.in/courses/106/107/106107220/
2.   UDEMY:https://www.udemy.com/topic/data-analysis

Suggested List of Experiments:
1.   Perform deep data analysis on any social media data to draw the conclusions
2.   Web Data Analytics

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1.   Question paper will comprise of total 6 questions
2.   All questions carry equal marks.
3.   Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4.   Only 4 questions need to be solved.
5.   In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS C202	Data Handling and Visualization	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Introduction to Data Science

Course Objectives:
1. To introduce the fundamental concepts and approaches in the design and analysis of data visualization.
2. To familiarize the stages of the visualization.
3. To acquaint the type of data and its impact on the type of visualization.
4. To accustom with designing, evaluating visualizations.

Course Outcomes:
1. Study the foundations of visualization pipeline
2. Explore visualization techniques, loosely grouped by data characteristics.
3. Understand interaction with visualizations
4. Design and improve the effectiveness of specific visualizations.
5. Evaluate available visualization systems, identify key features and observe limitations.
6. Identify trends, challenges and opportunities in the field of data visualization.

Unit No	Unit Title	Sub Topics	Total Hrs
01	Introduction to Visualization and Data Foundations	Definition and importance, Relationship between Visualization and Other Fields, Types of Data, Data Preprocessing, The Visualization Process, Semiology of Graphical Symbols, The Eight Visual Variables, Visualization Taxonomies.	10
02	Visualization techniques of different types of data	Visualization Techniques for Spatial Data, Visualization Techniques for Geospatial Data, Visualization Techniques for Multivariate Data, Visualization Techniques for Trees, Graphs, and Networks, Text and Document Visualization	12
03	Interaction Concepts and Techniques	Interaction Operators, Interaction Operands and Spaces, Interaction Techniques	06

04	Designing Effective Visualizations	Steps in Designing Visualizations, Problems in Designing Effective Visualizations	08
05	Comparing and Evaluating Visualization Techniques	User Tasks, User Characteristics, Data Characteristics, Visualization Characteristics, Structures for Evaluating Visualizations, Benchmarking Procedures. An Example of Visualization Benchmarking	08
06	Research Directions in Visualization	Issues of Data, Issues of Cognition, Perception, and Reasoning, Issues of System Design, Issues of Evaluation, Issues of Hardware, Issues of Applications	08

Self-Learning (optional)

1. Data Visualization with Tableau Specialization
   https://www.coursera.org/specializations/data-visualization#courses
2. Data Visualization & Dashboarding with R Specialization
   https://www.coursera.org/specializations/jhu-data-visualization-dashboarding-with-r
3. How to Process, Analyze and Visualize Data https://ocw.mit.edu/resources/res-6-009-how-to-process-analyze-and-visualize-data-january-iap-2012/

Books Recommended:
Text Books:
1. Ward, Matthew O., Georges Grinstein, and Daniel Keim. Interactive data visualization: foundations, techniques, and applications. CRC press, 2010.
2. Yau, Nathan. Visualize this: the FlowingData guide to design, visualization, and statistics. John Wiley & Sons, 2011.

Reference Books:
1. Chen, Chun-houh, Wolfgang Karl Härdle, and Antony Unwin, eds. Handbook of data visualization. Springer Science & Business Media, 2007.
2. Wexler, Steve, Jeffrey Shaffer, and Andy Cotgreave. The big book of dashboards: visualizing your data using real-world business scenarios. John Wiley & Sons, 2017.
3. Wilke, Claus O. Fundamentals of data visualization: a primer on making informative and compelling figures. O'Reilly Media, 2019.

Useful Links:
1. **What Is Data Visualization? Definition, Examples, And Learning Resources**
   https://www.tableau.com/learn/articles/data-visualization

Suggested List of Experiments:
1. Data Visualization using tools like Tableau
2. Data Visualization using libraries in Python / R or and other languages
3. Designing Data Visualization

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

<u>**Theory Examination:**</u>

1.   Question paper will comprise of total 6 questions
2.   All questions carry equal marks.
3.   Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4.   Only 4 questions need to be solved.
5.   In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS C203	AI and DS Applications	04	--	--	04	--	--	04
		Examination Scheme						
		Theory Examination						
		Internal Assessment		End Sem Exam	TW	Pract	Oral	
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Linear Algebra and Optimization
2. Principles of AI, ML and DS

Course Objectives:
1. Exemplify AI applied to issues various Medical domains
2. To determine the principles of reinforcement learning techniques for robots.
3. Use of Artificial Intelligence techniques in power system.
4. To apply knowledge about health care analytics.
5. Outline Knowledge about financial data analytics and its applications.
6. Design methods and choose tools for large data handling.

Course Outcomes:
1. Apply Machine Learning Applications in Medical domain.
2. Predict the use of reinforcement learning for robotics.
3. Determine the concepts of Artificial Intelligence and their role in optimization.
4. Predict health care analytics and benefits of electronic health records.
5. Outline and grade stock market prediction and crypto currency strategy.
6. Derive results using different analytical tools to handle process data

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Application of AI in Medicine	Overview of Prominent Machine Learning and Data Mining Methods with Example Applications in Medical Domain, Computational Intelligence Techniques and Areas of Applications in Medicine, Natural Language Processing in Medicine, Intelligent Personal Health Record.	8
2.	Artificial Intelligence for Robotics	Robotics introduction, historical perspective on AI and Robotics, Uncertainty in Robotics Reinforcement Learning: Basic overview with examples.	8

3.	Application of AI in Power Systems	Application of Neural Network and Expert Systems in Voltage Control, Security Assessment, Schedule Maintenance of Electrical Power Transmission Networks using Genetic Algorithm, Intelligent Systems for Demand Forecasting	8
4.	Healthcare Data Analytics	Healthcare Data Sources and Basic Analytics: Components of HER, Benefits of HER, Natural Language Processing and Data Mining for Clinical Text, Applications and Practical Systems for Healthcare: Data Analytics for Pervasive Health	8
5.	Financial Data Analytics & Predication	Machine learning in Finance, Stock price prediction, Derivative pricing, Fraud detection, Bitcoin Trading Strategy, Load default probability, Portfolio management.	8
6.	Data Processing	Identify tool and software to handle data with intelligent processing from industries like airline, automobile, inventory management and educational sectors.	12

Self-Learning (optional)

1. https://www.coursera.org/learn/ai-for-everyone#about
2. https://onlinecourses.nptel.ac.in/noc21_cs101/preview
3. https://onlinecourses.nptel.ac.in/noc22_hs40/preview
4. https://www.coursera.org/courses?query=healthcare%20data%20analytics

Books Recommended:

Text Books:

1. Agah, Arvin. "Artificial Intelligence Resources: Publications and Tools." Medical Applications of Artificial Intelligence (2013): 453.
2. Thrun, Sebastian, et al. "Probabilistic algorithms and the interactive museum tour-guide robot minerva." The International Journal of Robotics Research 19.11 (2000): 972-999.
3. Laughton, M. A. "Artificial intelligence techniques in power systems." IEE Colloquium on Artificial Intelligence Techniques in Power Systems (Digest No: 1997/354). Iet, 1997
4. Reddy, Chandan K., and Charu C. Aggarwal, eds. "Healthcare data analytics". Vol. 36. CRC Press, 2015

Reference Books:

1. Cleophas, Ton J., and Aeilko H. Zwinderman. "Machine Learning in Medicine-a

Course Code	Course Name	Teaching Scheme (Contact Hours)	Credits Assigned

Complete Overview". Springer International Publishing, 2015
2. Sutton, Richard S., and Andrew G. Barto. "Reinforcement learning: An introduction". MIT press, 2018.
3. Govers, Francis X. "Artificial intelligence for robotics: Build intelligent robots that perform human tasks using AI techniques". Packt Publishing Ltd, 2018.
4. Ukil, Abhisek. "Intelligent systems and signal processing in power engineering." Springer Science & Business Media, 2007.
5. Ukil, Abhisek, Willy Siti, and Jaco Jordaan. "Feeder load balancing using neural network." International Symposium on Neural Networks. Springer, Berlin, Heidelberg, 2006

Useful Links:
1. https://www.futurelearn.com/courses/artificialintelligence-technology-application
2. https://www.datacamp.com/courses/introduction-to-power-bi
3. https://www.wqu.edu/programs/data-science/
4. https://www.conted.ox.ac.uk/courses/developing-artificial-intelligence-applications-using-python-and-tensorflow

Suggested List of Experiments:
1. Installation and working on various AI tools viz. Python, R tool, GATE, NLTK, MATLAB, etc.
2. Data preprocessing and annotation and creation of datasets.
3. Data preprocessing and annotation and creation of datasets.
4. Connecting and Loading Data in PowerBI; PowerBI Data types; Basic graphs and charts; Sheet, Dashboard and Story
5. Programming using PowerBI; Simple linear and forecasting; Setting up a PowerBI Server for enterprise and management decision making

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai

		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO2021	Social Network Analysis	04	--	--	04	--	--	04

Examination Scheme						
Theory Examination						
Internal Assessment			**End Sem Exam**	**TW**	**Pract**	**Oral**
Test 1	Test 2	Avg				
20	20	20	80	--	--	--

Course Objectives:
1. Describe various social networks analysis and measures.
2. Illustrate various a social network Data representation & Collection
3. Describe various approaches of analysis and modeling of information diffusion
4. Illustrate the various community analysis approaches
5. Design and develop the application driven virtual communities

Course Outcomes:
1. Interpret the fundamental concepts and principles of social network analysis
2. Relate the basic concepts of network models, network measures, and graph algorithms.
3. Evaluation and characterization of the dynamic social network.
4. Inspect use of social network analysis in behavior analytics, and recommendations systems.
5. Design and analysis of application-driven virtual communities

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction to Social Network Analysis	Introduction to Social Network Analysis, New Challenges, Social network representation, Graph Basics, Graph Representation, Types of Graphs, Connectivity in Graphs, Special Graphs, Graph Algorithms	08
2.	Social Network Data and Measures	Fundamental Concepts in Network Analysis, Centrality, Transitivity and Reciprocity, Balance and Status, Similarity, Introduction to Network Data, Boundary Specification and Sampling, Types of Network, Network Data, Measurement and Collection	08
3.	Network Models	Properties of Real-World Networks, Random Graphs, Small-World Model, Preferential Attachment Model	10
4.	Community Analysis	Community Detection, Community Evolution, Community Evaluation	06
5.	Information Diffusion in social	Herd Behavior, Information Cascades, Independent Cascades, Diffusion of	08

	media	Innovations, Epidemics	
6.	Behavior Analytics and Recommendation in social media	Challenges, Classical Recommendation Algorithms, Recommendation Using Social Context, Evaluating Recommendations, Individual Behavior, Collective Behavior	12

Self-Learning (optional)

1. https://nptel.ac.in/courses/106/106/106106169/

Books Recommended:

Text Books:

1. Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Social media mining: an introduction. Cambridge University Press, 2014.
2. Wasserman, Stanley, and Katherine Faust. "Social network analysis: Methods and applications." (1994).
3. Wasserman, Stanley, and Katherine Faust. "Social network analysis: Methods and applications." (1994).

Reference Books:

1. Carrington, Peter J., John Scott, and Stanley Wasserman, eds. Models and methods in social network analysis. Vol. 28. Cambridge university press, 2005
2. Scott, John, and Peter J. Carrington. The SAGE handbook of social network analysis. SAGE publications, 2011
3. Borgatti, Stephen P., Martin G. Everett, and Jeffrey C. Johnson. Analyzing social networks. Sage, 2018.

Suggested List of Experiments:

1. Study of various tools used in analysis of Social Network
2. Implementation of real-world problem like small world network, scale free network, random network
3. Implementation various Centrality Measures
4. Implementation of case study (Mini Project)

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO2022	GPU Architecture and Programming	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Computer Organization and Architecture
2. Operating System
3. Distributed Computing

Course Objectives:
1. To extract the fundamental concepts of GPU architecture
2. To investigate and compare various GPU programming models
3. To Code the massive parallel processor.
4. To discover various issues in mapping algorithms for GPU
5. To illustrate GPU based solutions in various field

Course Outcomes:
1. Study the different parallel processing approaches and GPU computing architecture
2. Interpret CUDA architectural details
3. Code with GPU programming environments using OpenCL
4. Summarize various issues in mapping algorithms for GPUs
5. Design and develop programs that make efficient use of the GPU processing power.
6. Develop GPU based solutions to solve computationally intensive problems in various fields

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction	Introduction to Parallel Processing, Parallel Architecture, Parallel Platforms, Performance measures, GPU Architecture: Evolution of GPU Architectures, Typical GPU architecture, CPU-GPU interaction, Address Spaces, Software Architecture	08
2.	CUDA: GPU Parallel Development Environment	Compute Unified Device Architecture (CUDA) Architecture, CUDA programming model, execution model, Thread organization: Concept of threads, Blocks, grid, thread index generation, warp, Scheduling -Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory	12
3.	CUDA Algorithms and Programming	GPU primitives: scan (exclusive or	12

		inclusive), scatter, gather, reduce, CUDA structure, API and library (CUDPP, CUBLAS, FFT etc. Using CUDA - Multi CPU - Multi GPU Solutions - Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions	
4.	CUDA: Programming Issues Common Problems	CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors	**06**
5.	OpenCL Basics	Open CL Standard, Kernels – Host Device Interaction – Execution Environment, Memory Model, Basic OpenCL Examples	**06**
6.	Algorithms on GPU	Vector dot product, Matrix multiplication, Convolution, Prefix Sum, Graph algorithms, n-body simulations, dense linear algebra, etc. using GPU, Programming Heterogeneous Cluster, GPU Analytics	**08**

Self-Learning (optional)

1. **NPTEL Course on GPU Architectures and Programming
   (https://onlinecourses.nptel.ac.in/noc20_cs41/preview)**

Books Recommended:

Text Books:
1. Grama, Ananth, et al. "Introduction to parallel computing." Pearson Education, 2003.
2. Cook, Shane. "CUDA programming: a developer's guide to parallel computing with GPUs." Newnes, 2012.
3. Wilt, Nicholas. "The CUDA handbook: A comprehensive guide to GPU programming." Pearson Education, 2013.

Reference Books:
1. Sanders, Jason, and Edward Kandrot. "CUDA by example: an introduction to general-purpose GPU programming." Addison-Wesley Professional, 2010.
2. Kirk, David, and W. Hwu Wen-Mei. "Programming massively parallel processors: a hands-on approach." Morgan kaufmann, 2016.
3. Wilt, Nicholas. "The CUDA handbook: A comprehensive guide to GPU programming." Pearson Education, 2013.

Useful Links:
1. http://www.nvidia.com/object/cuda_home_new.html
2. http://www.openCL.org
3. CUDA: docs.nvidia.com/cuda
4. https://cuda-tutorial.readthedocs.io/en/latest/

Suggested List of Experiments:
1. Matrix multiplication using CUDA
2. Convolution using CUDA
3. Deep Learning using CUDA
4. Vector Addition using OpenCL

<u>Internal Assessment:</u>

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

<u>Theory Examination:</u>

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO2023	Robotics Process Automation	04	--	--	04	--	--	04

	Examination Scheme					
	Theory Examination			TW	Pract	Oral
	Internal Assessment		End Sem Exam			
	Test 1	Test 2	Avg				
	20	20	20	80	--	--	--

Prerequisites: Basic Programming Skills

Course Objectives:
1. To confer the essential concepts of Robotic Process Automation
2. To introduce the basic RPA design and Develop strategies specified in the context of Ui Path products
3. To develop the proficiency to design and develop a robot for a specified process

Course Outcomes: After the successful completion of this course, the learner will be able to:
1. Understand basic programming concepts and their operation from RPA perspective.
2. Understand the basic concepts of Robotic Process Automation and its applications
3. Develop familiarity and deep understanding of UiPath tools.
4. Apply automation to image, text, data tables, citric, pdf, email, etc., execute exception handling and apply various functionalities of orchestrator.
5. Analyze opportunities of research in Artificial Intelligence concerning RPA.
6. Design and create robots for business processes.

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Programming Fundamentals	Understanding the application; Basic Web Concepts; Protocols; Email Clients; Data Structures; Data Tables; Algorithms; Software Processes; Software Design; SDLC, Scripting; Net Framework; .Net Fundamentals; XML; Control structures and functions; XML; HTML; CSS; Variables & Arguments.	07
2.	RPA Concepts	Fundamentals: History of Automation, Introduction to RPA, RPA vs Automation, Processes & Flowcharts, Programming Constructs in RPA, Processes, and workloads that can be Automated, Types of Bots, Advanced concepts: Standardization of	10

		processes, RPA Development methodologies, Difference from SDLC, Robotic control flow architecture, RPA business case, RPA Team, Process Design Document/Solution Design Document, Industries best suited for RPA, Risks & Challenges with RPA, RPA and emerging ecosystem.	
3.	UiPath Introduction & Exploration	Installing UiPath Studio community edition, The User Interface, Keyboard Shortcuts About Updating, About Automation Projects, Introduction to Automation Debugging, Managing Activation Packages, Reusing Automations Library Installing the Chrome Extension; Variables; Control Flow; Data Manipulation; Recording and Advanced UI Interaction; Selectors	**10**
4.	UiPath Advanced Automation	Image, Text & Advanced Citrix Automation; Excel Data Tables & PDF; Email Automation; Debugging and Exception Handling; Project Organization, Orchestrator: Tenants, Authentication, Users, Roles, Robots, Environments, Queues & Transactions, Schedules.	**09**
5.	Artificial Intelligence and RPA	Research on application of RPA for Machine Learning, Agent awareness, Natural Language Processing, Computer Vision, etc.	**08**
6.	Case Studies and Projects	Case studies and projects on applying RPA for designing and developing robots for real-world problems.	**08**

Self-Learning (optional)

1. https://www.coursera.org/lecture/rpa-introduction/introduction-to-the-course-A3VLA
2. https://onlinecourses.nptel.ac.in/noc21_me32/preview
3. https://www.udemy.com/topic/robotic-process-automation/
4. https://academy.uipath.com/filter-learning-paths-org/Mw%3D%3D?contenttype=learningpath

Books Recommended:

Text Books:

1. Tripathi, Alok Mani. "Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool–UiPath." Packt Publishing Ltd, 2018.
2. Wibbenmeyer, Kelly. "The Simple Implementation Guide to Robotic Process Automation (Rpa): How to Best Implement Rpa in an Organization." (2018).

Reference Books:

1. Holst, T. G. M. "Turning data into value: determining which intelligent process

automation technologies can be used to automate the process of ordering packaging at Company X. MS thesis." University of Twente, 2021.
2. Lacity, Mary, and Leslie P. Willcocks. "Robotic process and cognitive automation: The next phase." SB Publishing, 2018.

Useful Links:

1. https://www.coursera.org/lecture/rpa-introduction/introduction-to-the-course-A3VLA
2. https://onlinecourses.nptel.ac.in/noc21_me32/preview

Suggested List of Experiments:
1. Study different use cases like:
   - Customer service and Support Desk,
   - IT & Infrastructure support,
   - Data Migration and Management
   - Connecting Process Island,
   - Digital and Online Initiative
2. Prepare SDLC of any one Use Case where RPA Delivers a Proven Value.
3. To Install UiPath Studio and using Uipath recorder perform how to empty the trash folder in GMAIL or with any other suitable example.
4. Design a Sequence and Control Flow using UI Path Studio based on taken CASE study in the above experiment (Experiment No -2).
5. Build a Data Scrapper by using data table of UI Path Studio.
6. Excel File Automation- Extract a Data from excel and map to Data Table and Vice versa.
7. Use a Screen Scrapper wizard in Full text, Native and OCR mode of Uipath to read data from PDF and give analysis between three which one is better for the Business Case model.
8. Take Any Application in area of Machine learning, NLP, Computer Vision etc and Build a Bot.

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO2024	Bio- inspired Computing and Bioinformatics	04	--	--	04	--	--	04
		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisites:
1. Fundamentals of Artificial Intelligence and Data Science

Course Objectives:
1. To introduce bio-inspired algorithms.
2. To impart knowledge of various evolutionary algorithms.
3. To introduce swarm intelligence and various optimization algorithms.
4. To introduce the concepts and ethics of bioinformatics
5. To know the importance of data mining in biomedical applications.

Course Outcomes: After the successful completion of this course, the learner will be able to:
1. Devise different concepts of bio-inspired computing.
2. Analyze evolutionary algorithms for various engineering applications.
3. Design swarm intelligence for dynamic optimization
4. Design and analysis of data mining applications towards molecular biology
5. Illustrate the use of biological sequences towards bioinformatics.
6. Design and implement data mining algorithms on various applications

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Introduction to Bio- inspired Computing	Bio-inspired computing, multi-objective optimization, Artificial Intelligence, Constraint handling, Cellular automata, sensor networks, artificial immune system.	06
2.	Evolutionary Computing	Foundation of evolutionary theory, Evolutionary algorithms for Optimization: Ant colony optimization, ACO algorithm, ACO and model-based search, Cuckoo Search and Firefly algorithm	08
3.	Particle Swarm Intelligence and Other Algorithms	Particle swarm optimization: Principles of bird flocking and fish schooling, Evolution of PSO, Operating principles, PSO algorithm, Neighborhood topologies, Convergence criteria, Overview of other bio-inspired algorithms: Harmony Search, Honey-Bee Optimization, Memetic	12

		Algorithms.	
4.	Bioinformatics	Introduction to Bioinformatics and Data Mining, Molecular Biology background: Analyzing DNA, Bioinformatics perspective of how individuals of a species differ and how different species differ, Bioinformatics challenges and opportunities, Ethics in Bioinformatics.	**08**
5.	Biological Sequence Analysis	DNA sequence analysis, DNA databases, Protein structure and function, Protein sequence databases, Sequence alignment, Sequence comparison, Sequence similarity search, Longest common subsequence problem, Scoring matrices for similarity search PAM, BLOSUM.	**10**
6.	Mining Biological Data	Protein structural classification, Protein structural prediction, Modeling text retrieval in biomedicine, Mining from microarray and gene expressions, Feature selection for proteomic and genomic data mining.	**08**

Self-Learning (optional)

1. https://www.coursera.org/specializations/bioinformatics

Books Recommended:

Text Books:

1. Floreano, Dario, and Claudio Mattiussi. Bio-inspired artificial intelligence: theories, methods, and technologies. MIT press, 2008
2. Olariu, Stephan, and Albert Y. Zomaya, eds. Handbook of bioinspired algorithms and applications. CRC Press, 2005.
3. Rastogi, S. C., Parag Rastogi, and Namita Mendiratta. Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery 3Rd Ed. PHI Learning Pvt. Ltd., 2008.
4. Ghosh, Zhumur, and Bibekanand Mallick. Bioinformatics: principles and applications. Oxford University Press, 2008.
5. Yang, Xin-She, ed. Cuckoo search and firefly algorithm: Theory and applications. Vol. 516. Springer, 2013.
6. Sivanandam, S. N., and S. N. Deepa. Principles of soft computing (with CD). John Wiley & Sons, 2007.

Reference Books:

1. Chiong, Raymond, ed. Nature-inspired algorithms for optimisation. Vol. 193. Springer, 2009.
2. Chen, Jake Y., and Stefano Lonardi, eds. Biological data mining. CRC Press, 2009.
3. Buffalo, Vince. Bioinformatics data skills: Reproducible and robust research with open source tools. " O'Reilly Media, Inc.", 2015.
4. Zengyou, He. Data mining for bioinformatics applications. Wood head Publishing, 2015.

5. Model, Mitchell L. Bioinformatics Programming Using Python: Practical Programming for Biological Data. " O'Reilly Media, Inc.", 2009.
6. Deb, Kalyanmoy. "Multi-objective optimization using evolutionary algorithms: an introduction." Multi-objective evolutionary optimization for product design and manufacturing. Springer, London, 2011. 3-34

Useful Links:
1. https://www.coursera.org/specializations/bioinformatics
2. https://www.udemy.com/course/ai-academy-4-learn-bio-inspired-optimization-methods-a-z/
3. https://onlinecourses.nptel.ac.in/noc21_bt06/preview
4. https://nptel.ac.in/courses/102/106/102106065/

Suggested List of Experiments:
1. To implement Ant colony algorithm to show optimization in any of the bioinformatics application.
2. Elaborate the honey bee and cuckoo search optimization algorithms.
3. Design a memetic algorithm using any evolutionary algorithms.
4. Simulate the DNA Sequence Analysis.
5. Design a Model for text retrieval in biomedicine.
6. Design a case study to demonstrate genomic Data mining.

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS DLO2025	**Security and AI**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Examination				TW	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
MEAIDS DLO2025	**Security and AI**	20	20	20	80	--	--	--

Prerequisites:
1. Python, Machine Learning Algorithms

Course Objectives:
1. To introduce the concepts of security in AI
2. To utilize AI for solving problem in cyber security
3. To make AI applications more secure

Course Outcomes: After completion of this course, students will be able to
1. To analyze malware using different machine learning algorithms
2. To analyze network security using various machine learning technique.
3. To evaluate the performance of a model
4. To design secure web application systems.
5. To develop cyber secure systems using AI.
6. To analyze malware using different machine learning algorithms

Unit No	Unit Title	Sub Topics	Total Hrs
1.	Malware analysis	Introduction to Malware detection, Static malware analysis, Dynamic malware analysis. Malware detection with decision trees, Random Forest Malware classifier, Clustering malware with K-Means. Detecting metamorphic malware with HMMs, Polymorphic malware detection strategies, Detecting obfuscated JavaScript, Tracking malware drift.	08
2.	Anomaly and Intrusion Detection	When to Use Anomaly Detection Versus Supervised Learning, Intrusion Detection with Heuristics, Data-Driven Methods, Feature Engineering for Anomaly Detection, Anomaly Detection with Data and Algorithms Challenges of Using Machine Learning in Anomaly Detection, Response and Mitigation Practical System Design Concern	10
3.	Network traffic analysis	Theory of Network Defense, Machine Learning Network Security, building a Predictive	10

		Model to Classify Network Attacks	
4.	Protecting the consumer web	Monetizing the Consumer Web, Types of Abuse and the Data That Can Stop Them Supervised Learning for Abuse Problems, Clustering Abuse, Further Directions in Clustering	08
5.	Adversarial machine learning	Terminology, The Importance of Adversarial ML, Security Vulnerabilities in Machine Learning Algorithms, Attack Technique: Model Poisoning, Attack Technique: Evasion Attack	06
6.	Applications of AI with cyber security	Case Studies for detecting email cyber security threats with AI, malware detection using Hidden Markov Model, Network anomaly detection with AI, securing user authentication, Intrusion Detection	10

Books Recommended:
 Text Books:
1. Menezes, Alfred J., Paul C. Van Oorschot, and Scott A. Vanstone. "Handbook of applied cryptography." CRC press, 2018.
2. Stallings, William. "Cryptography and network security", 4/E. Pearson Education India, 2006.
3. Chio, Clarence, and David Freeman. "Machine learning and security: Protecting systems with data and algorithms. " O'Reilly Media, Inc., 2018.

 Reference Books:
1. Dua, Sumeet, and Xian Du. "Data mining and machine learning in cybersecurity." CRC press, 2016.
2. Ventre, Daniel. "Artificial Intelligence, Cybersecurity and Cyber Defence." John Wiley & Sons, 2020
3. Parisi, Alessandro. "Hands-On Artificial Intelligence for Cybersecurity: Implement smart AI systems for preventing cyber attacks and detecting threats and network anomalies." Packt Publishing Ltd, 2019.

Useful Links:
1. The Complete Artificial Intelligence for Cyber Security 2021 | Udemy
2. Cybersecurity for Data Science | Coursera

Suggested List of Experiments:
1. Static and dynamic malware analysis
2. Anomaly detection using ML
3. Configure IDS to protect Network
4. Identification of artificially generated deep fake contents
5. Tracing origin of social media posts
6. Tracing IP address behind VPN/Proxy Server

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-

world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2021	Project Management	03	--	--	03	--	--	03

		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcomes:
1. Apply selection criteria and select an appropriate project from different options.
2. Write work breakdown structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earn devalue technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Total Hrs
1	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
2	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
3	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up	8

	budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	
4	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
5	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, 8 University of Mumbai, B. E. (Information Technology), Rev 2016 272 engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **a. Project Contracting** Project procurement management, contracting and outsourcing,	8
6	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Reference Books:

1. Jack Meredith & Samuel Mantel, "Project Management: A managerial approach", Wiley India, 7thEd.
2. "A Guide to the Project Management Body of Knowledge (PMBOK$^®$ Guide)", 5th Ed, Project Management Institute PA,USA
3. Gido Clements, "Project Management", Cengage Learning.
4. Gopalan, "Project Management", Wiley India
5. Dennis Lock, "Project Management", Gower PublishingEngland,9thEd.

<u>**Internal Assessment:**</u>

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

<u>**End Semester Theory Examination:**</u>

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2022	Finance Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Examination			TW	Pract	Oral
		Internal Assessment		End Sem Exam			
		Test 1	Test 2	Avg				
ILO2022	Finance Management	20	20	20	80	--	--	--

Course Objectives:
1. Over view of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Course Outcomes:
1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Total Hrs
1	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	6
2	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	6
3	**Overview of Corporate Finance:** Objectives of Corporate	9

		Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
4	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
5	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine 05 University of Mumbai, B. E. (Computer Engineering), Rev. 2016 128 Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	5
6	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	3

Reference Books:

1   Eugene F. "Fundamentals of Financial Management", 13th Edition (2015) Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2   Robert C. Higgins "Analysis for Financial Management", 10th Edition (2013) Publishers: McGraw Hill Education, New Delhi.
3   M.Y. Khan. "Indian Financial System," 9[th]Edition(2015); Publisher: McGraw Hill Education, New Delhi.
4   I. M. Pandey "Financial Management", 11th Edition Publisher: S. Chand (G/L) &

Company Limited, New Delhi. (2015)

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2023	Entrepreneur-ship Development and Management	03	--	--	03	--	--	03

			Examination Scheme					
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Course Outcomes:

1. Understand the concept to business plan and ownerships
2. Interpret key regulation sand legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Total Hrs
1	**Overview Of Entrepreneurship**: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
2	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development**: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
3	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
4	**Indian Environment for Entrepreneurship**: key	

	regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc		08
5	**Effective Management of Business**: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing		08
6	**Achieving Success In The Small Business**: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business		05

Reference Books:
1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, TaxmannPublication Ltd
9. Kurakto, Entrepreneurship- Principles and Practices
10. LaghuUdyogSamachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2024	Human Resource Management	03	--	--	03	--	--	03

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Course Outcomes:
1. Understand the concepts, aspects, techniques and practices of the human resource management
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Total Hrs
1	**Introduction to HR** Human Resource Management- Concept, Scope and Importance, Interdisciplinary, Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions Human resource development (HRD): changing role of HRM – Human resource, Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
2	**Organizational Behaviour (OB)** Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues, Personality: Meaning and Determinants of Personality,	

	Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	7
3	**Organizational Structure & Design** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
4	**Human resource Planning** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction,employee morale. PerformanceAppraisalSystems:Traditional&modernmethods,Performa nceCounseling,CareerPlanning. Training&Development:IdentificationofTrainingNeeds,TrainingMethods	5
5	**Emerging Trends in HR** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
6	**HR&MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent –Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Reference Books:
1. Stephen Robbins, Organizational Behavior,16[th]Ed, 2013
2. VSPRao, Human Resource Management, 3[rd]Ed,2010,Excel publishing
3. Aswathapa, Human resource management: Text &cases,6[th]edition,2011
4. C.B.MamoriaandSVGankar,DynamicsofIndustrialRelationsinIndia,15[th]Ed,2015,Himalaya

Publishing, 15th edition, 2015
5. P.Subba Rao,Essentials of Human Resource management and Industrial relations,5th Ed,2013,Himalaya Publishing
6. LaurieMullins,Management&OrganizationalBehavior,LatestEd,2016,PearsonPublications

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

Theory Examination:

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)	03	--	--	03	--	--	03

		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. To understand professional ethics in business
2. To recognized corporate social responsibility

Course Outcomes:
1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business.	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment**: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05

05	**Corporate Social Responsibility**: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	**08**
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	**08**

Reference Books:
1. BusinessEthics: Texts and Cases from the Indian Perspective (2013)by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Casesina Global Context (2007) by AndrewCrane, DirkMatten, LauraSpence; Publisher:Routledge.
3. BusinessEthics: Concepts and Cases, 7thEdition (2011) by Manuel G.Velasquez; Publisher: Pearson, New Delhi.

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination
In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2026	Research Methodology	03	--	--	03	--	--	03

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. To understand Research and Research Process
   To acquaint students with identifying problems for research and develop
2. research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcomes:
1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** • Basic Research • Applied Research • Descriptive Research • Analytical Research • Empirical Research • Qualitative and Quantitative Approaches	07
03	**Research Design and Sample Design** • Research Design – Meaning, Types and Significance • Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07

04	**Research Methodology** Meaning of Research Methodology Stages in Scientific Research Process: • Identification and Selection of Research Problem • Formulation of Research Problem • Review of Literature • Formulation of Hypothesis • Formulation of research Design • Sample Design • Data Collection • Data Analysis • Hypothesis testing and Interpretation of Data • Preparation of Research Report	08
05	**Formulating Research Problem** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	**Outcome of Research** • Preparation of the report on conclusion reached • Validity Testing & Ethical Issues • Suggestions and Recommendation	04

Reference Books:
1. Dawson, Catherine, "Practical Research Methods", New Delhi, UBS Publishers Distributors. 2002.
2. Kothari, C.R., "Research Methodology-Methods and Techniques", New Delhi, Wiley Eastern Limited 1985.
3. Kumar, Ranjit, "Research Methodology-A Step-by-Step Guide for Beginners", (2nded), Singapore, Pearson Education 2005,

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination
In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2027	IPR and Patenting	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Examination				TW	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
ILO2027	IPR and Patenting	20	20	20	80	--	--	--

Course Objectives:
1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Course Outcomes:
1. Understand Intellectual Property assets
2. Assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting
4. Understand Intellectual Property assets

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR):** Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent,	07

		Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	
05		**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06		**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Reference Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency

14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press.

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination
In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2028	Digital Business Management	03	--	--	03	--	--	03

		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Course Outcomes:
1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed Contents	Hours
1	**Introduction to Digital Business -**Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge TopeApps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
	Managing E-Business-Managing Knowledge, Management skills for e-business, Managing Risks in e–business Security Threats to e-business -Security Overview, Electronic	

4	Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation-Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Reference Books:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5 10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

<u>**Internal Assessment:**</u>

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

<u>**End Semester Theory Examination:**</u>

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination
In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.
1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ILO2029	Environmental Management	03	--	--	03	--	--	03

		Examination Scheme						
		Theory Examination						
		Internal Assessment			**End Sem Exam**	TW	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarize environment related legislations

Course Outcomes:
1. Understand the concept of environmental management
2. Understand eco system and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development ,The Energy scenario.	10
02	Global Environmental concerns: Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangeredlife-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Reference Books:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London,1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandraand Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February2005
5. Environmental Management: An Indian Perspective, S N Charyand Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing 2015

Internal Assessment:

Assessment consists of two tests out of which one should be a compulsory class test (on minimum 02 modules) and the other can be either a class test or assignment on real-world problems or course related projects.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination
In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total 6 questions
2. All questions carry equal marks.
3. Questions will be mixed in nature (for example, suppose Q2 has part (a) from module 3, then Q2 part (b) will be from any module other than module 3).
4. Only 4 questions need to be solved.
5. In the question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS L201	Data Handling & Visualization Lab	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				

Description of Lab: Lab is based on MEAIDSC 201, 202 and 203 courses.

Sr no	Topic	Sub Topics	Total Hrs
01	Descriptive & Inferential Statistics	1. Tools for central tendency of Data 2. Tools for variation in data 3. Probability, distributions, and hypothesis testing	04
02	Data Visualization	1. Data visualization through different types of plots mentioned in syllabus, Ex. Histogram, scatter plot, density plots, box plots, line graphs, bar charts etc. 2. Animating the plots 3. Interactive web based data visualization	04
03	Classification Techniques and comparisons	1. Logistic Regression 2. Naive Bayes 3. K-Nearest Neighbors 4. Decision Tree 5. Support Vector Machines	04
04	AI & DS Applications	Study/development of AI & DS application is expected. Sample application domains are listed below: 1. Chat bots 2. Email Spam Filtering 3. Weather Forecasting 4. Finance 5. Robotics	04
05	Social Media Data Analysis	Perform deep data analysis on any social media to draw the conclusions	02
		Web data analytics	04
06	Mini project	Concept based mini project using data science /analytics/deep learning/probabilistic reasoning/visualization Possible ideas for Mini project using	04

		R/Python/any data analytics tool. 1) To demonstrate the outcome of statistical analysis on dataset. 2) Exploratory data analysis on dataset.Comparative study of optimization techniques.	

Books Recommended:

  Text Books:
1. Parnell, Gregory S., et al. Handbook of decision analysis. Vol. 6. John Wiley & Sons, 2013.
2. B.Motwani, Data analytics with R, Wiley & Sons First Edition

  Reference Books:
1. Iliinsky, Noah, and Julie Steele. Designing data visualizations: Representing informational Relationships." O'Reilly Media, Inc.", 2011.

Internal Assessment:

Laboratory Project: Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work.

End Semester Examination:
Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDS L202	**DLOC Lab – 2**	04	--	--	04	--	--	04

		Examination Scheme						
		Theory Examination			TW	Pract	Oral	
		Internal Assessment		End Sem Exam				
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Description of Lab: **Lab should be based on Department level Elective course opted by students**

Lab Title	Suggested List of Experiments for DLOC Lab-2
MEAIDSDLO2021 **Social Network Analysis**	1. Study of various tools used in analysis of Social Network 2. Implementation of real-world problem like small world network, scale free network, random network 3. Implementation various Centrality Measures 4. Implementation of case study (Mini Project)
MEAIDSDLO2022 **GPU architecture and Programming**	1. Matrix multiplication using CUDA 2. Convolution using CUDA 3. Deep Learning using CUDA 4. Vector Addition using OpenCL

MEAIDSDLO2023
 	
Robotics Process Automation
	1. Study different use cases like:
	  • Customer service and Support Desk,
	  • It & Infrastructure support,
	  • Data Migration and Management,
	  • Connecting Process Island,
	  • Digital and Online Initiative
	  Prepare SDLC of any one Use Case where RPA Delivers a Proven Value.
	2. To Install Ui Path Studio and using Ui path recorder perform how to empty the trash folder in GMAIL or with any other suitable example
	3. Design a Sequence and Control Flow using UI Path Studio based on taken CASE study in the above experiment (Experiment No -2).
	4. Build a Data Scrapper by using data table of UI Path Studio
	5. Excel File Automation- Extract a Data from excel and map to Data Table and Vice versa
	6. Use a Screen Scrapper wizard in Full text, Native and OCR mode of Uipath to read data from PDF and give analysis

	between three which one is better for the Business Case model. 7. Take Any Application in area of Machine learning, NLP, Computer Vision etc and Build a Bot.
MEAIDSDLO2024 **Bio-inspired Computing and Bioinformatics**	1. To implement genetic algorithm to show optimization in any of the bioinformatics application. 2. Elaborate the honey bee and cuckoo search optimization algorithms 3. Design a memetic algorithm using any evolutionary algorithms 4. Simulate the DNA Sequence Analysis. 5. Design a Model for text retrieval in biomedicine 6. Design a case study to demonstrate genomic Data mining.
MEAIDSDLO2025 **Security and AI**	1. Static and dynamic malware analysis 2. Anomaly detection using ML 3. Configure IDS to protect Network 4. Identification of artificially generated deep fake contents 5. Tracing origin of social media posts 6. Tracing IP address behind VPN/Proxy Server

Internal Assessment:

Laboratory Project: Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work.

End Semester Examination:
Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDSS301	Seminar: State-of-the-art research topics	----	06	--	---	03	--	03
MEAIDSD301	Dissertation-I	----	24	--	---	12	--	12
Total		----	30	--	---	15	--	15

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Oral / Pract	Total
		Test 1	Test 2	Avg					
MEAIDSS301	Seminar: State-of-the-art research topics	---	---	---	---	---	50	50	100
MEAIDSD301	Dissertation-I	---	---	---	---	---	100	---	100
Total		---	---	---	----	---	150	50	200

Guidelines for Seminar:

- Seminar should be based on thrust areas in Artificial Intelligence and Data Science.
- Students should do literature survey, identify the topic of seminar and finalize it with consultationof Guide/Supervisor.
- Students should use multiple literatures from at least 10 papers from refereed Journals (Scopus Indexed & with good Thomson Reuters Impact Factor) / renowned Conferences to understand thetopic and research gap.
- Implementation of one paper from refereed journal as a case study is required.
- The report should be compiled in standard format and present to the panel of examiners. (Pair ofInternal and External examiners appointed by the University of Mumbai).
- It is advisable to students should publish at least one paper based on the work in reputedInternational / National Conference.

Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of 3rd semester.

Guidelines for Dissertation - I:

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures from refereed Journals (Scopus Indexed & with good Thomson Reuters Impact Factor) / renowned Conferences to understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justificationand compile the report in standard format.

Guidelines for Assessment of Dissertation - I:

Dissertation - I should be assessed based on following points:

- Quality of Literature Survey and Novelty in the Problem

- Clarity of Problem Definition and Feasibility of Problem Solution

- Relevance to the Specialization

- Clarity of Objective and Scope

Dissertation-I should be assessed through a presentation by a panel of Internal examiners and External examiner appointed by the Head of the Department/Institute of respective program

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
MEAIDSD401	Dissertation-II	--	30	--	---	15	--	15
Total		--	30	--	---	15	--	15

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Oral / Pract	Total
		Test 1	Test 2	Avg					
MEAIDSD401	Dissertation-II	---	---	---	---	---	100	100	200
Total		---	---	---	----	---	100	100	200

Guidelines for Assessment of Dissertation – II:

Dissertation - II should be assessed based on following points:

• Quality of Literature Survey and Novelty in the Problem

• Clarity of Problem Definition and Feasibility of Problem Solution

• Relevance to the Specialization

• Clarity of Objective and Scope

• Quality of Work Attempted or Learner Contribution

• Validation of Results

• Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred national/International conference/Journal of repute.

Dissertation II should be assessed by Internal and External Examiners appointed by the University of Mumbai.