PROGRAMME GUIDE

FOR

Master of Science (M.Sc.) (Data Science and Analytics) (MSCDSA)

(2 – Years Programme)

(Programme Code: MSCDSA)

January, 2026

SCHOOL OF COMPUTER AND INFORMATION SCIENCES (SOCIS)

INDIRA GANDHI NATIONAL OPEN UNIVERSITY

MAIDAN GARHI, NEW DELHI-110068

eProgramme Guide:

January, 2026 (version 1). This is a Programme Guide for MSCDSA Programme offered by IGNOU from January, 2026 admission cycle.

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Message from the MSCDSA Programme Coordinator(s)

Dear Learner,

It gives us immense pleasure to welcome you to the inaugural batch of IGNOU's Master of Science in Data Science and Analytics (MSCDSA) programme. This innovative two-year (four-semester) programme has been launched to meet the growing demand for skilled professionals in the rapidly expanding field of data science and analytics. It represents a major step forward for IGNOU in delivering cutting-edge, interdisciplinary education that blends theoretical depth with practical experience. As part of the first cohort, you hold a special place in shaping the future of this programme and contributing to its success.

The curriculum has been thoughtfully designed to provide a comprehensive understanding of the principles, tools, and applications of data science. It encompasses a wide range of subjects including mathematical foundations, artificial intelligence, big data analytics, deep learning, and cloud computing. Through an effective combination of theory courses, practical labs, and a capstone project, the programme aims to equip you with the knowledge, analytical skills, and problem-solving abilities essential for success in data-driven environments.

To ensure a meaningful and well-supported learning experience, IGNOU offers a strong academic ecosystem. This includes a network of Regional Centres (RCs) and Learner Support Centres (LSCs) (formerly known as Study Centres), which serve as your primary points of contact for academic and administrative support.

You will also have access to self-learning materials through the eGyankosh platform (http://www.egyankosh.ac.in), which provide extensive digital learning resources. In addition, regular theory and practical counselling sessions are conducted to enhance conceptual understanding and to provide hands-on exposure to data analysis tools and methods.

We encourage you to remain in close contact with your RC, LSC, and peer group, and to actively participate in discussions, collaborative projects, and online activities. These interactions will not only enhance your understanding of course materials but will also help you build a network of like-minded learners and professionals. For any academic or administrative assistance, our team is always available to support you through the official communication channels provided.

This Programme Guide has been prepared as your primary reference document throughout your studies. It contains detailed information about the instructional system, syllabus, and evaluation scheme, along with guidelines for accessing and submitting assignments within prescribed deadlines. It also provides links to essential forms, formats, and online resources that you will find helpful during your academic journey. Assignments form a vital component of the overall evaluation process. You are required to download your semester-wise assignments from the IGNOU website and submit them at your respective LSCs before the due dates. Timely submission of these assignments is mandatory for eligibility to appear in the Term-End pExaminations (TEE).

Practical and Counselling Sessions

Hands-on learning is an integral part of this programme. To ensure practical proficiency, each semester includes dedicated practical components designed to reinforce the theoretical concepts covered in the courses. Learners are required to maintain a minimum of 75% attendance in practical counselling sessions to qualify for the Term-End Practical Examinations. In addition, the timely submission of assignments remains a prerequisite for appearing in both theory and practical examinations.

Please note that the fee structure and other administrative details mentioned in admission or re-registration forms are subject to periodic revision. Therefore, learners are advised to confirm the latest information through the IGNOU website (https://www.ignou.ac.in) or contact their Regional Centre (RC) or Learner Support Centre (LSC) before making any payments.

Exit Option

In line with the National Education Policy (NEP) framework, this programme provides a flexible exit option. Learners who successfully complete all courses of the first 2 semesters (40 credits) may choose to exit the programme and become eligible for the award of the Post Graduate Diploma in Data Science and Analytics. However, it is important to note that there is no separate admission available directly to this diploma programme.

Communication and Feedback

As a member of the first batch, your feedback and suggestions will play an important role in improving the content and delivery of this programme. We encourage you to share your inputs and experiences with us, as they will help us strengthen the academic design and support mechanisms. You may reach out to the programme team at (mscdsa@ignou.ac.in) for general queries or use the iGRAM portal (http://igram.ignou.ac.in) for specific academic or administrative concerns.

Embarking on this journey in Data Science and Analytics marks the beginning of an exciting academic and professional path. As pioneers of this programme, you are part of a transformative initiative that combines innovation, analytical reasoning, and practical application. This Programme Guide is your constant companion—please read it carefully and keep it for reference throughout your studies.

We are delighted to have you join us for this landmark programme and look forward to supporting you at every step of your academic journey.

With best wishes for your success,

Programme Coordinators:
Prof. Sandeep Singh Rawat and Prof. Divakar Yadav
M.Sc. (Data Science and Analytics)
Email: mscdsa@ignou.ac.in

1. BASIC INFORMATION

1.0 Programme Objectives

The M.Sc. (Data Science Analytics) programme is designed to prepare graduate students for successful careers in the software industry and academia. Following are the objectives:

- To provide a strong foundation in statistical and computational methods for data analysis.
- To equip with the skills to collect, manage, analyze and interpret large and complex datasets.
- To apply data science techniques to solve real-world problems in various domains such as business, healthcare, social sciences, and engineering.
- To prepare for careers in data science and analytics.

1.1 Duration of the Programme

(Minimum -2 Years, Maximum - 4 Years)

To fulfil the requirements for acquiring the MSCDSA, a student may successfully complete each course of the programme in a minimum of 2 years and a maximum of 4 years.

1.2 Medium of Instruction

The medium of instruction is **English.** The course material is in English.

1.3 Credit System

The University follows the 'Credit System' for its programmes. Each credit is worth 30 hours of student learning time comprising all the learning activities. Thus, a four-credit course involves 120 study hours. This helps the student to understand the academic effort one has to put for successful completion of a course. **Successful completion of the programme requires successful completion of both assignments and the Term-End Examination of each course of the programme.**

1.4 Exit Option

If a learner decides to EXIT from the programme after successful completion of all the courses of first two semesters (40 credits), then the learner is eligible for the award of Post Graduate Diploma in Data Science and Analytics. However, to mention that there is no explicit admission for Post Graduate Diploma in Data Science and Analytics.

1.5 Mode of Delivery

This programme is offered through the Open and Distance Learning (ODL) mode, wherein a Learner Support Centre (LSC) is assigned to facilitate both theoretical and practical counselling sessions.

1.6 Programme Structure

The programme has been divided into two semesters per year (July to December and January to June), with a balanced blend of theory and practical components:

- **Semester I and II** focus on building foundational knowledge and practical skills in core subjects such as mathematics, programming, data structures, databases, data wrangling, visualization, and machine learning. These semesters emphasize strengthening the theoretical base and developing practical competence in essential data science tools and techniques.
- **Semester III and IV** are designed to deepen the conceptual understanding through advanced topics such as big data analytics, deep learning, soft computing, cloud computing, natural language

processing, and data security. The final semester also includes project work that allows students to apply their knowledge to real-world challenges, fostering innovation and independent research.

Overall, the MSCDSA programme aims to develop skilled professionals capable of addressing complex data-centric problems using cutting-edge technologies and methodologies.

Consequently, there will be two examinations every year - one in the month of December for the July to December semester courses and the other in June for the January to June semester courses. The students are at liberty to appear for any of the examinations conducted by the University during the year subject to completing the minimum time framework and other formalities prescribed for the programme.

M.SC. (DATA SCIENCE AND ANALYTICS) PROGRAMME STRUCTURE

Sr. No.	Course Title	Course Code	Theory/ Practical	Credits
Semester I (20)				
1.	Mathematical Foundations - I	MCS-061	Theory	4
2.	Introduction to Data Science	MCS-062	Theory	4
3.	Data Structures using Python	MCS-063	Theory	4
4.	Database Management Systems	MCS-207	Theory	4
5.	Data Structures using Python Lab	MCSL-064	Practical	2
6.	Data Science Lab	MCSL-065	Practical	2
Semester II (20)				
1.	Mathematical Foundations - II	MCS-066	Theory	4
2.	Data Wrangling and Visualization	MCS-067	Theory	4
3.	Artificial Intelligence and Machine Learning	MCS-224	Theory	4
4.	Predictive Data Analysis	MCS-068	Theory	4
5.	Artificial Intelligence and Machine Learning Lab	MCSL-069	Practical	2
6.	Data Analysis Lab	MCSL-070	Practical	2
Semester III (20)				
1.	Big Data Analytics	MCS-071	Theory	4
2.	Deep Learning	MCS-072	Theory	4
3.	Soft Computing	MCS-073	Theory	4
4.	Cloud Computing	MCS-074	Theory	4
5.	Big Data Analytics Lab	MCSL-075	Practical	2
6.	Deep Learning Lab	MCSL-076	Practical	2
Semester IV (20)				
1.	Natural Language Processing	MCS-077	Theory	4
2.	Data Security	MCS-078	Theory	4
3.	Project Work	MCSP-079	Project	12

No. of Theory Courses– 14; No. of Practical Courses –6; Project – 1; Total Credits: 80;
Total number of Courses are 21.

1.7 Recognition

IGNOU is a Central University established by an Act of Parliament in 1985 (Act No.50 of 1985) IGNOU Degrees/Diplomas/Certificates are recognized by all member Universities of Association of Indian Universities (AIU) and are at par with Degrees/Diplomas/Certificates of all Indian Universities/Deemed Universities/Institutions vide UGC Circular No. F1-52/2000 (CPP-II) dated 5 May, 2004 and AIU Circular No. EV/B (449)/94/177115 dated January 14, 1994, and UGC's letter no. UGC/DEB/2013 dated

14.10.2013, and UGC notification on UGC website F.No. 1-18/2018 (DEB-I) dated 21-02-2019. You may download all the recognition related information from the IGNOU's website.

1.8 Student Support Services

To provide individualized support to its learners, the University has created a number of Learner Support Centres (LSCs) throughout the country for this Programme. These are administratively coordinated by the Regional Centres (RCs). The LSCs are the contact points for the students on all major aspects of the Programme. These include counselling sessions, practical sessions, reference library facilities, disseminating information and advice, facilities for audio-visual training aids and teleconferencing.

The University may not always be able to communicate to all the students individually. All the important communications are sent to the Regional Directors who in turn will intimate them to the LSC Coordinators. The Coordinators display such Circulars / Notifications on their notice boards for the benefit of the students. You are, therefore, advised to be in touch with your LSC Coordinator on a more regular basis so as to get the latest information about assignments, submission schedules (assignments and examination forms), declaration of results, etc.

1.9 How to contact the Programme Coordinator?

Students may contact the Programme Coordinator by sending a communication through post to The MSCDSA Programme Coordinator, SOCIS, Vishveswaraiah Bhavan, C-Block, IGNOU Academic Complex, IGNOU, Maidan Garhi, New Delhi – 110068, or can send an Email to mscdsa@ignou.ac.in

2.   INSTRUCTIONAL SYSTEM

The methodology of instruction in this University is different from that of the conventional universities. The Open and Distance Learning (ODL) University system is more learner oriented, and the student has to be an active participant in the teaching-learning process. Most of the instruction is imparted through distance mode with only a small component of face-to face communication. The University follows a multi-channel approach for instruction. It comprises a suitable mix of:

☞   Self-learning materials in pdf/printed form

☞   Audio-video programmes transmitted through GYAN DARSHAN channel

☞   Face-to-face counselling at LSC by academic counselors

☞   Compulsory practical sessions at the LSCs

☞   eGyankosh (for downloading self-learning materials)

☞   Web based academic support

☞   Assignments

☞   Gyan Darshan Channel, including teleconferencing,

☞   Gyan Vani

☞   SWAYAMPRABHA-DTH (Channel-13) – Professional Education

2.0 Self-learning Material

Self-learning materials are the primary form of instructional materials. These are supplied to the learners in the form of booklets having several blocks. Each block consists of several units. The size of a unit is such that the material given therein may be expected to be studied by a student in a session of about 4 to 6 hours of study. This self-learning material is made in electronic form through IGNOU eContent App and eGyankosh website. However, the fast pace of computer industry necessitates that students must do some additional readings. Students are advised to study reference books without fail. Studying the self-learning material alone may not be sufficient to write assignments and prepare for the Term-end Examinations.

2.1 eGyankosh, SWAYAMPRABHA-DTH (Channel-13) and IGNOU eContent App

eGyankosh **(www.egyankosh.ac.in)** is a digital repository consists of the reference links Self instructional materials, recorded videos, YouTube-video archives etc. Various links for the eGyankosh related to SOCIS are:

eGyankosh Homepage: http://www.egyankosh.ac.in/

Self-Learning Material: https://www.egyankosh.ac.in/handle/123456789/72348

YouTube-Video Archives: http://www.egyankosh.ac.in/handle/123456789/35748

EMPC YouTube Live/Playlists: https://www.youtube.com/@EMPCIGNOU/streams

SWAYAM PRABHA Channel 13, designated as "Professional Education," is a specialized educational television channel operating under the SWAYAM PRABHA initiative of the Ministry of Education, Government of India. This channel is coordinated by the Indira Gandhi National Open University (IGNOU), New Delhi, and is dedicated to delivering high-quality educational content to a nationwide audience.

The primary objective of Channel 13 is to provide learners with the knowledge and skills necessary for entry into specific professions or occupational sectors. It serves as a vital platform to bridge the gap between academic learning and the skill requirements of contemporary workplaces. By offering industry-relevant courses, the channel supports individuals in developing competencies for career advancement, while also addressing workforce development needs by contributing to a skilled talent pool for the nation.

Channel 13 broadcasts an extensive range of academic programs, including Certificate, Diploma, Postgraduate Diploma, Postgraduate Certificate, Undergraduate, and Postgraduate courses. These courses span various disciplines such as Computer Science and Applications, Management Studies, Journalism and New Media Studies, etc.

The video content, which is visually engaging and graphically enhanced, is delivered by faculty members of IGNOU as well as subject matter experts from other prestigious institutions across India. The channel operates on a 24x7 basis, with a minimum of four hours of fresh content broadcasted daily. Each session is repeated five times during the day, thereby ensuring flexible and convenient access for learners.

SWAYAM PRABHA homepage: https://www.swayamprabha.gov.in/

LIVE sessions of SWAYAM PRABHA: https://splive.ignouonline.ac.in/live/ch/13

Professional Education (Channel-13): https://swayamprabha.gov.in/program/current_he/13

Archive Videos: https://swayamprabha.gov.in/program/archive_he/13

IGNOU eContent App

The self-learning material of various programmes of IGNOU are made available through **IGNOU eContent APP**

https://play.google.com/store/apps/details?id=ac.in.ignou.Viewer&hl=en

2.2 Counselling Sessions

The details of the theory and practical counselling sessions are given in the following sections. **Theory Sessions**

In distance education, face-to-face contact between the learners and their tutors/counsellors is relatively less. The purpose of such a contact is to answer some of your questions and clarify your doubts that may not be possible through any other means of communication. It also provides you with an opportunity to meet your fellow students.

There are academic counsellors at the LSC to provide counselling and guidance to you in the courses that you have chosen for study. Normally, these sessions will be held at the LSC on Saturdays and Sundays.

You should note that the counselling sessions would be very different from the classroom teaching or lectures. Counsellors will not be delivering lectures as in conventional teaching. They will try to help you to overcome difficulties that you face while studying for the MSCDSA programme. In these sessions, you must try to resolve your subject-based difficulties and any other related problems.

Practical Sessions and Compulsory Attendance
The practical sessions will be held in the computer centres / labs of the LSC. In these computer labs, the participants will have the facility to use the computer and software packages relevant to the syllabus. The following points regarding the practical attendance must be noted:

i) 75% attendance is compulsory for each lab course. This is a pre-requisite for taking the term-end practical examination in the respective lab courses.

ii) A student who fails to fulfil the 75% attendance requirements will be allowed to reregister for that lab course. For fee details and the application form, please contact your Regional Centre.

iii) Students are required to prepare a separate lab record for each lab course. The practical counsellor should duly sign this lab record after each session.

iv) Student attendance will be recorded course wise at the Learner Support Centre.

v) Strictly follow the guidelines given in the Lab manuals for the respective lab courses.

vi)   Computer to Student ratio in a practical session would be 1:2. (2 students would be sharing a machine)

> **Before attending the counselling session for each course, please go through your course material as per the session schedule and make a plan of the points to be discussed. Unless you have gone through the Units, there may not be much to discuss and a counselling session may not be fruitful.**

Counselling Sessions

The following is the counselling schedules for 1st to 4th Semesters of MSCDSA. **The respective Learner support centres will communicate you the exact dates of the Schedule.**

1st Semester

Course Code	Theory/Practical	Credits	No. of Theory Counselling Sessions*	Hours	No. of Practical Counselling Sessions**	Hours
MCS-061	Theory Sessions	4	6	12	-	-
MCS-062	Theory Sessions	4	6	12	-	-
MCS-063	Theory Sessions	4	6	12	-	-
MCS-207	Theory Sessions	4	6	12	-	-
MCSL-064	Practical Sessions	2			20	60
MCSL-065	Practical Sessions	2	-	-	20	60

2nd Semester

Course Code	Theory/Practical	Credits	No. of Theory Counselling Sessions*	Hours	No. of Practical Counselling Sessions**	Hours
MCS-066	Theory Sessions	4	6	12	-	-
MCS-067	Theory Sessions	4	6	12	-	-
MCS-224	Theory Sessions	4	6	12	-	-
MCS-068	Theory Sessions	4	6	12	-	-
MCSL-069	Practical Sessions	2	-	-	20	60
MCSL-070	Practical Sessions	2	-	-	20	60

3rd Semester

Course	Theory/Practical	Credits	No. of Theory Counselling Sessions*	Hours	No. of Practical Counselling Sessions**	Hours
MCS-071	Theory Sessions	4	6	12	-	-
MCS-072	Theory Sessions	4	6	12	-	-
MCS-073	Theory Sessions	4	6	12	-	-
MCS-074	Theory Sessions	4	6	12	-	-
MCSL-075	Practical Sessions	2	-	-	20	60
MCSL-076	Practical Sessions	2	-	-	20	60

4th Semester

Course	Theory/Practical	Credits	No. of Theory Counselling Sessions*	Hours	No. of Practical Counselling Sessions	Hours
MCS-077	Theory Sessions	4	6	12	-	-
MCS-078	Theory Sessions	4	6	12	-	-
MCSP-079	Project	12	4	8	-	-

*Each theory counselling session is for 2 hours duration.
**Each practical counselling session is for 3 hours duration.

Semester	No. of Sessions		No. of Hours	
	Theory	**Practical**	**Theory**	**Practical**
I	24	40	48	120
II	24	40	48	120
III	24	40	48	120
IV	12 + 4 sessions for discussions on Project	-	24 + 8 = 32	-
TOTAL	**84**	120	**176**	**360**

Total Computer time for Practicals (120 Sessions) =360 Hours
Note: 75% attendance is compulsory in Practical Lab Sessions.

MCS-061: Mathematical Foundations - I

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1 and Unit-2
	2	All topics of Block-1 Unit 3 and Unit-4
	3	All topics of Block-2 Unit-5, Unit 6 and Unit-7
	4	All topics of Block-3 Unit-8, Unit 9 and Unit-10
	5	All topics of Block-4 Unit-11, and Unit-12
	6	All topics of Block-4 Unit-13 and Unit-14

MCS-062: Introduction to Data Science

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1 and Unit-2
	2	All topics of Block-1 Unit-3, Unit-4
	3	All topics of Block-2 Unit-5 and Unit-6
	4	All topics of Block-2 Unit-7, Block-3 Unit-8
	5	All topics of Block-3 Unit-9, and Unit-10; Block-4 Unit-11
	6	All topics of Block-4 Unit-12 and Unit-13

MCS-063: Data Structures using Python

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Unit-1, Unit-2 and Unit-3
	2	All topics of Unit-4, Unit-5
	3	All topics of Unit-6, Unit-7 and Unit-8
	4	All topics of Unit-9, Unit-10, Unit-11
	5	All topics of Unit-12, Unit-13
	6	All topics of Unit-14, Unit-15 and Unit-16

MCS-207: Database Management Systems
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1, Unit-2 and Unit-3
	2	All topics of Block-1 Unit-4 Block-2 Unit-5
	3	All topics of Block-2 Unit-6, Unit-7 and Unit-8
	4	All topics of Block-2 Unit-9 Block 3 Unit-10, Unit-11
	5	All topics of Block-3 Unit-12, Block-4 Unit-13
	6	All topics of Block-4 Unit-14, Unit-15 and Unit-16

MCSL-064: Data Structures using Python Lab
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Practical Counselling	1-20	In each session, designated Exercises are to be done. Refer to MCSL-064 course material.

MCSL-065: Data Science Lab

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Practical Counselling	1-12	Data Science Lab - GUI Tools Based
	13-20	Data Science Lab – Programming Tools Based

MSCDSA 2nd Semester Schedule

MCS-066: Mathematical Foundations - II

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Unit-1, Unit-2 and Unit-3
	2	All topics of Unit-4 and Unit-5
	3	All topics of Unit-6 and Unit-7
	4	All topics of Unit-8 and Unit-9
	5	All topics of Unit-10 and Unit-11
	6	All topics of Unit-12 and Unit-13

MCS-067: Data Wrangling and Visualisation

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Unit-1 and Unit-2
	2	All topics of Unit-3 and Unit-4
	3	All topics of Unit-5 and Unit-6
	4	All topics of Unit-7 and Unit-8
	5	All topics of Unit-9 and Unit-10
	6	All topics of Unit-11 and Unit-12

MCS-224: Artificial Intelligence and Machine Learning

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1, Unit-2 and Unit-3
	2	All topics of Block-1 Unit-4 Block-2 Unit-5
	3	All topics of Block-2 Unit-6, Unit-7 and Unit-8
	4	All topics of Block-3 Unit-9, Unit-10, Unit-11
	5	All topics of Block-3 Unit-12, Block-4 Unit-13
	6	All topics of Block-4 Unit-14, Unit-15 and Unit-16

MCS-068: Predictive Data Analysis

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1, and Unit-2
	2	All topics of Block-1 Unit-3 and Unit-4
	3	All topics of Block-2 Unit-5,6 and Unit-7
	4	All topics of Block-3 Unit-8, 9 and Unit-10
	5	All topics of Block-3 Unit-11,12, Block-4 Unit-13
	6	All topics of Block-4 Unit-14, 15 and Unit-16

MCSL-069: Artificial Intelligence and Machine Learning Lab

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Practical Counselling	1-10	All topics of Artificial Intelligence
	11-20	All topics of Machine learning

MCSL-070: Data Analysis Lab
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Practical Counselling	1-10	All topics of Data Wrangling and Visualization
	11-20	All topics of Predictive Data Analysis

MSCDSA 3rd Semester Schedule

MCS-071: Big Data Analytics
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1, Unit-2 and Unit-3
	2	All topics of Block-1 Unit-4, Block-2 Unit-5
	3	All topics of Block-2 Unit-6 and Unit-7
	4	All topics of Block-3 Unit-8, Unit-9, and Unit-10
	5	All topics of Block-3 Unit-11, Block-4 Unit-12
	6	All topics of Block-4 Unit-13 and Unit-14

MCS-072: Deep Learning

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1 and Unit-2
	2	All topics of Block-1 Unit-3, Block-2 Unit-4
	3	All topics of Block-2 Unit-5 and Unit-6
	4	All topics of Block-3 Unit-7 and Unit-8
	5	All topics of Block-3 Unit-9, Block-4 Unit-10
	6	All topics of Block-4 Unit-11 and Unit-12

MCS-073: Soft Computing
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1 and Unit-2
	2	All topics of Block-1 Unit-3 Block-2 Unit-4
	3	All topics of Block-2 Unit-5 and Unit-6
	4	All topics of Block-3 Unit-7 and Unit-8
	5	All topics of Block-3 Unit-9 Block-4 Unit-10
	6	All topics of Block-4 Unit-11 and Unit-12

MCS-074: Cloud Computing
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1, Unit-2 and Unit-3
	2	All topics of Block-1 Unit-4, Block-2 Unit-5
	3	All topics of Block-2 Unit-6, Unit-7 and Unit-8
	4	All topics of Block-3 Unit-9 and Unit-10
	5	All topics of Block-3 Unit-11 Block-4 Unit-12
	6	All topics of Block-4 Unit-13 and Unit-14

MCSL-075: Big Data Analytics Lab
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Practical Counselling	1-20	All topics of Big Data Analytics

MCSL-076: Deep Learning Lab
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Practical Counselling	1-20	All topics of Deep Learning Lab

MSCDSA 4ᵗʰ Semester Schedule

MCS-077: Natural Language Processing
Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Block-1 Unit-1, Unit-2 and Unit-3
	2	All topics of Block-1 Unit-4, Unit-5 and Unit 6
	3	All topics of Block-2 Unit-7, and Unit 8
	4	All topics of Block-2 Unit-9 and Block -3 Unit-10
	5	All topics of Block-3 Unit-11 and Unit-12
	6	All topics of Block-4 Unit-13, Unit-14 and Unit-15

MCS-078: Data Security

Counselling Sessions

Sessions	Session Number	Topics to be Covered
Theory Counselling	1	All topics of Unit-1 and Unit-2
	2	All topics of Unit-3 and Unit-4
	3	All topics of Unit-5 and Unit-6
	4	All topics of Unit-7 and Unit-8
	5	All topics of Unit-9 and Unit-10
	6	All topics of Unit-11 and Unit-12

2.3 Web Based Support

The learners can have access to IGNOU's website at the following address (URL): *http://www.ignou.ac.in.* You can download assignments, old question papers, circulars, etc. from the website. The Programme Guide is also available at the website. Section 3 gives you how to browse the IGNOU's website.

3. SYLLABUS

SEMESTER - I

MCS-061 Mathematical Foundation – I
Credit – 4

Syllabus: Set, Relations , Functions, Graphical Representation of Function, Progressions ,Matrices, Determinants, Vector Analysis, Counting Techniques, Limit and Continuity, Differentiation and Integration.

Blocks and Units Structure:

Block-1: Sets , Relations and Functions

Unit -1 : Introduction to Sets
1.0   Objectives
1.1   Introduction
1.2 Set
1.2.1 Identity and Cardinality
1.2.2 Subsets
     1.2.2.1 Power Set of a Set
1.2.3 Finite and Infinite Sets
     1.2.3.1 Properties of Infinite Sets
1.3 Types of Sets
1.4 Hierarchy of Sets
1.5 Venn Diagrams
1.6 Set Operations
    1.6.1 Properties of Set Theoretical Operations
    1.6.2 Russell's Paradox
    1.6.3 Intervals
    1.6.4 Closed, Open, Bounded and Unbounded Sets
     1.6.5 Convex Set
1.7 Ordered Pairs and Cartesian Products
    1.7.1   Ordered Pairs
    1.7.2   Cartesian Products
1.8 Some Useful and Important Laws
1.9 Summary
1.10 Solutions/Answers

Unit -2 : Relations
2.0 Objectives
2.1 Introduction
2.2   Relations
    2.2.1 Domain and Range of Relation
    2.2.2 Binary Relation
    2.2.3 Properties of Binary Relations
          Reflexive, Symmetric and Transitive Relations
2.3 Inverse of a Relation
 2.4 Equivalence Relations and Partitions
         2.4.1 Equivalent Relation
         2.4.2 Partition
         2.4.3 Equivalent Class
2.5   Composition of Relations
         2.5.1 Composition of Binary Relations
2.6 Some Useful and Important Laws
2.7 Summary
2.8 Solutions/Answers

Unit-3: Functions
3.0 Introduction
3.1 Objectives
3.2 Quantity
3.3 Interval
3.4 Function
         3.4.1 Mapping
         3.4.2 Function
         3.4.3 Functions as Relations
         3.4.4 Inverse Functions
         3.4.5 Composition and Function
         3.4.6 Domains and Ranges of Composed Functions
3.5 Classification of functions
3.6 Types of functions
3.7 Summary
3.8 Solutions/Answers

Unit -4: Graphical Representation of Function
 4.0 Objectives
4.1   Introduction
4.2   Vertical Line Test of Function
4.2.1 Difference between Equation and Function
4.3   Graphical Representation of Single Variable Functions
4.4 Graph of Linear Types of Functions
         4.4.1 Absolute Value Function
         4.4.2 Step Function

9.9 Solutions/Answers

Unit 10 Counting Techniques
10.0 Introduction
10.1 Objectives
10.2 Factorial and its Notations
10.3 Fundamental Principles of Counting
10.4 Permutation
10.5 Combination
10.6 Selection of Permutation or Combination
10.7 Some Important Results
10.8 Binomial Theorem
10.9 Summary
10.10 Solutions/Answers

Block -4 : Calculus

Unit 11 Limit and Continuity
11.0 Introduction
11.1 Objectives
11.2 Concept of Limit
11.3 Direct Substitution Method
11.4 Failure of Direct Substitution Method
11.5 Concept of Infinite Limit
11.6 Concept of Left Hand and Right Hand Limits
11.7 Continuity of a Function at a Point
11.8 Continuous Function
11.9 Summary
11.10 Solutions/Answers

Unit 12 : Differentiation
12.0 Introduction
12.1 Objectives
12.2 Definition of Derivative, its Meaning and Geometrical Interpretation
12.3 Derivative at a Point
12.4 Derivative by First Principle
12.5 Chain Rule
12.6 Derivatives of Exponential, Logarithmic, Parametric and Implicit
       Functions
12.7 Derivatives up to 2nd Order
12.8 Concept of Maxima and Minima
12.9 Summary
12.10 Solutions/Answers

Unit -13 Indefinite Integration
13.0 Introduction
13.1 Objectives
13.3 Meaning and Terminology used in Indefinite Integration
13.4 Integration of some Particular Functions
13.5 Integration by Substitution

13.6 Integration using Partial Fractions
13.7 Integration by Parts
13.8 Summary
13.9 Solutions/Answers

Unit -14 : Definite Integration
14.0 Introduction
14.1 Objectives
14.2 Meaning and Geometrical Interpretation
14.3 Definite Integral of some commonly used Functions
14.4 Elementary Properties of Definite Integral
14.5 Examples based on Properties of Definite Integral
14.6 Summary
14.7 Solutions/Answers

MCS-062 Introduction to Data Science
Credit – 4

BLOCK-1 Introduction to Data Science – 1
Unit- 1 Data Science Fundamentals
1.0 Introduction; 1.1 Objectives 1.2 Understanding Data science, 1.3 Data Science Process , 1.4 Data Science Vs Data Analytics, , 1.5 Types of data analysis, 1.6 Philosophy of Exploratory Data Analysis, 1.7 Role of Data scientist and Data Analyst, 1.8 Crowd sourcing, 1.9 Languages for Data Science 1.10 Applications of Data Science 1.11 Data Science Life cycle 1.12 Summary 1.13 Solutions/Answers 1.14 Further Readings
Unit- 2 Understanding Data and its Types
2.0 Introduction 2.1 Objectives 2.2 Properties of Data, 2.3 Datafication, 2.4 Data Categories : Qualitatitive & Quantitative data ; 2.5 Data Formats : Structured, Unstructured and Semi Structured data ;   2.6 Primary data & secondary Data, 2.7 Categorical data & Numerical data 2.8 Cross-sectional data & Time series data, 2.9 Discrete data & Continuous Data, 2.10 Levels of Measurement of Data : Nominal, Ordinal, ratio and Interval data scales, Big Data, 2.11 Summary 2.12 Solutions/Answers 2.13 Further Readings

UNIT 3 Data Acquisition(DAQ): tools
3.0 Introduction 3.1 Objectives 3.2 DAQ Tools : Sensors and Actuators, Data Loggers, Transducers, Data Acquisition(DAQ) Cards, PLC, SCADA, Web scraping, Remote Sensing, 3.3 Accessing Data from Repositories, 3.4

Software's for Data Acquisition, 3.5 Summary 3.6 Solutions/Answers 3.7 Further Readings

UNIT 4 Data Acquisition(DAQ): techniques
4.0 Introduction 4.1 Objectives 4.2 DAQ Techniques: ADC & DAC conversion, 4.3 Signal conditioning, 4.4 Sampling, 4.5 Multiplexing, 4.6 Data Logging, 4.7 Triggering, 4.8 Sensor integration, 4.9 High Speed DAQ, 4.10 Summary 4.11 Solutions/Answers 4.12 Further Readings

Block-2 Introduction to Data Science – 2
UNIT 5 Data Preprocessing
5.0 Introduction 5.1 Objectives 5.2 Need for Data Preparation 5.3 Data preprocessing 5.3.1 Data Cleaning 5.3.2 Data Integration 5.3.3 Data Reduction 5.3.4 Data Transformation 5.4 Selection and Data Extraction 5.5 Data Curation 5.6.1 Steps of Data Curation 5.6.2 Importance of Data Curation 5.7 Data Integration 5.7.1 Data Integration Techniques 5.7.2 Data Integration Approaches 5.8 Knowledge Discovery 5.9 Summary 5.10 Solutions/Answers 5.11 Further Readings

UNIT 6 DESCRIPTIVE AND EXPLORATORY DATA ANALYSIS – AN INTRODUCTION

6.0 Introduction 6.1 Objectives 6.2 Data Science - Definition 6.3 Types of Data 6.3.1 Statistical Data Types 6.3.2 Sampling 6.4 Basic Methods of Data Analysis 6.4.1 Descriptive Analysis 6.4.2 Exploratory Analysis

UNIT 7 INFERENTIAL AND PREDICTIVE DATA ANALYSIS – AN INTRODUCTION

7.0 Introduction 7.1 Objectives 7.2 Inferential Data Analysis 7.3 Predictive Data Analysis 5.5 Common Misconceptions of Data Analysis 5.8 Summary 5.9 Solutions/Answers

BLOCK-3 DATA VISUALIZATION AND INTERPRETATION
UNIT 8: Data Visualization
8.0 Introduction 8.1 Objectives 8.2 Different types of plots 8.3 Histograms 8.4 Box plots 8.5 Scatter plots 8.6 Heat map 8.7 Bubble chart 8.8 Bar chart 8.9 Distribution plot 8.10 Pair plot 8.11 Line graph 8.12 Pie chart 8.13 Doughnut chart 8.14 Area chart 8.15 Summary 8.16 Answers 8.17 References
UNIT 9 : Excel for Descriptive Data Analysis

9.0 Introduction 9.1 Objectives 9.2 Importing data from various file formats, 9.3 Data Handling, and Pre processing ; 9.4 Frequency distribution, 9.5 central tendency and dispersion. 9.6 Descriptive data analysis and its interpretation 9.7 Summary 9.8 Answers 9.9 References
UNIT 10 : Excel for Inferential Data Analysis
10.0 Introduction 10.1 Objectives 10.6 Sampling 10.7 Hypothesis testing 10.7.1 t Test, 10.7.2 chi square Test, 10.7.3 F-Test, 10.7.4 Z-Test. 10.7.5 ANOVA. 10.8 Correlation and Regression Analysis : uni-variate , multi variate.10.9 Time Series and Forecasting Using Excel 10.10 Summary 10.11 Answers 10.12 References

BLOCK-4 Data Science – Allied Areas
Unit-11 Introduction to NoSQL and Bigdata
11.0 Introduction 11.1 Objectives 11.2 Introduction to NoSQL 11.2.1 What is NoSQL 11.2.2 Brief history of NoSQL Databases 11.2.3 NoSQL database features 11.2.4 Differentiate between RDBMS and NoSQL 11.2.5 Types of NoSQL Databases 11.3 Introduction to Big Data 11.3.1 Big Data and Characteristics 11.3.2 Big data Applications 11.3.3 Structured vs semi-structured and unstructured data 11.3.4 Big Data vs data warehouse 11.3.5 Distributed file system 11.3.6 HDFS and Map Reduce 11.3.7 Apache Hadoop 1 and 2 (YARN) 11.5 Summary 11.6 Solutions/Answers 11.7 Further Readings
Unit-12 Introduction to Data Stream Mining
12.0 Introduction 12.1 Objectives 12.4 Introduction to Data Streams 12.4.1 Model for Data Stream Processing 12.4.2 Data Stream Management 12.4.3 Queries of Data Stream 12.4.4 Examples of Data Stream and Queries 12.4.5 Issues and Challenges of Data Stream 12.5 Summary 12.6 Solutions/Answers 12.7 Further Readings
Unit-13 Tools for Data Science-An Introduction
13.0 Introduction 13.1 Objectives 13.1 Tools for Data Science 13.1.1 Basics of Tableu 13.1.2 Basics of Power BI 13.1.3 Basics of Python-Programming 13.1.4 Basics of R-Programming 13.2 Summary 13.3 Solutions/Answers 13.4 Further Readings

MCS-063 Data Structures using Python
Credit – 4

Unit 1: PYTHON PRIMER

1. Introduction

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• **Reference Books :** (1) Data Structures and Algorithms in Python by Michael T.Goodrich, Roberto Tamassia and Michael H.Goldwasse; Wiley India (Publisher); ISBN-10 :9354247865; ISBN-13: 978-9354247866

• (2) An Introduction to Data Structures with Applications by Jean Paul Tremblay and Paul Gordon Sorenson; McGraw Hill Higher Education (Publisher); ISBN-10 : 0070651574; ISBN-13: 978-0070651579

- (3) Data Structures and Algorithms by Aho. Hopcroft, Ullman; Pearson Education India (Publisher); ISBN-10 : 8178081021; ISBN-13: 978-8178081021
- (4) Fundamentals of Data Structures by Ellis Horowitz, Sartaj Sahni; Pitman Publishing (Publisher); ISBN-10: 027301062X; ISBN-13: 978-0273010623
- (5) Design and Analysis of Computer Algorithms by Aho, Hopcroft, Ullman; Pearson (Publisher); ISBN-10: 0201000296; ISBN-13: 978-0201000290
- (6) Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter by Wes McKinney; O'Reilly (Publisher); ISBN-10: 9355421907; ISBN-13: 978-9355421906
- (7) Python Crash Course: A Hands-On based Introduction to Programming by Eric Matthes; No Starch Press (Publisher); ISBN-10: 1718502702; ISBN-13: 978-1718502703

MCS-207 Database Management Systems
Credit – 4

Course Description:
This course provides a comprehensive understanding of Database Management Systems. Learners will learn the fundamental concepts of database design, query optimization, and data manipulation.

Objectives

After completing this course, the student will be able to:

1. Familiarize with the physical DBMS structure, including DML Precompiler, DDL Compiler, File Manager, Database Manager, Query Processor, Database Administrator, and Data Dictionary.
2. Explore relational algebra and execute example queries using relational algebra.
3. Understand E-R diagrams and enhanced ER tools such as subclasses, superclasses, specialization, generalization, constraints, and characteristics.
4. Learn about functional dependencies and normalization forms (1NF, 2NF, 3NF, BCNF) with desirable properties of decomposition.
5. Explore nested queries and advanced SQL features like assertions, cursors, triggers, stored procedures, embedded SQL, dynamic SQL, and their applications.
6. Understand database recovery, atomicity, checkpointing, buffer management, levels of

database security, access control, audit trails, and their SQL support.
7. Explore the role of relational algebra in query optimization, estimating statistics, views, query processing, storage, and optimization techniques.
8. Learn about Object-Oriented Databases, Data Mining, Data Warehousing, NoSQL databases, and emerging database models.

Block and Unit Structure

Block 1: Introduction to DBMS
Unit 1: Database Management System – An Introduction
Need for a Database Management System Logical DBMS Architecture - Three level architecture of DBMS Mappings between levels and data independence Physical DBMS Structure - DML Precompiler, DDL Compiler, File Manager, Database Manager , Query Processor, Database Administrator, Data files indices and Data Dictionary Introduction to Different Data Models and Current Trends

Unit 2: Relational Database
The Relational Model (Domains, Attributes, Tuple and Relation, Super keys Candidate keys and Primary keys for the Relations) Relational Constraints, (Domain Constraint, Key Constraint, Integrity Constraint, Update Operations and Dealing with Constraint Violations) Relational Algebra (Basic Set Operation, Cartesian product, Relational Operations) Example of queries using relational algebra

Unit 3: ER Model Entity Relationship (ER) Model (Entities, Attributes, Relationships) E-R Diagram Enhanced ER tools (Subclasses, Super class, and Inheritance, Specialization and Generalization, Constraints and Characteristics of Specialization and Generalization) Converting ER and EER diagram to tables

Unit 4: File Organisation in DBMS Physical Database Storage of Database on Hard Disks File Organisation and Its Types Sequential File Organisation, Indexed File Organisation, Hashed File Organisation Types of Indexes, Index and Tree Structure, Multi-key File Importance of File 28 Organisation in Databases

Block 2: Normalisation and Database Queries
Unit 5: Integrity, Functional Dependency and Normalization

Relational Database Integrity (The Keys, Referential Integrity, Entity Integrity) Redundancy and Associated Problems Functional Dependencies Normalization (The First Normal Form, The Second Normal Form, The Third Normal Form, Boyce Codd Normal Form Desirable Properties of Decomposition with examples

Unit 6: Higher Normal Forms Multivalued dependency
4NF Join Dependency 5NF Introduction to other normal form

Unit 7: Structured Query language
Data Definition Language Data Manipulation Language Data Control Language SQL Introduction Aggregate functions, Group by and having clause

Unit 8: Complex Queries
Joins Equi join, self join, outer joins etc. Sub-queries and correlated subqueries Views, Sequences, Indexes, Synonyms Nested Queries

Unit 9: Advanced SQL
Assertion and views Cursors, triggers and stored procedures Embedded SQL Dynamic SQL Advanced Features of SQL

Block 3: Database Transactions, Recovery and Security
Unit 10: Transaction Management
The Transactions and its Properties The Concurrent Transactions and associated problems The Locking Protocol (Serialisable Schedules, Locks, Two Phase Locking (2PL) Deadlock and its Prevention Deadlock Handling, Optimistic Concurrency Control Timestamp based Protocol Multi-version Schemes Weak Levels of Consistency SQL commands for Transactions

Unit 11: Database Recovery and Security
Recovery and Atomicity Recovery with Concurrent Transaction Checkpointing Buffer Management Levels of database security Access control Audit trails in the databases Relationship between Security and Integrity SQL support for recovery and security

Unit 12: Query Evaluation Measures of Query
Cost (Selection Operation,, Sorting, Join Operation, other Operations) Evaluation of Expression Transformation of Relational Expressions Role of Relational Algebra in query optimization Estimating Statistics of Expression Choice of Evaluation Plans Views and query processing Storage and query optimization.

Block 4: Introduction to Advanced Database Models
Unit 13: Object Oriented Database
Unit 14: Distributed Database, Data Mining and Data Warehousing
Unit 15: NOSQL databases
Unit 16: Emerging Database Models

References:
"Database Management Systems" by R. Ramakrishnan and J. Gehrke

MCSL-064 Data Structures using Python Lab
Credit – 2

Objective: To provide hands-on exercises to the learners based on Data Structures using Python Course.

Block 1: Data Structures Using Python Lab Manual

Section 1: Data Structures Using Python Lab

Structure
1.0   Introduction
1.1   Objectives
1.2   Basic elements
1.3   Sequences
1.4   Arrays
1.5   Stacks
1.6   Queues
1.7   Dequeues
1.8   Linked Lists
1.9   Trees
1.10   Maps, Hash Tables, Skip Lists
1.11   Trees
1.12   Searching and Sorting
1.13   Graph Algorithms
1.14   Summary
1.15   Further Readings
There are 20 lab sessions in the courses. In the lab manual, problems will be given session wise for learners to work on them during lab sessions.

MCSL – 065 Data Science Lab
Credit – 2

Main objective of this laboratory course is to provide hands-on exercises to the learners based on the Mathematical Foundation for Data Science – I and Introduction to Data Science Courses.

Lab Sessions:
• There will be 20 practical sessions (3 hours each) of which 10 sessions will be on Mathematical Foundation for Data Science – I and 10 sessions will be on Introduction to Data Science.
• The practice problems for all 20 sessions will be listed session-wise in the lab manual.

SEMESTER - II

MCS-066   Mathematical Foundation
                Credit – 4

This course introduces the students to the mathematical foundations of data science. The focus of this course is on statistics, Probability and Optimisation.

Block 1: Descriptive Statistics

Unit 1: Introduction to Statistics
What is statistics? Measurement Scale (Nominal, Ordinal Scale)
Data Collection, Descriptive Statistics
Inferential Statistics and Probability Models, Population and Sampling
Population Parameters

Unit 2: Describing data Sets and Measures of Central Tendencies
Describing Data Sets
Frequency Tables and Graphs
Relative Frequency Tables and Graphs
Grouped Data, Histograms, Ogives, and Stem and Leaf Plots
Sample Mean, Sample Median, and Sample Mode
Sample Percentiles and Box Plots

Unit 3: Measures of Dispersion
Variance
Standard Deviation
Skewness
Kurtosis
Other measures of dispersion
Normal Data Sets

Block 2: Probability and Distributions

Unit 4: Basics of Probability

Sample Space and Events
Venn Diagrams
Axioms of Probability
Sample Spaces
Conditional Probability
Bayes' Formula
Independent Events

Unit 5: Random Variables and Expectation
Random Variables
Types of Random Variables
Jointly Distributed Random Variables
Expectation
Variance
Covariance and Variance of Sums of Random Variables
Law of Large Numbers

Unit 6: Discrete Probability Distributions
The Bernoulli and Binomial Distribution
The Poisson Distribution
The Hypergeometric Distribution
The Poisson Process

Unit 7: Continuous Probability Distribution
The Uniform Distribution
Normal Random Variables
The Chi-Square Distribution
The t-Distribution
The F-Distribution

Block 3: Parameter Estimation and Hypothesis Testing

Unit 8: Sampling Distribution
The Sample Mean
The Central Limit Theorem
Approximate Distribution of the Sample Mean
How is Large a Sample Needed?
The Sample Variance
Distribution of the Sample Mean
Joint Distribution of X and S^2

Unit 9: Estimating Parameter
Maximum Likelihood Estimators
Confidence Interval
Point Estimator
Estimating the Difference in Means of Two Normal Populations
Approximate Confidence Interval for the Mean of a Bernoulli

Unit 10: Hypothesis Testing
Significance Levels
Tests regarding Mean of a Normal Population

t-Test
z-Test
Testing of Means of Two Normal Populations
hypothesis Test in Bernoulli Populations

Block 4: Analysing data and Optimisation

Unit 11: Analysis of Variance
One-Way Analysis of Variance
Two-Factor Analysis of Variance
Two-Factor Analysis of Variance

Unit 12: Categorical Data Analysis
Goodness of Fit Tests
Tests of Independence
Tests of Independence
The Kolmogorov – Smirnov Goodness of Fit
Test

Unit 13: Introduction to Optimisation
Gradient Descent
Gradient Ascent
Stochastic Gradient Descent
Randomisation
Local and Global Minima

Reference:
"Introduction to Probability and statistics for
engineers and scientists" 3rd Edition, Sheldon M.
Ross, Elsevier Academic Press, 2004

MCS-067 Data Wrangling and Visualization
Credit – 4

This course explains some of the most
fundamental methods of preparing data for
analysis. In addition, this course discusses data
visualisation techniques.

Block 1: Data Wrangling -I

Unit 1: Data Wrangling and Profiling

- Why Wrangling
- Process of data semantics
- Set-based profiling
- Basic Tools for Data Wrangling
- Summary Statistics

Unit 2: Data Cleaning and Preparation.

Handling Missing Data
Filtering Out Missing Data
Filling In Missing Data
Data Transformation :
Removing Duplicates

Transforming Data Using a Function or Mapping
Replacing Values
Renaming Axis Indexes

Unit 3: Data Transformation

Discretisation and Binning
Detecting and Filtering Outliers
Permutation and Random Sampling
Computing Indicator/Dummy Variables
String Manipulation , String Object Methods,
Regular Expressions,
String Functions

Block 2: Data Wrangling - II

Unit 4: Combining and Reshaping Datasets

Hierarchical Indexing
Reordering and Sorting Levels
Combining and Merging Datasets
Merging
Concatenating
Combining Data with Overlap
Reshaping and Pivoting
Reshaping with Hierarchical Indexing

**Unit 5: Data Aggregation and Group
Operations**

Group By Mechanics
Iterating Over Groups
Selecting a Column or Subset of Columns
Grouping with Dictionaries and Series
Grouping with Functions
Data Aggregation
Column-Wise and Multiple Function Application
Returning Aggregated Data Without Row
Indexes

**Unit 6: Plotting and Visualisation using
Python**

A Brief matplotlib API
Figures and Subplots
Colors, Markers, and Line Styles
Ticks, Labels, and Legends
Annotations and Drawing on a Subplot
Saving Plots to File
matplotlib Configuration
Plotting with pandas and seaborn
Line Plots
Bar Plots

Histograms and Density Plots
Scatter or Point Plots
Facet Grids and Categorical Data

Block 3: Visualisation for Statistical Analysis

Unit 7: Graphical Data Representation

Presentation Graphics, Exploratory Graphics
The Media and Graphics
Presentation (What to Whom, How and Why)
Scientific Design Choices in Data Visualisation
Choice of Graphical Form,
Graphical Display Options
Higher-dimensional Displays and Special
Structures
Scatter plot Matrices
Time Series and Maps

Unit 8: Design of Graphical Plots
Plots
Sensible Defaults
User Interface
Customisation
Setting Parameters
Arranging Plots
Annotation
The User Interface
Extensibility
Building Blocks
Combining Graphical Elements
The User Interface
3-D Plots
Speed

Unit 9: Data Visualisation Through Graph Representations

Data and Graphs
Graph Layout Techniques
Multidimensional Scaling
Bipartite Graphs
Hierarchical Trees
Spanning Trees
Trees
Graph Drawing

Block 4: Visualization for Specific Analytical Methods

Unit 10: Visualising Trees and Forests

Individual Trees

Hierarchical Views
Recursive Views
Fitting Tree Models
Visualising Forests
Split Variables
Data View
Trace Plot

Unit 11: Multivariate Visualization by Density Estimation

Univariate Density Estimates.
Histograms
Improved Binned Density Estimates
Kernel Density Estimates
Kernel Variants
Multiscale Visualisation of Density Estimates
Bivariate Density Estimates
Bivariate Histograms
Bivariate Kernel Density Estimators
High-Dimensional Space
Structure of High dimensional spaces
The Geometry of High Dimensions
Higher-dimensional Density Estimates

Unit 12: Graphs for Regression

Cartesian Products and the Trellis Paradigm
Trellis Paradigm
Implementation of Trellis Graphics
Scatterplot Matrices:
Display of Scatterplot Matrix
Coordinating Sets of Related Graphs
Summary Plot with Legend
Regression Diagnostic Plots.
Analysis of Covariance Plots
References

1. "Python for Data Analysis. Data Wrangling with Pandas, NumPy, and IPython", Wes McKinney,
 2nd Edition, O'Reilly, 2017

2. "Handbook of Data Visualization" , Chun-houh Chen, Wolfgang Hardle, Antony Unwin, Springer, 2008

MCS-224 Artificial Intelligence and Machine Learning Credits- 4

The course relates to the conceptual understanding of the Artificial Intelligence and Machine Learning. Generally, Artificial Intelligence (AI) is considered as the discipline, to deal with the solution of the hard and insolvable

problems using reasonable amount of time, by exploiting the knowledge of the problem domain. In view of the significance of knowledge in AI, in this course, a number of knowledge representation formalisms are introduced. The formalisms discussed include Propositional Logic, First Order Predicate Logic, Rule-based systems, Semantic Networks and Frames. Further, the course introduces the various concepts of Machine learning, Viz. Supervised learning, Unsupervised Learning and their respective application areas. Currently these two fields i.e. Artificial Intelligence and Machine Learning are in high demand, the course will help the learners to build the understanding of these fields.

Detailed Course Structure*

Block-1 Artificial Intelligence -Introduction:

Unit-1 Introduction to Artificial Intelligence -
What is AI? Examples of AI systems, Approaches to AI, Brief history of AI, Comparison Between Artificial intelligence, Machine Learning, and Deep Learning, Intelligent Agent: stimulus response agents. components of intelligence.

Unit-2 Problem Solving using Search –
Single agent search: Introduction to State Space Search, Statement of Search problems: state space graphs, Searching explicit state spaces. Feature based state spaces. Problem types, examples (puzzle problem, n-queen, the road map) Two agent search: Adversarial search: Two agent games (alpha-beta pruning). Min-Max Search.

Unit-3 Uninformed and Informed Search–
Uninformed Search: Formulating the state space, iterative deepening, bidirectional
search. Informed Search Strategies: Using evaluation functions. A* & AO*, admissibility of A* , Iterative deepening A*, recursive best first search.

Unit-4 Predicate and Propositional Logic –
Propositional logic, syntax, semantics, semantic rules, terminology - validity, satisfiability. interpretation, entailment, proof systems. Propositional Logic inference rules, natural deduction, propositional resolution.

Block-2 Artificial Intelligence - Knowledge Representation:

Unit-5 First Order Logic -

First Order Logic: Motivation, Syntax, Interpretations, semantics of quantifiers, Entailment in FOL, Interpretation, Inference in FOL: First Order resolution. Conversion to clausal form. Unification. Most general unifier. Resolution with variables Proving validity.

Unit-6 Rule based Systems and other formalism -
Rule Based Systems: Forward chaining. Backward chaining. Conflict resolution. Semantic nets, Frames, Scripts.

Unit-7 Probabilistic Reasoning
Reasoning with uncertain information Review of Probability Theory, Introduction to Bayesian Theory, Bayes' Networks, Probabilistic Inference, Basic idea of inferencing with Bayes networks. Other paradigms of uncertain reasoning. Dempster-Scheffer Theory

Block-3 Introduction to Machine Learning

Unit-8 Introduction to Machine Learning Methods:
Introduction to Machine Learning, Techniques of Machine Learning, Reinforcement Learning and algorithms, Deep Learning and its Algorithms, Ensemble Methods.

Unit-9 Feature selection and Extraction:
Introduction to Feature Selection and Extraction, Dimensionality Reduction, Principal Component Analysis, Linear Discriminant Analysis, Singular Value Decomposition.

Unit-10 Association Rules
Introduction to Pattern search and its algorithms: Apriori Algorithms. and its variants, FP Tree Growth, Pincer Search.

Block-4 Machine Learning Types

Unit-11 Supervised Learning
Understanding of Supervised Learning, Introduction to Classification, Classification Algorithms: Naïve Bayes, K-NN, Decision Trees, Logistic Regression, Support Vector Machines, Random Forest Algorithm, Introduction to Regression, Regression algorithm: Linear Regression and Polynomial Regression, Support Vector Regression.

Unit-12 Unsupervised Learning

Understanding of Supervised Learning, Introduction to Clustering, Types of Clustering, Partition Based, Hierarchical Based, Density Based Clustering Techniques, Clustering algorithms: KMeans, Agglomerative and Divisive, DBSCAN, Introduction to Fuzzy Clustering.

Unit 13: Reinforcement Learning:
Introduction to reinforcement learning, benefits of reinforcement learning, reinforcement learning workflow, Reinforcement learning models: Q-learning, SARSA, Deep Q-network (DQN), Markov Decision Process, Uses of reinforcement learning.

Unit – 15 Machine Learning Programming using Python
Implementations of various algorithms learned in different units of this course.

MCS-068 Predictive Data Analysis
Credit – 4

Block-1 DATA ANALYSIS – AN INTRODUCTION
Unit-1 Descriptive Data Analysis
1.0 introduction 1.1 objectives 1.2 descriptive analysis (Collecting Data, Kinds of Data, Frequency Distribution of a Variable, Graphical Representation of Frequency Distribution, Summarization of Data, Measures of Central Tendency, Measures of Dispersion or Variability) 1.3 Summary 1.4 Answers 1.5 References/Further Readings

Unit-2 Diagnostic Data Analysis
2.0 introduction 2.1 objectives 2.3 diagnostics analysis (Data Mining & Correlation Analysis) 2.3 Summary 2.4 Answers 2.5 References/Further Readings

Unit-3 Predictive Data Analysis
3.0 introduction 3.1 objectives 3.2 predictive analysis (Regression Analysis, Time Series Analysis, Classification, Clustering) 3.3 Summary 3.4 Answers 3.5 References/Further Readings

Unit-4 Prescriptive Data Analysis
4.0 introduction 4.1 objectives 4.2 prescriptive analysis (optimization, simulation, game theory and decision-analysis methods) 4.3 Summary 4.4 Answers 4.5 References/Further Readings

Block-2 Predictive Data Analysis-I

UNIT 5 Similarity Measures
5.0 Introduction 5.1 Objectives 5.2 Finding Similar Items 5.3 Finding Similar Sets 5.3.1 Jaccard Similarity of Sets 5.3.2 Documents Similarity 5.3.3 Collaborative Filtering and Set Similarity 5.4 Finding Similar Documents 5.4.1 Shingles 5.4.2 Min-hashing 5.4.3 Locality Sensitive Hashing 5.5 Distance Measures 5.5.1 Euclidean Distance 5.5.2 Jaccard Distance 5.5.3 Cosine Distance 5.5.4 Edit Distance 5.5.5 Hamming Distance 5.6 Introduction to Other Techniques 5.7 Summary 5.8 Solutions/Answers 5.9 References/Further Readings

Unit 6 – Outlier Detection
6.0 introduction 6.1 objectives 6.2 Standard deviation method, 6.3 Box-plots, 6.4 Z-score, 6.5 Percentiles, 6.6 DBSCAN, 6.7 Local Outlier factor 6.8 Summary 6.9 Answers 6.10 References/Further Readings

Unit 7 - Predictive Analytics Models
7.0 introduction 7.1 objectives 7.2 Regression models an Introduction, 7.3 Time series & Forecasting models an Introduction, 7.4 Supervised learning models an Introduction, 7.5 Unsupervised learning Models an Introduction 7.6 Summary 7.7 Answers 7.8 References/Further Readings

Block-3 Predictive Data Analysis-II
Unit 8 – Regression Models
8.0 introduction 8.1 objectives 8.2 introduction to regression 8.3 regression models 8.3.1 Linear Regression 8.3.2 Multiple regression 8.3.3 polynomial regression 8.3.4 Ridge and Lasso regression 8.3.5 Support Vector regression 8.6 Summary 8.7 Answers 8.8 References/Further Readings

Unit 9 – Time Series Models
9.0 introduction 9.1 objectives 9.2 ARIMA 9.3 SARIMA 9.4 LSTM 9.5 Bi-LSTM 9.6 Exponential Smoothing 9.7 seasonal trends Decomposition 9.8 Summary 9.9 Answers 9.10 References/Further Readings

Unit 10 – Supervised learning Models for Data Analysis
10.0 introduction 10.1 objectives 10.2 Supervised Vs Unsupervised Learning 10.3 Supervised Learning models 10.3.1 K-Nearest neighbor, 10.3.2 naïve-bayes , 10.3.3 Logistic regression, 10.3.4 decision trees 10.3.5 Random Forest 10.3.6

Support vector Machines 10.4 Summary 10.5 Answers 10.6 References/Further Readings

Unit 11 –Unsupervised learning Models for Data Analysis
11.0 introduction 11.1 objectives 11.4 unsupervised learning models 11.4.1 K-Means Clustering 11.4.2 Hierarchical Clustering 11.4.3 Agglomerative Clustering 11.4.4 Association Rules 11.6 Summary 11.7 Answers 11.8 References/Further Readings

Unit-12 Performance Evaluation Measures
12.0 introduction 12.1 objectives 12.2 Confusion matrix, 12.3 Accuracy Precision, 12.4 Sensitivity, Specificity, 12.5 F1-Score, 12.6 ROC curve, 12.7 PR curve 12.8 Summary 12.9 Answers 12.10 References/Further Readings

Block-4 R-Programming for Data Analysis

UNIT 12 BASICS OF R PROGRAMMING
12.0 Introduction 12.1 Objectives 12.2 Environment of R 12.3 Data types, Variables, Operators, Factors 12.4 Decision Making, Loops, Functions 12.5 Data Structures in R 12.5.1 Strings and Vectors 12.5.2 Lists 12.5.3 Matrices, Arrays and Frames 12.6 Summary 12.7 Answers 12.8. References and Further Readings

UNIT 13 DATA INTERFACING AND VISUALISATION IN R
13.1 Introduction 13.2 Objectives 13.3 Reading Data From Files 13.3.1 CSV Files 13.3.2 Excel Files 13.3.3 Binary Files 13.3.4 XML Files 13.3.5 JSON Files 13.3.6 Interfacing with Databases 13.3.7 Web Data 13.4 Data Cleaning and Pre-processing 13.5 Visualizations in R 13.5.1 Bar Charts 13.5.2 Box Plots 13.5.3 Histograms 13.5.4 Line Graphs 13.5.5 Scatter plots 13.6 Summary 13.7 Answers 13.8. References and Further Readings

UNIT 14 DATA ANALYSIS AND R
14.1 Introduction 14.2 Objectives 14.3 Chi Square Test 14.4 Linear Regression 14.5 Multiple Regression 14.6 Logistic Regression 14.7 Time Series Analysis 14.8 Summary 14.9 Answers 14.10 References and Further Readings

UNIT 15 ADVANCE ANALYSIS USING R
15.0 Introduction 15.1 Objectives 15.2 Decision Trees 15.3 Random Forest 15.4 Classification 15.5 Clustering 15.6 Association rules 15.7

Summary 15.7 Answers 15.8 References and Further Readings

MCSL-069 AI and Machine Learning Lab
                                    (Credits 2)

Main objective of this laboratory course is to provide hands-on exercises to the learners based on the Artificial Intelligence and Machine Learning Course.

Lab Sessions:
• There will be 20 practical sessions (3 hours each) of which 10 sessions will be on AI and
10 sessions will be on machine learning.
• The practice problems for all 20 sessions will be listed session-wise in the lab manual.

MCSL-070   Data Analysis Lab
                                    Credit – 2
Main objective of this laboratory course is to provide hands-on exercises to the learners based on the Mathematical Foundation for Data Science – II and Predictive Data Analysis Courses.

Lab Sessions:
• There will be 20 practical sessions (3 hours each) of which 10 sessions will be on Mathematical Foundations- II and 10 sessions will be on Predictive Data Analysis.
• The practice problems for all 20 sessions will be listed session-wise in the lab manual.

SEMESTER - III

MCS – 071 Big Data Analytics
                                    Credit – 4

Objectives

After completing this course, the student will be able to:

1. Understand Big Data Challenges and Characteristics
2. Learn about Big Data Sources and Comparisons
3. Explore Analytic Processes and Modern Tools
4. Understand Hadoop's Role and Evolution
5. Learn Hadoop Components and Configurations

6. Explore Data Ingestion and Processing Tools
7. Understand Advanced Hadoop Ecosystem Components

Block 1: Introduction to Big Data and Hadoop Ecosystem

Unit 1: Introduction to Big Data Analytics

- Understanding the challenges of traditional data processing, Introduction to Big Data, Characteristics of Big Data: The Three Vs: Volume, Velocity, and Variety, Comparison with other systems, Sources of Big Data, Big Data in enterprise
- Evolution of Analytic Scalability
- Analytic Processes and Tools, Analysis vs Reporting, Modern Data Analytic Tools
- Challenges and Opportunities, Characteristics and significance of Big Data
- Overview of the Big Data ecosystem

Unit 2: Introduction to Hadoop

- Understanding the Apache Hadoop, The Role of Hadoop in Big Data Processing, Hadoop's Historical Evolution, architecture of Hadoop
- Configurations of Hadoop, Hadoop Distributed File System (HDFS)
- Hadoop MapReduce framework

Unit 3: Hadoop Distributed File System (HDFS)
- HDFS Design and Architecture, Data Storage and Replication in HDFS
- HDFS Concepts: Blocks, Name node-Secondary name node, Job tracker-Task tracker, Data node.
- Hadoop –Setup, Hadoop -Pseudo mode, Hadoop - Cluster mode
- Interacting HDFS using command line
- Interacting HDFS using Java APIs
- Big Data Management

Unit 4: Hadoop Ecosystem Components

- Apache Hive for data warehousing
- Apache Pig for data flow scripting
- Apache HBase for NoSQL database

Block 2: Data Ingestion and Processing with Hadoop

Unit 5: Data Ingestion in Hadoop

- Data Collection Methods
- Data Ingestion Tools and Techniques
- Best Practices for Data Ingestion

Unit 6: Data Processing with Hadoop

- Preprocessing Data with Hadoop
- Performing ETL (Extract, Transform, Load)
- Using Pig and Hive for Data Processing

Unit 7: Data Ingestion with Apache Flume and Apache Spark

- Introduction to Apache Flume
- Setting up Flume agents for data collection
- Introduction to Apache Spark
- Spark RDDs and transformations
- Spark SQL for structured data processing

Block 3: Advanced Hadoop Ecosystem

Unit 8: Advanced Hadoop MapReduce

- Custom MapReduce programs
- Hadoop streaming for non-Java languages
- Combiners and Partitioners

Unit 9: Data Storage and Retrieval with Apache Cassandra

- Introduction to Apache Cassandra
- Cassandra data model and architecture
- Query language (CQL) for data retrieval

Unit 10: Apache Kafka for Real-time Data Streaming

- Introduction to Apache Kafka
- Kafka architecture and components
- Real-time data streaming with Kafka

Unit 11: Machine Learning with Apache Mahout

- Introduction to machine learning
- Apache Mahout algorithms and implementation
- Integration with Hadoop

Block 4: Big Data Analytics and Use Cases

Unit 12: Introduction to Data Analytics

- Understanding data analytics
- Descriptive, predictive, and prescriptive analytics
- Tools and techniques for analytics

Unit 13: Real-world Use Cases

- Industry-specific Big Data use cases
- Case studies and success stories
- Challenges and solutions in real-world applications

Unit 14: Future Trends in Big Data and Hadoop

- Emerging technologies in Big Data
- Future trends and directions
- Continuous learning and staying updated in the field

MCS – 072   Deep Learning

                              Credit – 4

Course Objectives:

After studying this course the student will be able to:

- Understand the fundamental history fundamental concepts of deep learning
- Discuss the architectures and optimization methods for deep neural network training
- Implement, apply and test relevant learning algorithms in TensorFlow
- Critically evaluate the method's applicability in new contexts and construct new applications

Block 1: Deep Learning Basics

Unit 1: Introduction to Deep Learning

- History of Deep Learning
- Deep Learning – An Introduction
- Applications of Deep Learning
- Limitations of Deep Learning
- Early Neural Network Models
    - McCulloch Pitts Neuron
    - Thresholding Logic
    - Perceptrons
    - Perceptron's Learning Algorithm and Convergence
    - Boltzmann Machines (New Addition)
- Multilayer Perceptrons (MLPs)
    - Representation Power of MLPs
    - Limitations of Linear Nets and Perceptrons
- Neural Networks and Their Applications
    - Sigmoid Neurons
    - Feed Forward Neural Networks
    - Different Layers of Neural Network
    - Loss Function
    - Backpropagation
    - Gradient Descent (GD)
    - Momentum Based GD
- Eigenvalues and Eigenvectors
    - Eigenvalue Decomposition
    - Principal Component Analysis (PCA)
    - Singular Value Decomposition (SVD)
- Advanced Techniques in Neural Networks
    - Parameter Sharing and Tying
    - Injecting Noise at Input
    - Ensemble Methods
    - Batch Normalization

Unit 2: Activation Functions

- Introduction to Activation Functions
- Different Activation Functions
- Sigmoid function
- Hyperbolic Tangent function
- ReLu - Rectified Linear Units
- Softmax function

Unit 3: Auto-Encoders and Regularization

- Auto-Encoders and their relation to PCA
- Regularization in Auto-Encoders
- Denoising Auto-Encoders
- Sparse Auto-Encoders
- Bias Variance Tradeoff
- L2 Regularization
- Early Stopping
- Dataset Augmentation
- Encoder Decoder Models
- Attention Mechanism
- Attention over images

Block 2: Deep Learning Models

Unit 4: Artificial Neural Networks (ANNs)

- Basics of artificial neural networks
- Perceptrons and activation functions
- Feedforward neural networks

- Training neural networks: gradient descent and backpropagation

Unit 5: Convolutional Neural Networks (CNNs)

- Introduction to convolutional neural networks
- CNN architecture and components
- Convolutional layers and filters
- Pooling layers and feature maps
- Popular CNN Model Architectures (LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet)

Unit 6: Recurrent Neural Networks (RNNs)

- Introduction to recurrent neural networks
- RNN architecture and structure
- Long Short-Term Memory (LSTM) networks
- Gated Recurrent Units (GRUs)

Block 3: Advanced Topics in Deep Learning

Unit 7: Advanced Architectures

- Attention Mechanisms in Deep Learning
  - Introduction to attention mechanisms
  - Mechanisms for capturing context and relevance within input data
  - Applications in natural language processing, image captioning, and machine translation
- Transformer Architecture and Self-Attention
  - Overview of the Transformer architecture
  - Self-attention mechanism for capturing long-range dependencies
  - Transformer variants such as BERT, GPT, and T5
  - Applications in natural language understanding, generation, and summarization
- Capsule Networks
  - Introduction to capsule networks (CapsNets)
  - Hierarchical representation learning using capsules
  - Dynamic routing for routing-by-agreement

- Applications in image recognition and understanding spatial relationships
- Deep Residual Networks (ResNets) and Skip Connections
  - Deep residual learning for addressing the vanishing gradient problem
  - Introduction to skip connections and identity mappings
  - Training deeper networks with improved convergence and performance
  - Applications in image classification, object detection, and semantic segmentation

Unit 8: Deep Reinforcement Learning

- Introduction to Reinforcement Learning (RL)
- Markov Decision Processes (MDPs)
- Q-Learning and Temporal Difference (TD) Learning
- Deep Q-Networks (DQN)
- Policy Gradient Methods
- Actor-Critic Methods
- Deep Deterministic Policy Gradient (DDPG)
- Advanced Topics in Deep RL

Unit 9: Deep Generative Models

- Introduction to Generative models
- Autoregressive and invertible models
- Latent variable models
- Variational inference and recognition networks (VAE, WAE),
- Adversarial Learning
- Generative Adversarial networks and variants (BiGAN, CycleGAN, StyleGAN, WGAN),
- Normalizing Flows
- Score/Diffusion based models

Block 4: Applications and Ethical Issues

Unit 10: Transfer Learning and Fine-Tuning

- Introduction to Transfer Learning
- Pre-Trained Models and Feature Extraction
- Fine-Tuning Deep Learning Models
- Strategies for Fine-Tuning
- Domain Adaptation in Transfer Learning
- Evaluation and Performance Metrics

Unit 11:   Applications of Deep Learning

- Computer Vision
- Natural Language Processing (NLP)
- Speech Recognition and Synthesis
- Healthcare
- Autonomous Vehicles
- Finance
- Gaming
- Recommendation Systems
- Manufacturing and Industry
- Social Media and Marketing
- Environmental Monitoring
- Education

Unit 12: Ethical and Societal Implications

- Bias and Fairness
- Understanding Bias in Machine Learning
- Sources of Bias in Deep Learning Models
- Fairness in Algorithmic Decision Making
- Mitigating Bias and Promoting Fairness in Deep Learning Models

Privacy Concerns and Data Ethics
- Data Privacy in Deep Learning Systems
- Ethical Collection and Use of Data
- Privacy-Preserving Techniques in Deep Learning
- Regulatory Compliance and Data Governance

Responsible AI Practices
- Ethical Design and Development of AI Systems
- Transparency and Explainability in Deep Learning Models
- Accountability and Liability in AI Systems
- Responsible Deployment and Use of AI Technologies

Societal Impacts of Deep Learning Technologies
- Socio-Economic Implications of Automation
- Job Displacement and Workforce Reskilling
- Socio-Cultural Changes due to AI Adoption
- Inequality and Accessibility in AI Technologies

Ethical Considerations in Specific Applications
- Healthcare: Patient Privacy and Medical Ethics

- Criminal Justice: Fairness and Bias in Predictive Policing
- Finance: Algorithmic Trading and Market Manipulation
- Social Media: Filter Bubbles and Polarization

Human-Centered Design and Human-AI Collaboration
- Designing AI Systems with Human Values in Mind
- Human-AI Interaction and Collaboration
- Empowering Users with Control and Transparency

Education and Awareness
- Ethical Education for AI Practitioners
- Public Awareness and Discourse on AI Ethics
- Ethical Guidelines and Frameworks for Deep Learning Research and Practice

Text Books/Suggested References:

1. Deep Learning, Ian Goodfellow, YoshuaBengio, Aaron Courville, MIT press, 2016.
2. Neural Networks and Deep Learning, Charu C. Aggarwal, Springer, 2018.
3. Learning deep architectures for AI-Foundations and trends in Machine Learning 2.1, Bengio, Yoshua, Now Publishers, 2009.
4. Deep Learning, Rajiv Chopra, Khanna Book Publishing, Delhi 2020.
5. Deep Learning with Python by Francois Chollet, Manning Publications,December 2017.
6. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.
7. Deep Learning: Methods and Applications, Deng & Yu, Now Publishers, 2013.
8. Satish Kumar, Neural Networks: A classroom Approach, TMGH, 2004.
9. Artificial Neural Networks, Yegnanarayana B, PHI Learning, 2006.

MCS – 073 Soft Computing
Credit – 4

Block 1: Introduction to Soft Computing and Fuzzy Logic
Unit 1: Introduction to Soft Computing

- Concept of computing systems.
- "Soft" computing versus "Hard" computing
- Characteristics of Soft computing
- Some applications of Soft computing techniques

Unit 2: Fuzzy Set theory

- Introduction to Fuzzy logic.
- Fuzzy Sets & Classical Sets;
- Operations on Fuzzy Sets, Fuzzy Relations, Linguistic Variables.

Unit 3: Membership Functions

- Introduction,
- Features & Fuzzification,
- Methods of Membership Value Assignment;
- Defuzzification.

Unit 4: Fuzzy Systems:

- Crisp Logic, Predicate Logic, Fuzzy Logic;
- Fuzzy Rule Base and Approximate Reasoning, Fuzzy Quantifiers;
- Fuzzy Inference Systems, Fuzzy Decision Making, Fuzzy Logic Control System; Fuzzy Expert Systems.
- Some applications of Fuzzy logic

Block 2: ANN
Unit 5: Artificial Neural Networks

- Fundamental Concepts, Basic Models and Architecture;
- Machine Learning Using Neural Networks;
- Activation functions
- Associative Memory Networks and their Applications.

Unit 6: Supervised and unsupervised learning Networks:

- Perceptron Networks,
- Radial Basis Function Networks:
- Back Propagation Neural Network: Architecture, Learning, Applications, & Research Directions;
- Competitive Learning networks;

- Kohonen Self-Organizing Networks;
- Hebbian learning; The Hopfield Network;

Block 3: Genetic Algorithm
Unit 7: Genetic Algorithms: concepts, framework and architectures

- Introduction to Genetic Algorithms (GA) and their Terminology;
- Traditional Optimization and Search Techniques vs Genetic Algorithm;
- Basic GA framework and different GA architectures.

Unit 8: GA operators and problem solving with GA

- Operators in Genetic Algorithms;
- Problem Solving using Genetic Algorithm;
- Classification of Genetic Algorithms; Holland's Classifier Systems;

Unit 9: Genetic Programming and applications of GA

- Genetic Programming;
- Advantages and Limitations of Genetic Algorithm;
- Applications of Genetic Algorithm;
- Applications of GA in Machine Learning.

Block 4:
Unit 10: Multi-objective Optimization Problem Solving

- Concept of multi-objective optimization problems (MOOPs) and issues of solving them.
- Multi-Objective Evolutionary Algorithm (MOEA).
- Non-Pareto approaches to solve MOOPs
- Pareto-based approaches to solve MOOPs
- Some applications with MOEAs.

Unit 11: Swarm Intelligence

- Particle Swarm Optimization
- Ant Colony Optimization
- Honeybee mating Optimization
- Firefly Algorithm
- Shuffled frog leaping algorithm

Unit 12: Applications of Soft Computing

- Applications of Fuzzy logic to solve some real-life problems
- Applications of ANNs to solve some real-life problems
- Applications of GA to solve some real-life problems

Text and Reference books:

1. Soft Computing, D. K. Pratihar, Narosa, 2008.
2. Fuzzy Logic: A Pratical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional, 2000.
3. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey, 2010.
4. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.
5. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India, 2007.
6. Neural Networks and Learning Machines, (3rd Edn.), Simon Haykin, PHI Learning, 2011.
7. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.
8. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education, 2002.
9. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Willey & Sons, 2002.

MCS – 074   Cloud Computing
Credit – 4

Objectives

After completing this course, the student will be able to:

- Understand the differences between traditional computing and cloud computing
- Compare and contrast various deployment models and service delivery models of a cloud computing architecture.
- Understand the ways of virtualization
- Interpret the resource pooling, sharing and provisioning
- Understand the concept of scaling and load balancing in cloud

- Elaborate the need of security in cloud computing
- Understand the concept of Service Level Agreement (SLA) in Cloud Computing
- Define IoT and related terminology, technology and its applications
- Interpret the impact and challenges posed by IoT networks, leading to new architectural models.
- Compare and contrast the deployment of smart objects and the technologies to connect them to networks.
- Appraise the role of IoT protocols for efficient network communication.
- Elaborate on the need for security in IoT.
- Understand Fog, Edge and Dew Computing Paradigms

BLOCK 1: CLOUD COMPUTING FUNDAMENTALS AND VIRTUALIZATION

Unit 1: Cloud Computing: An Introduction
1.0 Introduction
1.1 Objectives
1.2 Traditional Computing
1.3 History and Evolution of Cloud Computing
1.4 Cluster Vs Grid Vs Cloud Computing
1.5 Characteristics of Cloud Computing
1.6 Benefits of Cloud Computing
1.7 Cloud Computing Applications
1.8 Challenges of Cloud Computing
1.9 Summary
1.10   Solutions/Answers
1.11 Further Readings

Unit 2: Cloud Deployment Models, Service Models and Cloud Architecture
2.0 Introduction
2.2 Objectives
2.2.   Cloud Deployment Models
2.2.1   Public Cloud
2.2.2   Private Cloud
2.2.3   Community Cloud
2.2.4   Hybrid Cloud
2.3 Choosing Appropriate Deployment Model
2.3.1   Suitability of Public Cloud
2.3.2   Suitability of Private Cloud
2.3.3   Suitability of Community Cloud
2.3.4   Suitability of Hybrid Cloud
2.3.5   Comparative Analysis of Cloud Deployment Models
2.4 Service Delivery Models
2.4.1   Infrastructure As a Service (IaaS)

Unit 7 Cloud Data Management

Unit 8: Security Issues in Cloud Computing

BLOCK 3: SLAs and IoT

Unit 9: Service Level Agreements in Cloud Computing

Unit 10: Internet of Things

Unit 11: IoT Networking and Connectivity Technologies

References:

1. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, Wiley, 2011.
2. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, Tata McGraw Hill, 2013.
3. Essentials of cloud Computing: K. Chandrasekhran, CRC press, 2014.
4. Cloud Computing, Sandeep Bhowmik, Cambridge University Press, 2017.
5. Internet of Things, Jeeva Jose, Khanna Publishing, 2018.
6. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015.
7. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, Hanes David, Salgueiro Gonzalo, Grossetete Patrick, Barton Rob, Henry Jerome, Pearson, 2017.

Designing the Internet of Things, Adrian Mcwen, Hakin cassimally, Wiley, 2015.

MCSL – 075 Big Data Analytics Lab
Credit – 2

Main objective of this laboratory course is to provide hands-on exercises to the learners based on the Big Data Analytics Course.

There will be 20 practical sessions (3 hours each) on Big Data Analytics.

Lab Sessions:

• The practice problems for all 20 sessions will be listed session-wise in the lab manual.

MCSL – 076 Deep Learning Lab
Credit – 2

Main objective of this laboratory course is to provide hands-on exercises to the learners based on the Deep Learning Course.

Lab Sessions:

• The practice problems for all 20 sessions will be listed session-wise in the lab manual.

SEMESTER – IV

MCS – 077   Natural Language Processing
Credit – 4

Syllabus:
Natural language processing (NLP) is a branch of artificial intelligence (AI) used for computer enabled comprehension, generation, and manipulation of human language. The basic goal of NLP is to help computers understand language as human beings do. NLP is a very promising and growing area of study which helps in many area of applications including virtual assistants, speech recognition, sentiment analysis, automatic text summarization, and machine translation.

This course will cover basics of NLP, Collections (Basic Statistical tools for computational linguistics and their application to part-of-speech tagging), foundational understanding in NLP methods and strategies including Statistical Inference: n-gram Models over Sparse Data, Large Language Models, Morphological and Lexical Processing, different types of parsing, and some Applications and Techniques of NLP.

Course Structure:

Block -1: Basics of NLP
Unit-1 : Introduction to NLP
1.1 Brief History of NLP
1.2 Language and Linguistics
1.3 Indian Linguistic Diversity
1.4 Significance of Natural Language Processing
1.5 Major Tasks in NLP
1.6 Role of Knowledge in Natural Language Processing
1.7 Levels of Natural Language Processing
• Phonological Analysis
• Morphological Analysis
• Lexical Analysis
• Syntactic Analysis
• Semantic Analysis
• Pragmatic and Discourse Analysis
1.8 Evaluation of Natural Language Processing Systems
• Evolution of NLP Evaluating Systems
• Types and Metrics of Evaluation
• Statistical NLP
• Neural NLP
1.9 Some Early NLP Systems
• Eliza System /LUNAR System/SHRDLU System /Practical Front Ends
• General NLP System etc.
1.10 Programming Languages Used for Natural Language processing

Unit-2 : Linguistics Essentials- 1
2.1 An Introduction to Linguistics and Indian Languages
• The science of languages
• Language and Script
• Descriptive and Prescriptive
• Language Families in India
• Areal and Typological Diversity of Indian Languages
2.2 Parts of Speech and Morphology
• Noun pronouns
• Words that accompany nouns: determiners and adjectives
• Verb
• Other parts of speech
• Words and Word Forms
• Morphology fundamentals
• Morphology Paradigms

Unit-3 : Linguistics Essentials -2
3.1 Syntax

- Generative Syntax from Phrase Structure to Minimalism
- Dependency: Arguments and adjuncts

3.2 Semantics and Pragmatics
- Lexical Semantics and Lexical Relationships
- Speech Acts
- Conversational Maxims and Implicature
- Linguistic Politeness

Unit-4 : Corpus-Based Work

4.1 Getting Set Up
- Computers
- Corpora
- Software

4.2 Collecting and Building Corpus
- Different kinds of corpora
- Methods of collecting corpora

4.3 Looking at Text
- Low-level formatting issues
- Tokenization: What is a word?
- Stemming and Lemmatization

4.4 Marked-up Data
- Markup schemes
- Grammatical tagging

Unit-5 : Language Models

5.1 Introduction to N-Gram Language Models
5.2 Basic Smoothing
5.3 Advanced smoothing for Language Modeling,
5.4 Evaluation of Language Models

Unit-6 : Large Language Models

6.1 Neural Language Models
6.2 Use of Transformers in NLP
6.3 Large Language Models
6.4 Architecture of LLM
- Transformer Based Architecture

6.5 Prompting Techniques and Instruct Tuning
6.6 LLM Examples (GPT-3, LLaMA, BLOOM, Gemini, Mistral etc)
6.7. Applications of Language Models
   6.7.1 Spelling Correction: Edit Distance, Weighted Edit Distance, Other Variations , Noisy Channel , Classical Model for Spelling Correction, Language model based spelling and grammar correction
   6.7.2 Content Generation, Language Translation, sentiment analysis, text summarization, question-answering systems

Block -2: Statistical Inference and Grammer

Unit- 7 : Statistical Inference: n-gram Models over Sparse Data

7.1 Bins: Forming Equivalence Classes
- Reliability vs. discrimination
- N-gram models
- Building n-gram models

7.2 Statistical Estimators
- Maximum Likelihood Estimation (MLE)
- Laplace's law, Lidstone's law and the Jeffreys-Perks law
- Held out estimation
- Cross-validation (deleted estimation)
- Good-Turing estimation

7.3 Combining Estimators
- Simple linear interpolation
- Katz's backing-off
- General linear interpolation

Unit-8 : Sequence Labelling

8.1 Introduction to Sequence Labelling
8.2 POS Tagging and Named Entity Recognition
8.2 Markov Model Taggers
- The probabilistic model
- The Viterbi algorithm
- Variations

8.3 Hidden Markov Model taggers
- Applying HMMs to POS tagging
- The effect of initialization on HMM training

8.4 Transformation-Based Learning of Tags
- Transformations
- The learning algorithm
- Relation to other models
- Automata

8.5 Other Methods, Other Languages
- Other approaches to tagging
- Languages other than English
- Maximum Entropy Models;
- Random Fields

8.6 Tagging Accuracy and Uses of Taggers
- Tagging accuracy
- Applications of tagging

Unit-9: Morphological Processing

9.1 Morphological Analysers
9.2 Morphological Analysis
- Finite State Machine Based Morphology
- Automatic Morphology Learning
- Introduction to Shallow Parsing

9.3 Evaluation of Morphological Analysers
9.4 Morphological Paradigm Generation

Block -3: Basics of Parsing

Unit-10 : Probabilistic Context Free Grammars and Parsing
10.1 Some Features of PCFGs
10.2 Questions for PCFGs
10.3 The Probability of a String
- Using inside probabilities
- Using outside probabilities
- Finding the most likely parse for a sentence
- Training a PCFG
10.4 Probabilistic parsing : Introduction
- Sequence labeling,
10.5 Probabilistic parsing : Training issues
10.6 Arguments and Adjuncts
10.7 Problems with the Inside-Outside Algorithm

Unit-11 : Syntax-Constituency Parsing
11.1 Theories of Parsing,
- Syntax-Introduction
- Syntactic parsing
11.2 Parsing Algorithms.
- CYK (Cocke–Younger–Kasami) Algorithm,
- Evidence for deeper structure: Top-Down Parsing Algorithms
- Noun structure, Top-down parsing Algorithms
- Non-noun structure and parsing Algorithms
11.3 Robust and Scalable Parsing on Noisy Text as in Web documents.
11.4 Hybrid, Rule Based and Probabilistic Parsing
11.5 Scope Ambiguity and Attachment Ambiguity resolution.

Unit -12 : Dependency Parsing Basics
12.1 Dependency Grammar and parsing - Introduction
12.2 Transition Based Parsing : Formulation
12.3 Transition based Parsing: Learning
12.4 MST- based Dependency Parsing
12.5 MST- based Dependency Parsing : Learning

Block -4: Applications and Techniques
Unit 13: Information Retrieval and Question Answering
13.1 Intoduction to Information Retrieval
13.2 Question Answering Systems
- Datasets for QA systems
- Algorithms for QA Systems
13.3 Evaluation of IR and QA Systems
- Methods and Metrics of IR and QAS Evaluation

Unit -14 : Machine Translation
14.1 Rule-Based Machine Translation
14.2 Statistical Machine Translation
- Indian Language Statistical Machine Translation
- Phrase-Based Statistical Machine Translation
- Factor-Based Statistical Machine Translation
14.3 Cooperative NLP: Pivot-Based Machine Translation
14.4 Neural Machine Translation and Transformers
14.5 Evaluation of Machine Translation
- Methods and Metrics of MT Evaluation

Unit-15: Sentiment Analysis
15.1 Problem Statement
15.2 Ambiguity for Sentiment Analysis
15.3 Lexicons for Sentiment Analysis
15.4 Rule-Based Sentiment Analysis
15.6 Statistical Sentiment Analysis
15.7 Neural Approaches to Sentiment Analysis
15.8 Sentiment Analysis in Different Languages
References:
1. Foundations of Statistical Natural Language Processing, Chris Manning and and Hinrich Schütze, MIT Press
2. Natural Language Processing, Pushpak Bhattacharya and Aditya Joshi, Wiley Press

Speech and Language Processing (3rd ed), Dan Jurafsky and James Martin.
https://web.stanford.edu/~jurafsky/slp3/

MCS – 078   Data Security

Credit – 4

Block-1:   INTRODUCTION   TO   DATA SECURITY

Unit-1: Introduction

1.0 Introduction
1.1 Objectives
1.2 Cryptography
1.3 Data Security
1.4 Cryptographic Systems
1.5 Information Theory
1.6 Complexity Theory
1.7 Number Theory
1.8 Summary
1.9 Solutions/Answers
1.10 Further Readings

Unit-10: User Authentication

Unit-11: Transport Level Security

Unit-12: Wireless Network Security

Reference Books : 1. Cryptography and Data Security by Dorothy Elizabeth, Robling Denning; Addison Wesley Publishing Company (Publisher); ISBN-10: 0-201-10150-5

2.   Cryptography and Network Security by William Stallings; Pearson (Publisher); ISBN: 978-93-570-5971-8

MCSP – 079 Project Work   Credit – 12

The primary objective of the M.Sc. Data Science and Analytics project work is to enable learners to gain hands-on experience in applying software engineering practices within the context of data science and analytics. This includes developing robust software solutions for data processing, analysis, and visualization, preparing learners for roles where they may lead or contribute significantly to data-driven projects in various industries or research settings. It is only possible when a learner goes about with the task independently. The learner should begin by formulating a clear project proposal that outlines the problem statement, objectives, methodology, expected outcomes, and deliverables, ensuring alignment with data science and scientific principles. Conduct a thorough literature review to identify gaps and opportunities. Collect relevant data, preprocess it for analysis, and apply data science techniques like machine learning and statistical analysis, etc. Evaluate model performance, interpret results, and communicate findings through reports and presentations. Document the project process, reflect on lessons learned, and prepare for project defense by showcasing technical understanding and contributions.

Learners are encouraged to dedicate efforts equivalent to 12 credits towards a project, preferably in a software industry or research organization specializing in data science and analytics. The selected topics should be sufficiently complex and substantial to qualify as a M.Sc. Data Science and Analytics project. The coursework completed during the M.Sc. program equips learners with a comprehensive background to work across diverse data science and analytics domains. Strict adherence to project guidelines is expected, which will be provided and made available on the university's website.

4 EVALUATION SCHEME

Completion of the programme requires successful completion of both assignment component and the Term-end Examination component for each course in the programme. The total number of courses in this MSCDSA programme are 21 (including a Project course) of 80 credits in total.

Evaluation of each course of MSCDSA programme (except project course) covers two aspects:

a) Continuous evaluation through Assignment with a weightage of 30% which includes compulsory viva-voce (please refer to the Table in section 4.0).
b) Term-end examination with a weightage of 70% (please refer to the Table in section 4.0).

Note: *A learner should not apply for appearing in the term-end examination of any course without getting registered for the same and that if s/he does so, her/his result would not be declared and the onus shall be on her/him.*

Award of Final Division:

The final score of a student is computed as follows:
* The marks obtained in a 4-credit course are computed out of maximum of 100
* The marks obtained in a 2-credit course are computed out of maximum of 50
* The marks obtained in the Project course are computed out of maximum of 200
* The marks of all the semesters are added. These marks are out of maximum of 1900 marks.

The final division of a student is awarded as follows:

Marks Range	Division
75% and above	First Division with Distinction
60% or more but less than 75%	First Division
50% or more but less than 60%	Second Division
40% or more but less than 50%	Third Division

4.0 Assignments and Term – End Examination

The main purpose of assignments is to test student's comprehension of learning the materials they receive from the University and also to help them get through the courses by providing feedback to them. The information given in the course materials should be sufficient for answering the assignments. However, as Computer Science is an ever-enhancing area, the students should make an attempt and work with extra reading material, which is easily available at the Learner Support Centre / Regional Centre libraries or through websites, for working on the assignments. This will enhance your learning capabilities. Mostly the assignments are designed in such a way as to help you concentrate mainly on the course material, exploit their personal experiences and apply the knowledge gained from various sources.

Assignments

There will be **one comprehensive assignment for each course of 100 marks (weightage of 30%)**. The assignments for each semester are uploaded on the IGNOU's website.

All the assignments and term-end exams will be scored on a **numerical marking scheme.** Any component that has not been attempted would be treated as having a score of zero marks. The requirement for passing

would be at least **40% in continuous evaluation (assignment) and 40% in the term-end examination,** with an **overall average of 40% for a pass in the course.**

The viva voce is compulsory for the assignment evaluation. For any course, in case, if a student submitted the assignment but did not attend the viva-voce, then the assignment is treated as **not successfully completed** and would be marked as **ZERO.**

In order to be able to appear for the Term-end examination, it is a requirement that the student submit all the assignments according to the prescribed schedule. All students will be required to give an undertaking to this effect, and should it be later found that they had in fact not submitted the assignments as prescribed; the results for the Term-end examination will be treated as cancelled.

Viva-voce is compulsory for all the Assignments.

Unfair means in attempting the assignments

If the learners copy the assignments, which is an important component of the ODL system, such assignments will be awarded "zero" and such students will be directed to re-attempt the fresh assignments pertaining to the next year which will indirectly delay the award of degree by a semester/ year.

Additional guidelines for Lab Course assignments and TEE

A student MUST maintain lab records of all the practical sessions attended by him/her. This lab record has weightage in continuous evaluation of lab courses. The following are the evaluation guidelines for the lab courses.

(i)   Evaluation of the assignments of lab courses

Evaluation of the assignment of each lab course consists of the following:
- Practical sessions - lab records (40 marks)
- Assignment questions (40 marks)
- Viva-voce (20 marks)

The marks allotment for assignments of the lab courses are shown in the following table:

Course code	Lab records (40)	Assignment questions (40)	Viva-Voce (20)	Total marks (100)
MCSL-064	Part–1(40)	Part–1(40)	20	100
MCSL-065	Part–1(20) Part–2(20)	Part–1(20) Part–2(20)	20	100
MCSL-069	Part–1(20) Part–2(20)	Part–1(20) Part–2(20)	20	100
MCSL-070	Part–1(20) Part–2(20)	Part–1(20) Part–2(20)	20	100

MCSL-075	Part–1(40)	Part–1(40)	20	100
MCSL-076	Part–1(40)	Part–1(40)	20	100

Note: Minimum passing marks in each lab assignment (lab records + Assignment questions + viva-voce) is **40%.**

Evaluation Scheme

The table shown below provides the detailed marking scheme for the MSCDSA courses:

Seme-ster	Course Code	Course Title	Credits	Continuous Evaluation Assignment (Weightage – 30%)		Term End Examination Theory OR Practical* (for Lab courses only) (Weightage – 70%)		
				Max Marks	Min. Marks	Duration	Max. Marks	Min. Marks
I	MCS-061	Mathematical Foundations - I	4	100	40	3	100	40
	MCS-062	Introduction to Data Science	4	100	40	3	100	40
	MCS-063	Data Structures using Python	4	100	40	3	100	40
	MCS-207	Database Management Systems	4	100	40	3	100	40
	MCSL-064	Data Structures using Python Lab	2	100	40	2	50	20
	MCSL-065	Data Science Lab	2	100	40	2	50	20
II	MCS-066	Mathematical Foundations - II	4	100	40	3	100	40
	MCS-067	Data Wrangling and Visualization	4	100	40	3	100	40
	MCS-224	Artificial Intelligence and Machine Learning	4	100	40	3	100	40
	MCS-068	Predictive Data Analysis	4	100	40	3	100	40
	MCSL-069	Artificial Intelligence & Machine Learning Lab	2	100	40	2	50	20
	MCSL-070	Data Analysis Lab	2	100	40	2	50	20

III	MCS-071	Big Data Analytics	4	100	40	3	100	40
	MCS-072	Deep Learning	4	100	40	3	100	40
	MCS-073	Soft Computing	4	100	40	3	100	40
	MCS-074	Cloud Computing	4	100	40	3	100	40
	MCSL-075	Big Data Analytics Lab	2	100	40	2	50	20
	MCSL-076	Deep Learning Lab	2	100	40	2	50	20
IV	MCS-077	Natural Language Processing	4	100	40	3	100	40
	MCS-078	Data Security	4	100	40	3	100	40
	MCSP-079	Project Work**	12	Report – 150 (Min. 60) and Viva 50 (Min. 20)				

* **Practical examination will be conducted for the lab courses only. The letter 'L' in the course code represents the lab course. Pass in each and every part in the practical course of Term-End Practical Examination is compulsory in order to get it declared successful in the respective course.**

** **The Project consist of 2 components namely project report evaluation and viva-voce. Viva-voce is compulsory and forms part of evaluation. A student in order to be declared successful in the project must secure 40% marks in each component (i) Project Evaluation and (ii)Viva-voce.**

** **Students are required to submit the MCSP-079 Project Proposal (Synopsis) during the third semester through their respective Regional Centre (RC) or Learner Support Centre (LSC) to ensure timely approval. This will allow learners adequate time to work on the project and submit the Project Report in the fourth semester, thereby enabling them to complete the programme within the minimum prescribed duration.**

Note: If a learner decides to EXIT from the programme after successful completion of all the courses of first two semesters (40 credits), then the learner is eligible for the award of Post Graduate Diploma in Data Science and Analytics. However, to mention that there is no explicit admission for Post Graduate Diploma in Data Science and Analytics.

Evaluation of Term-End Practical Examinations for Lab Courses

The term-end examination of the practical courses consists of several sections. Each section will be evaluated separately. The viva-voce for each section will also be separate. The following table shows the details:

(Practical questions –80 % and Viva-voce – 20 %)

Course Code	Duration of term-end practical exam. (Each section gets Equal time)	Term-end practical examination and viva-voce	
		Marks Section-1	Marks Section-2
MCSL-064 (2 credits)	2 hours	40(P) + 10 (V) = 50 marks	#
MCSL-065 (2 credits)	2 hours	20(P) + 5(V) = 25 marks	20(P) + 5(V) = 25 marks
MCSL-069 (2 credits)	2 hours	20(P) + 5(V) = 25 marks	20(P) + 5(V) = 25 marks

Course Code	Duration	Section P	Section V
MCSL-070 (2 credits)	2 hours	20(P) + 5(V) = 25 marks	20(P) + 5(V) = 25 marks
MCSL-075 (2 credits)	2 hours	40(P) + 10 (V) = 50 marks	#
MCSL-076 (2 credits)	2 hours	40(P) + 10 (V) = 50 marks	#

P- Problems given in the exam paper, V – Viva-voce for that section, # - Not Applicable.

A student needs to obtain a minimum of 40% in each section of the term-end practical examination for successful completion of that particular section. In case a student does not secure the minimum passing marks in a section, s/he needs to appear for the term-end practical examination again for that section only.

4.1 Instructions for Assignments

While answering Assignments, the following guidelines are required to be followed:

The word limits for answering most of the questions are mentioned with them. If no word limit is prescribed, then assume it to be about 300 words. You will find it useful to keep the following points in mind:

i) **Planning:** Read the assignment carefully. Go through the units on which they are based. Make some points regarding each question and rearrange these in logical order.

ii) **Organisation:** Be a little more selective and analytical before drawing up a rough outline of your answer. In an essay-type question give adequate attention to your introduction and conclusion. The introduction must offer brief interpretation of the question and how you propose to develop it. The conclusion must summarize your response to the question. Make sure that your answer:

   a) is logical and coherent;

   b) has clear connection between sentences and paragraphs;

   c) is written correctly giving adequate consideration to your expression, style and presentation;

   d) do not exceed the number of words indicated (if any) in your questions.

iii) **Presentation:** Once you are satisfied with your answers, you can write down the final version for submission, writing each answer neatly and underlining the points you want to emphasize.

The following format is to be followed for submission of the assignment:

1. The top of the first page of your response sheet for each assignment should look like this:

PROGRAMME TITLE:............................   ENROLMENT No. :................................

COURSE CODE:..   NAME :..

COURSE TITLE:.......................................   ADDRESS:..

ASSIGNMENT CODE :............................   SIGNATURE :...

LSC NAME AND CODE:....................   DATE : ....

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2. Read instructions for submission of assignments given here. The assignments response sheets should be **HANDWRITTEN**. However, the software coding, snapshots, test cases, etc. can be in the printed form. Students should not reproduce their answers from the units sent to them by the University. If they reproduce from the units, they will get poor marks for the respective question**.**

3. The students should write each assignment separately. All the assignments should not be written in continuity.

4. **The students should write the question number with each answer. Photocopy of the submitted assignment is to be retained by the student for his or her own record and future reference, if any.**

5. The students should use only A4 size paper for their response and tag all the pages carefully. Avoid using very thin paper. They should allow a 4-cm. margin on the left and at least 4 lines in between each answer. This may facilitate the evaluator to write useful comments on the margins at appropriate places.

6. **The students should not copy the assignments from others. If copying is noticed, the assignments of such students will be rejected, and disciplinary action will be taken against the students as per rules of the University.**

7. **The completed assignment response should be sent to the Coordinator of the Learner Support Centre**. **Under no circumstances should they be sent to the SED Division or the School at Headquarters**, for evaluation. After submitting the assignment at the Learner Support Centre in person, the students should get the acknowledgement from the Coordinator on the prescribed assignment-cum-acknowledgement card; otherwise, the assignment response should be sent under certificate of posting through post. The students should get back evaluated assignments from their Learner Support Centres within one month of its submission for the feedback and for their future guidance.

8. In case the student has requested for a change of LSC, s/he should submit her/his assignments only to the original LSC until the University effects the change of LSC.

4.2 Guidelines Regarding the Submission of Assignments

1. It is compulsory for the students to submit all the prescribed assignments. They will not be allowed to appear for the term-end examination of a course if they do not submit the specified number of assignments in time for that course.

2. Students should download the latest assignment from the IGNOU website.

3. The assignment responses should be complete in all respects. Before submission, the students should ensure that they have answered all the questions in all assignments. Incomplete answer sheets bring poor grades.

4. The Coordinator of the LSC has the right to reject the assignments received after the due date. Therefore, the students are advised to submit their assignments before the due date.

5. Students should enclose a self-addressed stamped assignment remittance-cum- acknowledgement card **(Form No. 2)** with each assignment response to ensure the delivery of assignments before the last dates prescribed for submission of assignments.

6. In case any student fails to submit the assignments or fails to score minimum qualifying marks, s/he has to wait for fresh assignments meant for the current batch of students.

7. For their own record, students should retain a photocopy of all the assignment responses, which they submit to the Coordinator of their LSC. If they do not get back their duly evaluated assignment within a month after submission, they should try to get it from their LSC personally. This may help them to improve upon future assignments.

8. As per the University norms, once the student's scores pass marks in an assignment, they cannot re-submit it for improvement of marks.

9. Assignments are not subject to re-evaluation except for factual errors, if any. The discrepancy noticed by the students in the evaluated assignments should be brought to the notice of the Coordinator of the LSC, so that he forwards the correct score to the SED at the Headquarters.

10. The students should not enclose or express doubts for clarification, if any, along with the assignments. They should send their doubts in a separate cover to the Registrar, SED, Indira Gandhi National Open University, Maidan Garhi, New Delhi - 110 068. While doing so they should give their complete Enrolment number, name, address, programme code.

Note: **Please submit your Assignments on or before the due date at your LSC.**

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11. In case of not successfully completed or missed; the assignments should be demanded only if your registration for that course is valid.

12. Assignments should not be demanded to improve your score if you have secured minimum qualifying score in a course.

13. Please do not submit your assignment responses twice either at the same LSC or at different LSC for evaluation.

14. There is no provision for reevaluation of Assignments, practical examination and project evaluation.

4.3 General Guidelines Regarding the Term-End Examination

1. To be eligible to appear the Term-end Examination in any course, the students are required to fulfil the following conditions:

    a) registration for the courses, in which they wish to appear is valid,

    b) they should have opted and pursued the prescribed courses

    c) minimum time to pursue these courses is elapsed

    d) they have also submitted the required number of assignment(s), if any.

    e) they have submitted the online examination form of IGNOU and have paid the requisite examination fees.

2. The University conducts term-end examination twice a year, in June and December. The student can take the examination only after the minimum period prescribed for the course of study has elapsed.

3. Examination schedule indicating the date and time of examination which is available at IGNOU website http://www.ignou.ac.in for each session i.e. June/December.

4. The online examination form is to be filled up from IGNOU website about 2-3 months prior to examination. (You MUST visit IGNOU website for actual cutoff dates. The details of late fee are also displayed on the website.). You are required to pay examination fee per course at the time of filling up of the form. You can pay online using Credit Card / Debit Card /Net Banking while filling up the form. It may also be noted that in case, examination fee needs to be returned to student due

to technical reasons, the fee will be refunded to the same account (Credit card/ Debit card/ Net Banking) from which the payment was made.

The link to online Examination form, in general, is put on the HOME page of IGNOU website.

YOU MUST READ and FOLLOW all the instructions very carefully. You can save these instructions for any future reference. These instructions relates to:

- Dates for the Submission of Online Term End Examination form
- Prerequisite for the submission of the Term End Examination Form
- Process to submit Term End Examination Form
- Examination fee and Mode of Payment
- Un-successful Submission of Exam Form
- Related to Refund excess Examination Fee
- Hall Ticket for Term End Examination
- Contact Details

Important Guidelines and instructions for submission of Term End Examination form and other forms (Please note that guidelines and fee for forms may change, therefore, you are advised to read guidelines and fee details as per latest forms available online or on the IGNOU website)

1. Please ensure that you have already submitted the assignments as applicable for the courses you are filling in the Examination Form. You are required to pay examination fee for every course of theory as well as practical.

2. Students are requested to check the result status before filling examination form.

3. Select and enter Programme code and Examination Centre Code from the options available. If the centre opted by the student is not activated as examination centre or not allotted for any other reason, alternative examination centre will be allotted.

4. Select courses carefully. Courses for theory as well as practical need to be selected separately from the list appearing on the screen.

5. Students will be allowed to appear in Term-end Examination for the course(s) for which registration is valid and not time-barred and assignment(s) is/are submitted. Examination Fee once submitted will not be refunded.

6. Students should carry their **Identity Card and Hall ticket** (download hall ticket from IGNOU website indicating Centre and Date of Examination) to the Examination Centre.

7. In case a student fails to receive the intimation slip/Hall ticket may please contact at SED (SE-II) http://www.ignou.ac.in/ignou/aboutignou/division/sed/contact branch.

8. Students must carry IGNOU Identity-Card in the Examination Hall for writing Examination. In case, students do not have IGNOU Identity card due to various reasons, they must get it issued (i.e. duplicate copy of IGNOU Identity card) from Regional Centre concerned well before the start of the Examination. Students are required to contact the RC in person (by post) and get the duplicate Identity card for attending Examination.

9. The students will be entitled to appear for the examination only at the examination centre allotted to them and **NOT** at any other centre without specific permission from the University. The Examination Centre once opted for in a form shall not be changed.

10. Although all efforts will be made to declare the results in time, there will be no binding on the University to declare the results of the last examination before the commencement of next examination. The students may, therefore, fill up the examination form without necessarily waiting for the result and get it cancelled at a later date, if so desired. In case the student gets result after filling up the exam form, s/he should not re-appear in the course qualified by her/ him with a view to improve the qualified score.

11. Students who fail to complete the minimum required number of course(s) prescribed for the Programme within the allotted period of study shall cease to be on the rolls of this University for that programme till they re-enroll themselves, if they wish to do so. Such students are advised to get in touch with the Regional Director concerned.

12. **Obtaining Photocopy of Answer Scripts:** After the declaration of result, if the students are not satisfied with the marks awarded, they can request the University for Photocopy of Answer Scripts on payment of ₹ 100/- per course. The request for obtaining Photocopy of Answer Scripts by the student must be made within 30 days from the date of declaration of result to the Evaluation Centre concerned in the prescribed format along with the fee of ₹ 100/- per course in the form of Demand Draft in favour of IGNOU payable at the city where submitting the request for Photocopy. Format is available on the IGNOU website: http://www.ignou.ac.in

13. **Re-evaluation of Answer-script(s):** The University has replaced the scheme of rechecking with the re-evaluation whereby the answer-scripts will be re-evaluated by another Evaluator in case the students are not satisfied with the marks/grades secured by them in Term-end Examination. Such students can apply for re-evaluation within one month from the date declaration i.e. the date on which the results are made available on the University Website on payment of ₹ 750/- per course in the prescribed application form available on the University Website. The better of the two courses or original marks/grades and re-evaluated marks/grades will be considered and the revised marks/grades shall be incorporated in the students' record as applicable and the revised grade card/marks sheet will be sent to the students within one month from the receipt of application. Re-evaluation is not permissible for Projects, Practical, Assignments and Seminars etc.

5   OTHER USEFUL INFORMATION

5.0 Reservation of Seats

The University provides reservation of seats for Scheduled Castes, Scheduled Tribes and Physically Handicapped students as per the Government of India rules.

5.1 Scholarships and Reimbursement of Fee

Reserved Categories, viz., Scheduled Castes, Scheduled Tribes and Physically Handicapped students etc. have to pay the fee at the time of admission to the University along with other students. Physically Handicapped students admitted to IGNOU are eligible for Government of India scholarships. They are advised to collect scholarship forms from the respective State Government Directorate of Social Welfare or Office of the Social Welfare Officer and submit the filled-in forms to them **through the Regional Director of IGNOU concerned.**

Similarly, SC/ST students have to submit their scholarship forms to the respective State Directorate of Social Welfare or Office of the Social Welfare Officer, **through the Regional Director of IGNOU concerned for suitable reimbursement.**

5.2 Change/Correction of Address

There is a proforma for change/correction of address. This form duly filled in is to be submitted to the **Regional Director concerned**. Students are advised not to write letters to any other officer in the University in this regard. Normally, it takes 4-6 weeks to effect the change. Therefore, the students are advised to make their own arrangements to redirect the mail to the changed address during this period.

5.3 Change of Regional Centre and Learner Support Centre

Counselling facilities are not available for all the programmes at all the Learner Support Centres. As such, students are advised to make sure that counselling facilities are available, for the subject s/he has chosen, at the new centre opted for. Request for change of Learner Support Centre is acceded subject to availability of seats for the programme at the new centre asked for only on compelling grounds. Students are required to get a NOC from the Regional center where they are willing to get themselves transferred in view of the practical sessions involved in MSCDSA. When a student wants transfer from one region to another, s/he has to write to that effect to the Regional Centre from where s/he is seeking a transfer, marking copy to the Regional Centre where s/he would like to be transferred to and also to Registrar, Student Registration Division (SRD), IGNOU, Maidan Garhi, New Delhi-110068. Further, s/he has to obtain a certificate from the Coordinator of the Learner Support Centre from where s/he is seeking transfer from, regarding the number of assignments submitted. The Regional Director from where the student is seeking the transfer will transfer all records including details of fee payment to the Regional Centre where the student is going, under intimation to the Registrar, SRD and the student. The transfer will be permitted only if seats are available at the new Learner Support Centre.

5.4 Procurement of Official Transcripts

The University provides the facility of obtaining official transcripts on request, made by the learners in prescribed application form for official transcript, which provides details of fee, where to apply etc.

5.5 Duplicate Grade Card

The learner can apply for obtaining duplicate Grade Card in case the same has been lost/misplaced/damaged, by making a request in prescribed application form for Duplicate Grade card, which provides details of fees etc.

5.6 Self- instructional Materials of Your Programme of Study

Self-instructional material will be available through eGyankosh, IGNOU eContent App and later the self-instructional materials may be dispatched to the student's registered address.

You should visit your Regional Centre (RC)/ Learner Support Centre (LSC) concerned with ID card for schedule of theory and practical counselling sessions.

5.7 Disputes on Admission and other University Matters

In case of any dispute, the place of jurisdiction for filing of a suit/plaint/petition will be only at New Delhi / Delhi.

6 SOME USEFUL ADDRESSES

For specific queries related to Admission, Study Material, Assignment, Examination, Counselling etc. the students may contact the following:

Sl. No.	Issues	Authority to be contacted		
1	Identity Card, Fee Receipt, Bonafide Certificate, Migration, Certificate, Scholarship Forms, change of name, correction ofname/address	Concerned Regional Centre		
2	Non-receipt of study material	Registrar (MPDD), IGNOU, Maidan Garhi, New Delhi-110068 mpdd@ignou.ac.in, Ph: 011-29572008, 29572012		
3	Change of Elective/Medium/opting of left over electives/ Deletion of excess credits	Concerned Regional Centre		
4	Credit Transfer	Student Registration Division, Block No. 1 & 3, IGNOU, Maidan Garhi, New Delhi-110068 Email: registrarsrd@ignou.ac.in		
5	Purchase of Audio/Video CDs	Marketing Unit, EMPC, IGNOU, Maidan Garhi, New Delhi-110068 Email: empcmktunit@ignou.ac.in		
6	Academic Content	Director of the School concerned (www.ignou.ac.in)		
7	Approval of a Project Synopsis	Project Co-ordinator in the Concerned School of Studies/ Regional Centres		
8.	International Students residing in India should contact	Director, International Division, IGNOU, Block-15, Section K, Maidan Garhi, New Delhi. Tel. Nos. : 29533987; 29571681 E-mail : internationaldivision@ignou.ac.in		
9	Issue of Degree/ Diploma Certificate/ Despatch of returned Degrees/ Verification of Degrees/Convocation	011-29572213 011-29535438	Asstt. Registrar 011-29572224	convocation@ignou.ac.in
10	Issue of Hall Ticket/ Correction in the hall ticket for handicapped student s/ Non-receipt of hall tickets for term-end- examination & Entrance Test/Entrance, Test Results/Queries related to dispatch of attendance, list of examinees etc./ writer	011-29572209 011-29572202	Asstt. Registrar 011-29535064	bhavna@ignou.ac.in ssbhandari@ignou.ac.in examiii@ignouac.in
11	Declaration of results of Masters & Bachelors degree level programme/Issueof grade card and provisional certificate of Masters and Bachelors degree level prog./ Practical marks of all programmes	011-29572212	Section Officer 011-29536103	mdresult@ignou.ac.inbdresult@ignou.ac.in practicalsed@ignou.ac.in
12	Declaration of results of Masters, Bachelor and Diploma programme/Issue of gradecard and provisional certificate of Masters, Bachelor and Diploma level programme	011-29572211	Section Officer 011-29536743	bdresult@ignou.ac.indpresult@ignou.ac.in

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13	Declaration of results of DPE and Certificate programme/ Issue of grade card and provisional certificate of DPE & Certificate level programme	011-29572208	Section Officer 011-29536405	cpresult@ignou.ac.in
14	Verification of genuineness ofprovisional certificate and grade card/ Issue of Transcript	011-29572210	Section Officer 011-29536405	gcverification@ignou.ac.in
15	Queries related to UFM cases	011-29572208 011-29576405	Section Officer	ufmgroup@ignou.ac.in
16	Status of Project Report of all Programmes/ Dissertation and Viva marks	011-29571324 011-29571321	Asstt.Registrar 011-29532294	projects@ignou.ac.in
17	Queries related to Assignment Marks	011-29571325 011-29571319	Asstt.Registrar 011-29571313	assignment@ignou.ac.in
18	Students general enquiries and grievances/ Issue of duplicate mark sheet	011-29572218 011-29571313	Asstt. Registrar	sedgrievance@ignou.ac.in
29	Discrepancy in grade card, non updation of grade/marks in the grade card etc.	011-29572208 011-29572211 011-29572212	Dy. Director/ Asstt.Director	mdresult@ignou.ac.in bdresult@ignou.ac.in bdpresult@ignou.ac.in dpresult@ignou.ac.in cpresult@ignou.ac.in

Telephone numbers of the Divisions/ Schools are also provided on the website under the "Contact Us" option. Students are advised to be in touch with their LSCs for advance/timely/day-to-day information or visit the website with URL www.ignou.ac.in

7   QUESTION PAPER PATTERN

The old question papers of MSCDSA are not available.

Pattern of the theory question papers is as follow:

- Each question paper consists of 5 questions. Time: 3 Hours, Maximum Marks : 100
- Question No. 1 is compulsory which carries 40 marks.
- Question no. 2 to 5 are 20 marks each. Answer any three questions from these.

Pattern of the Practical question papers is as follow:

- Each question paper consists of 1 or 2 compulsory sections.
  Time: 2 Hours, Maximum Marks: 50.

Details of evaluation scheme for lab courses are given in section 4.0.

8   BROWSING IGNOU'S WEBSITE AND SOME USEFUL LINKS

The IGNOU's website is a dynamic source of latest information and is subject to continuous updates. Thus, various pages shown here may change in future. IGNOU itself is continuously changing to bring about improvement in quality of its services. You must visit IGNOU website for all the latest information, filling up or downloading various form, downloading of assignments, results etc.

Navigation from Home Page

The learners can have access to IGNOU's website at the following address (URL) ***http:// www.ignou.ac.in***. As students get connected to this site, the following page displays the Home Page of IGNOU's web site (Figure 1). Students need to click on various options to get the related information.
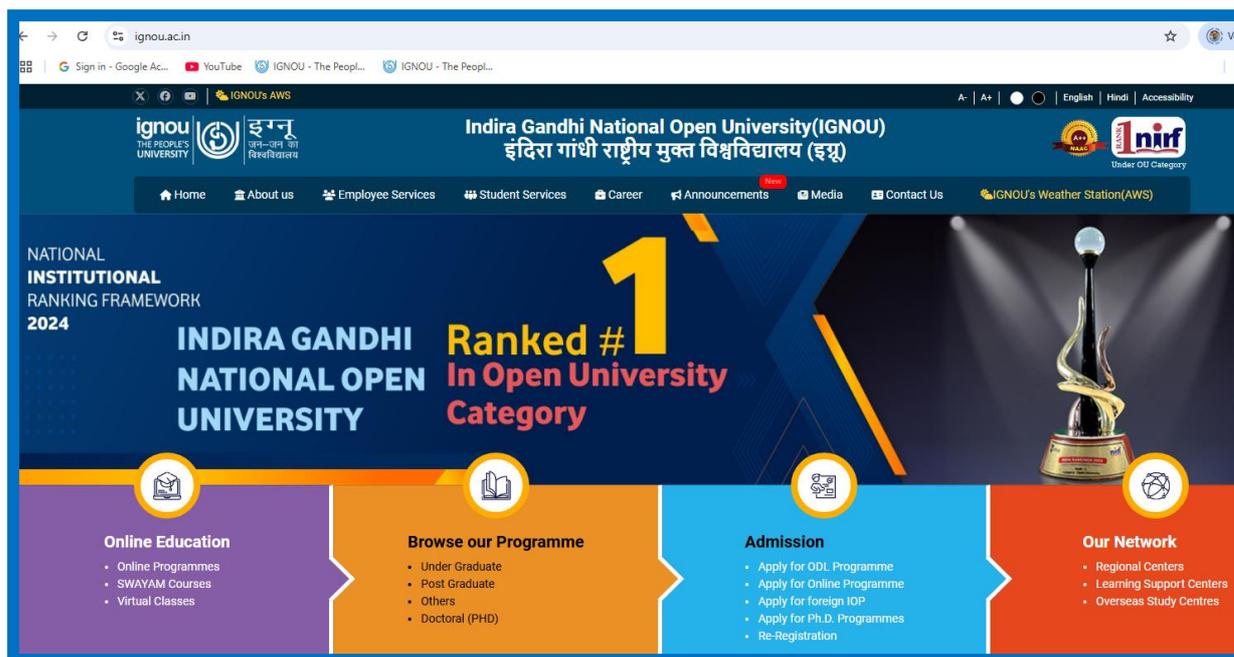

Figure 1: IGNOU Website

From this **Home page** Select **About IGNOU,** which will display an Option List select **School of Studies.** It will show you a page of all the schools of studies of IGNOU, Select **School of Computer and Information Sciences (SOCIS)** to display page of SOCIS (Figure 2). School of Computer and Information Sciences (SOCIS) offers PhD in Computer Science, MCA, MSCDSA, BCA, PGDCA, CMAD and CIT programmes, you can click on **Our Programmes** link on SOCIS page to get the list of programmes on offer as shown in Figure 2.
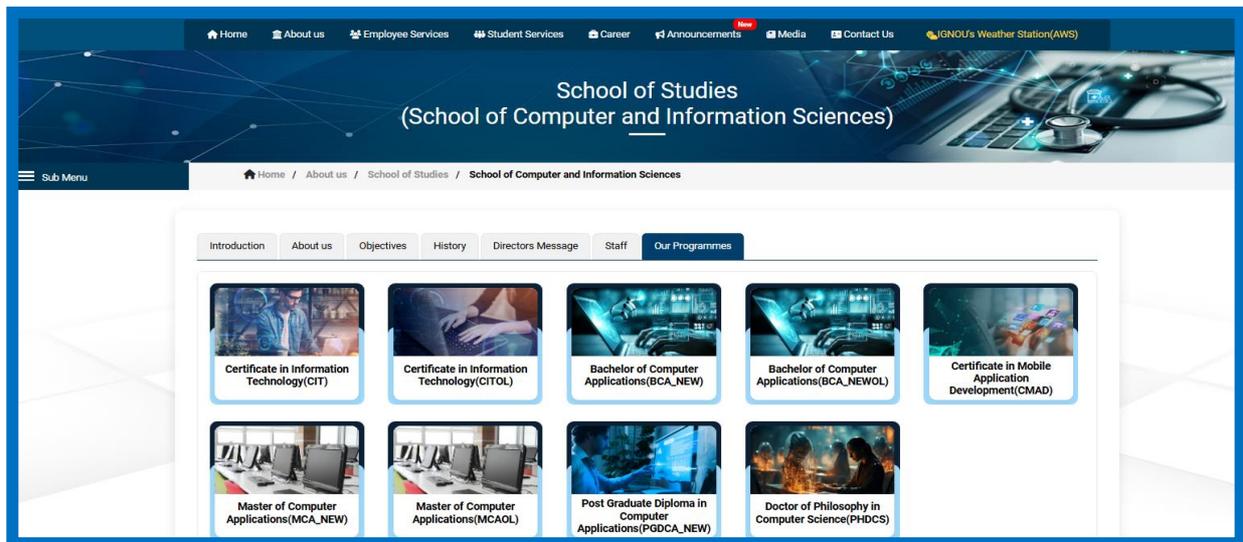
Figure 2: SOCIS Programmes

One of the most important links for students is Student Services which can be reached from Home page by selecting Student Services option. (Link address: *https://www.ignou.ac.in/pages/4*). Figure 3 displays the options of the Student Services page.
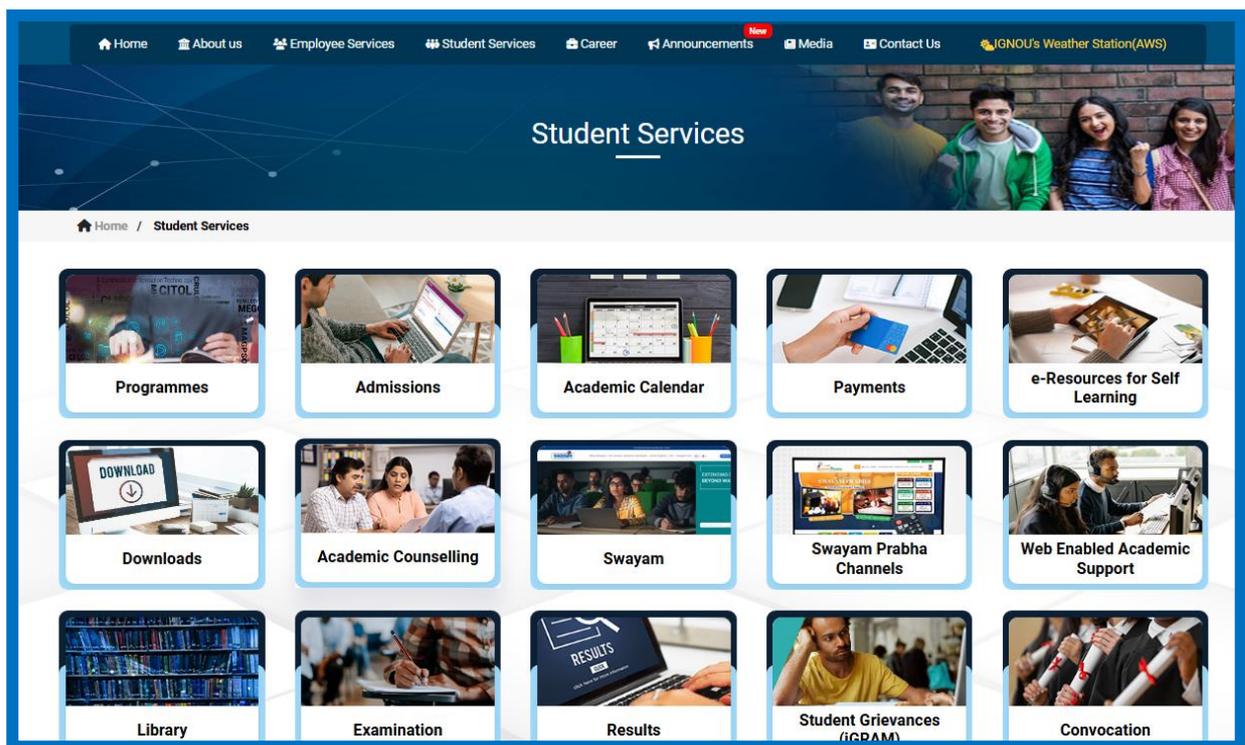

Figure 3: Student Services page

KNOW YOUR STATUS

Under the **Student Services page** one can opt for **Know Your Status** option. Figure 4 will display the result of *Know Your Status* Page where clicking on Check Your Registration Status, you will need to submit the details related to your programme.
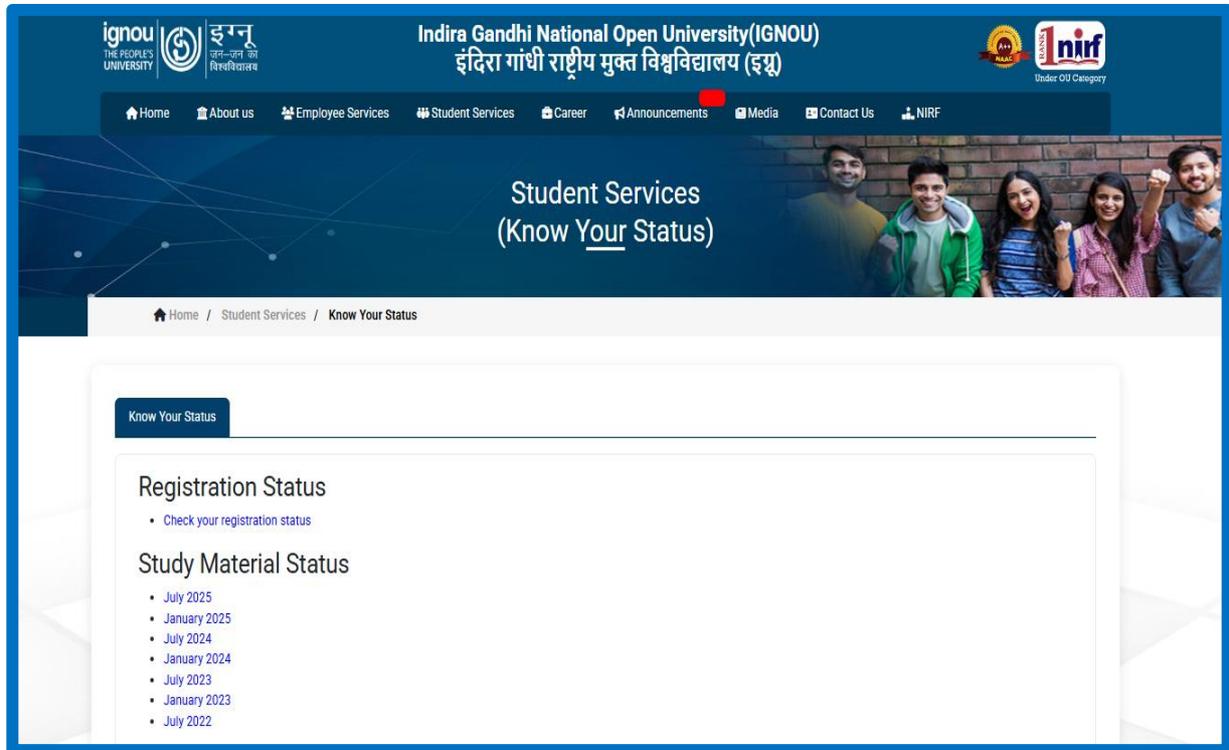

Figure 4: Know Your Status Page will display the above links

Submitting the required details, **Downloads heading** will be displayed on the left side of the page **shown in the Figure-5.**

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Figure-5: Downloads options displayed

On clicking the first link (Formats (Re Registration, Address Change, TEE, Revaluation, Re-admission), you may get the information regarding the Re-Registration, Address Change, TEE, Revaluation, Re-admission etc.

SOME OTHER USEFUL LINKS:

To facilitate easy access to important academic and administrative resources, learners of the M.Sc. (Data Science and Analytics) (MSCDSA) programme are advised to make use of the following online links provided by the University. These links enable students to download assignments, apply for examinations, and access various support services conveniently.

Link to Latest Assignments

Learners may download the latest assignments for all courses of the programme from the official IGNOU website or directly from the eGyanKosh repository.

🔗 URL: https://www.ignou.ac.in/studentService/download/assignments

Assignments are an integral component of the evaluation system. Students must ensure timely submission of the same at their respective Learner Support Centres (LSCs) as per the schedule notified by the University.

Link for Online Re-registration

Re-registration for the subsequent semester(s) or year(s) of the programme should be completed online through the following link:

🔗 URL: https://onlinerr.ignou.ac.in/

Students are advised to review their course details carefully before submission and to retain a printed acknowledgment for future reference.

Link for Online Term-End Examination Form

Learners are required to submit their Term-End Examination (TEE) forms through the online portal within the prescribed deadlines.

🔗 URL: https://exam.ignou.ac.in/

Please verify the course codes and examination centre details before submission. Admit cards/hall tickets are made available online prior to the commencement of examinations.

Link for Re-evaluation of Answer Scripts

Students who wish to apply for re-evaluation of their answer scripts may submit their request online using the following link:

🔗 URL: https://onlineservices.ignou.ac.in/reevaluation/

It is important to refer to the relevant notification for the prescribed time frame and fee structure before submission.

Note:

All learners are strongly encouraged to visit the official IGNOU website (https://www.ignou.ac.in) and the eGyanKosh portal (https://www.egyankosh.ac.in) regularly for updates, announcements, and academic resources related to the MSCDSA programme.

Note