Central University of Himachal Pradesh

Department of Computer Science and Informatics

School of Mathematics, Computers and Information Science

AGENDA

8th BOARD OF STUDIES MEETING
TO BE HELD ON **12th MAY, 2023**

Venue:-Seminar Hall, Central University of Himachal Pradesh,
Shahpur Parisar, Shahpur

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Established under Central Universities Act 2009)
शाहपुर परिसर, शाहपुर, ज़िला काँगड़ा (हि.प्र.) - 176206
Shahpur Parisar, Shahpur, Distt. Kangra (HP) - 176206
Website: www.cuhimachal.ac.in

AGENDA-INDEX

Agenda Item No.	Particulars	Information
CSI-BOS-8/23-1	Confirmation and Approval of the Minutes of the 7th Board of Studies meeting held on 28th September 2021.	Annexure –I
CSI-BOS-8/23-2	Confirmation and Approval of the Minutes of the 1st Research Degree Committee (RDC) meeting held on 7th November 2022.	Annexure – II
CSI-BOS-8/23-3	To approve the Course Contents of course code CSI-ITKP and course name Indian Traditional Knowledge and Practices for the Ph.D. coursework w.e.f. 2021-2022 onwards	Annexure – III
CSI-BOS-8/23-4	To ratify and approve the credits and the course contents of the Minor courses i.e., Software Engineering (MCA 521) and Software Testing (MCA 522) from 04 credits to 02 creditsw.e.f. academic session 2021-22 onwards to meet the minimum requirement of NEP 2020.	Annexure-IV
CSI-BOS-8/23-5	To add and approve two new Minor Courses and theirContentsi.e., MCA 538 (Fundamentals of ICT), and MCA 539 (Problem Solving using C) each of 2 credits w.e.f. academic session 2021-22 onwards to meet the minimum requirement of NEP 2020.	Annexure–V
CSI-BOS-8/23-6	To ratify and approve the course codeof the following courses: 1. NoSQL Databases (MCA 537) to NoSQL Databases (MCA 540) 2. Fundamentals of Computer (CS 401) to Fundamentals of Computer (MCA 401) 3. Programming in C (CS 402) to Programming in C (MCA 402)	Annexure–VI
CSI-BOS-8/23-7	To discuss and approve the modalities for the Course "Review of Literature (MCA 604)" as per NEP 2020 CUHP Guidelines	
CSI-BOS-8/23-8	To discuss and approve the modalities for the Course "Research Proposal (MCA 605)" as per NEP 2020 CUHP Guidelines	
CSI-BOS-8/23-9	To discuss and approve the modalities for the Course "Research Paper Publication (MCA 603)" as per NEP 2020 CUHP Guidelines	
CSI-BOS-8/23-10	To ratify and approve the course name and its credits of the course "Dissertation(MCA 606)" - 4 credits to "Dissertation/Project (MCA 606)" - 8 credits.	
CSI-BOS-8/23-11	To approve the shifting of the course Computer Network (MCA 519) from the list ofminor courses to elective specialization.	
CSI-BOS-8/23-12	To discuss and approve the modalities for the evaluation of the Course "Dissertation/Project (MCA 606)".	
CSI-BOS-8/23-13	To approve the course content of the course "Academic writing (MCA 602) - 2 credits".	Annexure–VII

CSI-BOS-8/23-14	To change and approve the course content of courses w.e.f academic session 2022-23 onwards. 1. Design & Analysis of algorithms (MCA 507) 2. Java Programming (MCA 536) 3. Database Management System (MCA 505)	**Annexure–VIII**
CSI-BOS-8/23-15	To discuss and approve the Value-Added Course "Certificate in Artificial Intelligence with Quantitative Aptitude" in collaboration with the Srinivasa Ramanujan Department of Mathematics w.e.f. The Academic Year 2022-23 onwards.	
CSI-BOS-8/23-16	To approve the modalities (Course Name, Course duration, eligibility, admission criteria, etc.) of the Value-Added Course "Certificate in Artificial Intelligence with Quantitative Aptitude".	**Annexure–IX**
CSI-BOS-8/23-17	To approve the List of Courses & Course Contents for the Value-Added Course "Certificate in Artificial Intelligence with Quantitative Aptitude".	**Annexure–X**
CSI-BOS-8/23-18	Any other issue on permission of the chair	

Dr. Pradeep Chouksey
Head,
Department of Computer Science and Informatics

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Shahpur Parisar, Shahpur, Distt. Kangra (HP) - 176206
Website: www.cuhimachal.ac.in

File No.: CSI/1-5/BoS/CUHP/21/ 99

Dated: 12-05-2023

MINUTES OF THE MEETING

The **meeting** of the **08th Board of Studies** of the **Department of Computer Science and Informatics**, School of Mathematics, Computers and Information Science, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur was **held on 12th May, 2023** at **11:00 AM** onwards in the **Seminar Hall** of the Central University of Himachal Pradesh, Shahpur Parisar, Shahpur. **Dr. Pradeep Chouksey**, Head, Department of Computer Science and Informatics **chaired** the meeting.

Following members attended the meeting:

1. **Dr. Pradeep Chouksey – Head and Convener**
   Associate Professor & Head, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

2. **Dr. T.P. Sharma– Subject Expert**
   Associate Professor, Department of Computer Engineering, National Institute of Technology, Hamirpur.

3. **Dr. Sakshi Kaushal – Subject Expert**
   University Institute of Engineering and Technology, Punjab University

4. **Prof. O.S.K.S. Sastri – Vice Chancellor's Nominee**
   Professor, Department of Physics and Astronomical Science, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

5. **Dr. Rajender Kumar – Vice Chancellor's Nominee**
   Associate Professor, Department of Chemical and Chemical Sciences, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

6. **Dr. Kranti Kumar – Dean's Nominee**
   Associate Professor, Srinivasa Ramanujan Department of Mathematics, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

7. **Mr. Ajay Kumar - Member**
   Assistant Professor, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

8. **Mr. Manoj Dhiman– Special Invitee**
   Assistant Professor, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Temporary Academic Block, Shahpur.

The **Chairman** welcomed all the **Hon'ble members** and **briefed** about the **past activities** and also about the various **agenda items** to be **discussed** in the **meeting** which were **sent** in **advance** to all the members through **e-mail** including **External Subject Experts**. The **Agenda Items** were **placed** before the **committee** and after detailed **discussions** and **deliberations** on each, the following **decisions** were taken:-

AGENDA ITEM NO. - CSI-BOS-8/23-1

Confirmation and Approval of the Minutes of the 7th Board of Studies meeting held on 28th September 2021.

Decision:

The Minutes of the 7th Board of Studies meeting were Confirmed and Approved as attached at Annexure-I.

AGENDA ITEM NO. - CSI-BOS-8/23-2

Confirmation and Approval of the Minutes of the 1st Research Degree Committee (RDC) meeting held on 7th November 2022.

Decision:

The Minutes of the 1st Research Development Committee (RDC) meeting were confirmed and approved as attached at Annexure-II.

AGENDA ITEM NO. - CSI-BOS-8/23-3

To approve the Course Contents of course code CSI-ITKP and course name Indian Traditional Knowledge and Practices for the Ph.D. coursework w.e.f. 2021-2022 onwards

Decision:

All members agreed and approved the Course Contents of the Course Name: Indian Traditional Knowledge System, Course Code: CSI-ITKP Credits: 02 for the course work of Ph.D. CSI w.e.f. Academic Session 2021-22 onwards as attached in Annexure –III.

AGENDA ITEM NO. - CSI-BOS-8/23-4

To ratify and approve the credits and the course contents of the Minor courses i.e., Software Engineering (MCA 521) and Software Testing (MCA 522) from 04 credits to 02 creditsw.e.f. academic session 2021-22 onwards to meet the minimum requirement of NEP 2020.

Decision:
The course contents of the Minor courses i.e., Software Engineering (MCA 521) and Software Testing (MCA 522) from 04 credits to 02 credits w.e.f. the Academic Session 2021-22 onwards were ratified and approved by all respective members as per Annexure-IV.

AGENDA ITEM NO. - CSI-BOS-8/23-5

To add and approve two new Minor Courses and their Contents i.e., MCA 538 (Fundamentals of ICT), and MCA 539 (Problem Solving using C) each of 2 credits w.e.f. academic session 2021-22 onwards to meet the minimum requirement of NEP 2020.

Decision:

All members agreed and approved to add 02 Minor Courses and their Contents i.e., MCA 538 (Fundamentals of ICT), and MCA 539 (Problem Solving using C) each of 2 credits w.e.f. academic session 2021-22 onwards to meet the minimum requirements of NEP 2020 as attached in Annexure -V.

AGENDA ITEM NO. - CSI-BOS-8/23-6

To ratify and approve the course code of the following courses:
1. NoSQL Databases (MCA 537) to NoSQL Databases (MCA 540)
2. Fundamentals of Computer (CS 401) to Fundamentals of Computer (MCA 401)
3. Programming in C (CS 402) to Programming in C (MCA 402)

Decision:

All the members of BoS agreed and approved the ratification in the course codes of NoSQL Databases (MCA 537) to NoSQL Databases (MCA 540), Fundamentals of Computer (CS 401) to Fundamentals of Computer (MCA 401), and Programming in C (CS 402) to Programming in C (MCA 402) as attached in Annexure -VI.

AGENDA ITEM NO. - CSI-BOS-8/23-7

To discuss and approve the modalities for the Course "Review of Literature (MCA 604)" as per NEP 2020 CUHP Guidelines

Decision:

After the deliberations of all respective members, the following evaluation criterion for the Course: Review of Literature, Course Code: MCA 604, Course Credit: 04, was approved, in the light of NEP-2020:-

Course Code: MCA-604 Course Name: Review of Literature		
S. No.	**Evaluation**	**Weightage**
1.	Internal Evaluation	40%
2.	External Evaluation	60%

AGENDA ITEM NO.- CSI-BOS-8/23-8

To discuss and approve the modalities for the Course "Research Proposal (MCA 605)" as per NEP 2020 CUHP Guidelines

Decision:

After the deliberations of all respective members, the following evaluation criterion for the Course: Research Proposal, Course Code: MCA 605, Course Credit: 04, was approved, in the light of NEP-2020:-

Course Code: MCA-605 Course Name: Research Proposal		
S. No.	**Evaluation**	**Weightage**
1.	Internal Evaluation	40%
2.	External Evaluation	60%

AGENDA ITEM NO.- CSI-BOS-8/23-9

To discuss and approve the modalities for the Course "Research Paper Publication (MCA 603)" as per NEP 2020 CUHP Guidelines

Decision:

After the deliberations of all respective members, the following evaluation criterion for the Course: Research Paper Publication, Course Code: MCA 603, Course Credit: 02, was approved, in the light of NEP-2020:-

Course Code: MCA-603 Course Name: Research Paper Publication		
S. No.	Publication Type	Weightage
1.	National level conference	60%-70%
2.	international level conference	70%-80%
3.	Peer-reviewed Journal/conference proceedings*	80%-90%
4.	Scopus/SCI Journal*	90%-100%
*Marks will be awarded even on the acceptance of the research paper.		

Suppose any student submits a paper to the journal for publication which is not accepted till the end of the semester; in that case, the student must produce the proof of communicated paper to the Department Research Paper Publication Committee (DRPPC) for the evaluation of the research paper to declare the student's result within the stipulated time.

The constitution of the DRPPC Committee will be the following:

1. Head of the Department.
2. Research Guide of the Student.
3. All remaining faculty members of the Department

AGENDA ITEM NO. - CSI-BOS-8/23-10

To ratify and approve the course name and its credits of the course "Dissertation(MCA 606)" - 4 credits to "Dissertation/Project (MCA 606)" - 8 credits.

Decision:

All the members of BoS agreed and approved the ratification in the Course: Dissertation, Course Code: MCA 606, Credits 04 to the Course Name: Dissertation/Project, Course Code: MCA 606, Credits 08, in the light of NEP-2020.

AGENDA ITEM NO. - CSI-BOS-8/23-11

To approve the shifting of the course Computer Network (MCA 519) from the list of Minor Courses to Elective Specialization.

Decision:

All the members of BoS suggested and agreed to shift the Course Name: Computer Network, Course Code: MCA 519 from the list of Minor Courses to Vocational/Skill Courses in place of Elective Specialization, in light of NEP-2020.

AGENDA ITEM NO. - CSI-BOS-8/23-12

To discuss and approve the modalities for the evaluation of the Course "Dissertation/Project (MCA 606)".

Decision:

After the deliberations of all respective members, the following evaluation criterion for the Course: Dissertation/Project, Course Code: MCA 606, Course Credit: 08, was approved, in the light of NEP-2020:-

Course Code: MCA-606 Course Name: Dissertation/Project		
S. No.	Evaluation	Weightage
1.	Internal Evaluation	40%
2.	External Evaluation	60%

AGENDA ITEM NO. - CSI-BOS-8/23-13

To approve the course content of the course "Academic writing (MCA 602) - 2 credits".

Decision:

All members agreed and approved the Course Content of Course Name: Academic Writing, Course Code: MCA 602, Credits: 02 as attached in Annexure -VII.

AGENDA ITEM NO. - CSI-BOS-8/23-14

To change and approve the course content of courses w.e.f academic session 2022-23 onwards.
1. Design & Analysis of algorithms (MCA 507)
2. Java Programming (MCA 536)
3. Database Management System (MCA 505)
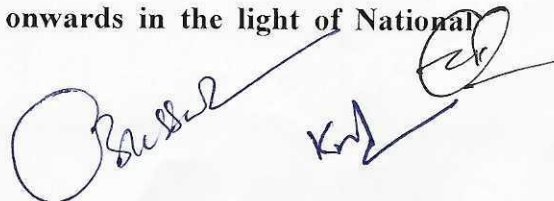
Decision:
All members of BoS agreed and approved the Course Content of Design & Analysis of algorithms (MCA 507), Java Programming (MCA 536) w.e.f. Academic Session 2022-23 onwards, and Database Management System (MCA 505) w.e.f. Academic Session 2023-24 onwards as attached in Annexure -VIII.

AGENDA ITEM NO. - CSI-BOS-8/23-15

To discuss and approve the Value-Added Course "Certificate in Artificial Intelligence with Quantitative Aptitude" in collaboration with the Srinivasa Ramanujan Department of Mathematics w.e.f. The Academic Year 2022-23 onwards.

Decision:

The BoS members unanimously approved the Value Added Course "Certificate in Artificial Intelligence with Quantitative Aptitude" in collaboration with the Srinivasa Ramanujan Department of Mathematics w.e.f. the academic year 2022-23 onwards in the light of National Education Policy-2020.

AGENDA ITEM NO. - CSI-BOS-8/23-16

To approve the modalities (Course Name, Course duration, eligibility, admission criteria, etc.) of the Value-Added Course "Certificate in Artificial Intelligence with Quantitative Aptitude".

Decision:

After the deliberations, the BoS members unanimously approved the modalities (Course Name, Course duration, eligibility, admission criteria etc.) of the Value Added Course "Certificate in Artificial Intelligence with Quantitative Aptitude" as attached at Annexure-IX.

AGENDA ITEM NO. - CSI-BOS-8/23-17

To approve the List of Courses & Course Contents for the Value-Added Course "Certificate in Artificial Intelligence with Quantitative Aptitude".

Decision:

After the deliberations, the course contents of Course Name: Artificial Intelligence, Course Code: CSI 451, Credits: 04, Course Name: Data Mining, Course Code: CSI 453, Credits: 04, and Course Name: Python Programming, Course Code: CSI 452, Credits: 02were unanimously approved by the BoS members as attached at Annexure-X.

AGENDA ITEM NO. - CSI-BOS-8/23-18

Any item with the permission of the Chair: **No item was taken**

The meeting ended with a vote of thanks to the chair.
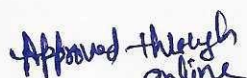
Mr. Manoj Dhiman
(Special Invitee)

Mr. Ajay Kumar
(Member)

Dr. Kranti Kumar
(Dean's Nominee)

Dr. Rajender Kumar 12-5-2023
(VC's Nominee)

Prof. O.S.K.S. Sastri
(VC's Nominee)

Dr. Sakshi Kaushal
(Subject Expert)

Dr. T.P. Sharma
(Subject Expert)

Dr. Pradeep Chouksey
Chairman & Convener

Respected Sir/Madam,

Please find attached herewith the **Updated** Minutes of the 8th Board of Studies meeting of the Department of Computer Science and Informatics, CUHP, held on 12.05.2023.

You are requested to check the Minutes and give your approval if no changes are required, as soon as possible

📄 **Annexure -IX Modalities of the Value Added Cour...**

📄 **Annexure-1 Minutes of the 7th BOS meeting of CS...**

📄 **Annexure-II Minutes of the 1st RDC meeting held...**

📄 **Annexure–III.pdf**

📄 **Annexure–IV.pdf**

📄 **Annexure–V.pdf**

📄 **Annexure–VI.pdf**

📄 **Annexure–VII.pdf**

📄 **Annexure–VIII.pdf**

📄 **Annexure–X.pdf**

📄 **Annexure–XI.pdf**

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धन्यवाद/Thanking you

सादर/regards,

गौरव चम्बयाल/GOURAV CHAMBYAL
डाटा एंट्री ऑपरेटर/Data Entry Operator
गणित, कंप्यूटर एवं सूचना विज्ञान स्कूल/School of Mathematics, Computers and Information Science
हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय/Central University of Himachal Pradesh
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ई-मेल/ E-mail: **gourav.cuhimachal@hpcu.ac.in**

9 Attachments • Scanned by Gmail

Minutes of the 8t...	Annexure–III.pdf	Annexure–IV.pdf	Annexure–V.pdf
Annexure–VI.pdf	Annexure–VII.pdf	Annexure–VIII.pdf	Annexure–X.pdf
Annexure–XI.pdf			

Dear Mr. Gourav,

Attached MoMs are ok from my side.

Dr. T.P. Sharma
Department of Computer Science & Engineering
NIT Hamirpur, HP.
Alternate mail: teekparval@gmail.com
Mobile: 9418463114

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sakshi
to hod_csi, dr.pchouksey, me, TEEK

Dear Team,

Minutes are Ok and approved from my side. Please go ahead.

Thanks

Sakshi

| Approved. | Thanks a lot. | Please go ahead. |

| Reply | Reply all | Forward |

Central University of Himachal Pradesh

Department of Computer Science and Informatics

School of Mathematics, Computers and Information Science

AGENDA

7th BOARD OF STUDIES MEETING
TO BE HELD ON **28th September, 2021**

Venue: Through Online Mode on Google Meet

हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Established under Central Universities Act 2009)
शाहपुर परिसर, शाहपुर, ज़िला काँगड़ा, हिमाचल प्रदेश -176206
Shahpur Block, Shahpur, Distt. Kangra (HP) - 176206
Website: www.cuhimachal.ac.in

7th Meeting of Board of Studies (BOS), 28th September 2021

AGENDA-INDEX

Agenda Item No.	PARTICULARS	Information
CSI-BOS-7/21-1	Confirmation and Approval of the Minutes of the 6th Board of Studies meeting held on 23rd July, 2021.	Annexure – I
CSI-BOS-7/21-2	To place before the BoS for its approval, a revised structure of the MCA (2 Year) program in light of the National Education Policy-2020. All the revisions made from time to time in the scheme and syllabus of different courses of the MCA (2 Year) program as per the NEP-2020 guidelines will be reported to the upcoming BOS meetings.	Annexure-II,III
CSI-BOS-7/21-3	To place before the BoS for its approval, the adoption of Blended mode of learning in MCA (2 Year) program in the light of National Education Policy-2020.	-
CSI-BOS-7/21-4	To place before the BoS for its approval, the adoption of Multiple Entry-Exit systems in MCA (2 Year) programme in the light of National Education Policy-2020.	-
CSI-BOS-7/21-5	To place before the BoS for its approval, the list of new courses to be included in the course work of Ph.D. Computer Science & Informatics in the light of National Education Policy-2020.	Annexure- IV
CSI-BOS-7/21-6	To place before the BoS for correction in the typo errors in the MCA (3 years, 2020-23 Batch) programme scheme. The following corrections are required: MCA-E04 Data Mining, MCA-OC7 Image Processing, MCA-SD4 Introduction to Latex, MCA-SD2 Web Designing, and MCA-SD7 Network Administration.	-
CSI-BOS-7/21-7	Any item with the permission of the Chair.	-

हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय

Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

Shahpur Parisar, Shahpur, Distt. Kangra (HP) - 176206

Website: www.cuhimachal.ac.in

आज़ादी का
अमृत महोत्सव

File No.: CSI/1-5/BoS/CUHP/21/~~133~~   Dated: 28/09/2021

MINUTES OF THE 7ᵗʰ BOARD OF STUDIES MEETING

HELD ON 28ᵗʰ September, 2021

The **meeting** of the 7ᵗʰ **Board of Studies** of the **Department of Computer Science & Informatics**, School of Mathematics, Computers and Information Science, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur was held through **online mode** on Google Meet on **28ᵗʰ September, 2021** at **9:00 AM**. During the meeting, all members were available on Google Meet. Prof. Rakesh Kumar, Head and Dean, School of Mathematics, Computers and Information Sciences chaired the meeting.

Following members attended the meeting:

1. **Prof. Rakesh Kumar – Head and Convener**
   Head, Department of Computer Science and Informatics and Dean, School of Mathematics, Computers and Information Science, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

2. **Dr. T.P. Sharma– Subject Expert**
   Associate Professor, Department of Computer Engineering, National Institute of Technology, Hamirpur.

3. **Prof. Shakshi Kausal – Subject Expert**
   Professor, UIET, Panjab University, Sector- 25, Chandigarh

4. **Prof. O.S.K.S. Sastri – Vice Chancellor's Nominee**
   Professor, Department of Physics and Astronomical Science, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

5. **Dr. Rajender Kumar – Vice Chancellor's Nominee**
   Associate Professor, Department of Chemical and Chemical Sciences, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

6. **Dr. Keshav Singh Rawat – Dean's Nominee**
   Incharge, Assistant Professor, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

7. **Sh. Ajay Kumar, Member**
   Assistant Professor, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

8. **Sh. Manoj Dhiman– Special Invitee**
   Assistant Professor, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.

The **Chairman** welcomed all the **Hon'ble members & Special Invitees** and **briefed** about the **past activities** and also about the various **agenda items** to be **discussed** in the **meeting** which were **sent** in **advance** to all the members through **e-mail** including **External subject experts.**

All the members were **informed** about the issuance of the **University guidelines** regarding **the** implementation of NEP 2020 which are **subject to** the **approval** from **Academic Council** and **Executive Council** of CUHP. The **Agenda Items** were **placed** before the **committee** and after **detailed** discussions and **deliberations** on each, the **following** decisions were taken:-

AGENDA ITEM NO. - CSI-BOS-7/21-1

Confirmation and Approval of the Minutes of the 6th Board of Studies meeting held on 23rd July, 2021.

Decision:
The Minutes of the 6th meeting of the BoS were Confirmed and Approved attached as Annexure-I.

AGENDA ITEM NO. - CSI-BOS-7/21-2

To place before the BoS for its approval, a revised structure of the MCA (2 Year) program in light of the National Education Policy-2020. All the revisions made from time to time in the scheme and syllabus of different courses of the MCA (2 Year) program as per the NEP-2020 guidelines will be reported to the upcoming BOS meetings.

Decision:
All the members of BoS unanimously approved the revised course basket of the MCA (2 Year) program in light of the National Education Policy-2020 as Annexure-II, III. Subject Experts were of the opinion that the revisions made from time to time in the scheme & syllabus of different courses of the MCA program as well as other modifications as per the NEP-2020 guidelines of the Central University of Himachal Pradesh may be reported to the upcoming BOS meetings.

AGENDA ITEM NO. -CSI-BOS-7/21-3

To place before the BoS for its approval, the adoption of Blended mode of learning in MCA (2 Year) program in the light of National Education Policy-2020.

Decision:
All the members of BoS unanimously approved the adoption of blended/hybrid mode of learning in MCA (2 year) programme of study in the light of National Education Policy-2020 of the Central University of Himachal Pradesh.

AGENDA ITEM NO. - CSI-BOS-7/21-4

To place before the BoS for its approval, the adoption of Multiple Entry-Exit systems in MCA (2 Year) programme in the light of National Education Policy-2020.

Decision:
All the members of BoS unanimously approved the adoption of Multiple Entry-Exit system in MCA (2 Year) programme in the light of National Education Policy-2020 of the Central University of Himachal Pradesh.

AGENDA ITEM NO. - CSI-BOS-7/21-5

To place before the BoS for its approval, the list of new courses to be included in the course work of Ph.D. Computer Science & Informatics in the light of National Education Policy-2020.

Decision:
All the members of BoS unanimously approved the list of new courses for the course work in Ph.D. Computer Science & Informatics in the light of National Education Policy-2020 attached at Annexure-IV. Subject experts also suggested that the subjects of PhD course work may be divided into two semesters.

AGENDA ITEM NO. - CSI-BOS-7/21-6

To place before the BoS for correction in the typo errors in the MCA (3 years, 2020-23 Batch) programme scheme. The following corrections are required: MCA-E04 Data Mining, MCA-OC7 Image Processing, MCA-SD4 Introduction to Latex, MCA-SD2 Web Designing, and MCA-SD7 Network Administration.

Decision:
All members agreed and approved the correction in the typo errors in the MCA (3 years, 2020-23 Batch) programme scheme.
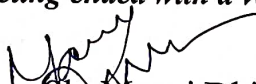
AGENDA ITEM NO. - CSI-BOS-7/21-7
Any item with the permission of the Chair:
All the members were of the opinion that approved CUHP guidelinesas per National Education Policy 2020 may be incorporated in the course schemes of different programmes of study of the Department of Computer Science & Informatics, and advised to report the same in the upcoming BoS meetings.
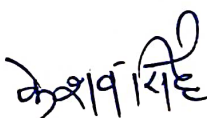
The meeting ended with a vote of thanks to the chair.

Sh. Ajay Kumar
(Member)

Sh. Manoj Dhiman
(Special Invitee)

Dr. Keshav Singh Rawat
(Dean's Nominee)

(approved through E-mail)
Dr. Rajender Kumar
(VC's Nominee)

Prof. O.S.K.S. Sastri
(VC's Nominee)

(approved through E-mail)
Dr. T.P. Sharma
(Subject Expert)

(approved through E-mail)
Prof. Sakshi Kausal
(Subject Expert)

Prof. Rakesh Kumar
(Chairman & Convener)

हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय

Central University of Himachal Pradesh

[Established under Central Universities Act 2009]

अस्थाई शैक्षणिक खण्ड, शाहपुर, जिला कांगड़ा, हिमाचल प्रदेश -176206

Temporary Academic Block, Shahpur, Distt. Kangra (HP) - 176206

Website: www.cuhimachal.ac.in

File No.: CSI/1-5/BoS/CUHP/21/ 82(a)

Dated: 23.07.2021

MINUTES OF THE 6ᵗʰ BOARD OF STUDIES MEETING

HELD ON 23ʳᵈ JULY, 2021

The meeting of the 6ᵗʰ Board of Studies of the Department of Computer Science and Informatics, School of Mathematics, Computers and Information Science, Central University of Himachal Pradesh, Temporary Academic Block, Shahpur was held through online mode on Google Meet (meet.google.com/pqp-tgzb-pwx)on 23ʳᵈ July, 2021 at 11:00 AM. During the meeting, all members were available on Google Meet. Prof. Rakesh Kumar, Head, Department of Computer Science and Informatics and Dean, School of Mathematics, Computers and Information Science chaired the meeting.

Following members attended the meeting:

1. **Prof. Rakesh Kumar – Head and Convener**
   Head, Department of Computer Science and Informatics and Dean, School of Mathematics, Computers and Information Science, Central University of Himachal Pradesh, Temporary Academic Block, Shahpur.

2. **Dr. ArvindKalia – Subject Expert**
   Department of Computer Sciences,Himachal Pradesh University, Shimla.

3. **Dr. T.P. Sharma– Subject Expert**
   Associate Professor, Department of Computer Engineering, National Institute of Technology, Hamirpur.

4. **Prof. O.S.K.S. Sastri – Vice Chancellor's Nominee**
   Professor, Department of Physics and Astronomical Science, Central University of Himachal Pradesh, Temporary Academic Block, Shahpur.

5. **Dr. Rajender Kumar – Vice Chancellor's Nominee**
   Associate Professor, Department of Chemical and Chemical Sciences, Central University of Himachal Pradesh, Temporary Academic Block, Shahpur.

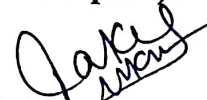6. **Dr. Keshav Singh Rawat – Dean's Nominee**
   Assistant Professor, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Temporary Academic Block, Shahpur.

7. **Mr. ManojDhiman– Special Invitee**
   Assistant Professor, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Temporary Academic Block, Shahpur.

The **Chairman** welcomed all the Hon'ble members &Special Inviteesand briefed about the past activities and also about the various agenda items to be discussed in the meeting which were sent in advance to all members through e-mail including Subject Experts. Various Agenda Items were placed before the committee and after detailed discussion and deliberations on each, the following decisions were taken:-

AGENDA ITEM NO. - CSI-BOS-6/21-1

Confirmation and Approval of the Minutes of the 5th Board of Studies meeting held on 23rd September, 2020attached as Annexure - I.

Decision:

The Minutes of the 5th meeting of the Board of Studies were Confirmed and Approved.

AGENDA ITEM NO. - CSI-BOS-6/21-2

To deliberate and approve the start of a MCA (Masters of Computer Applications)Programme of Two Years durationw.e.f. Academic Session 2021-22.

Decision:

Both Subject expertsDr.ArvindKalia, Dr. T. P. Sharma, and Prof. O.S.K.S Shastrisuggested the following points regarding duration of MCA programme-

1. MCA programme of 2 year duration with eligibility criteria "Bachelor of Computer Applications (BCA)/ B.Sc.(Computer Science)/ B.Sc. (IT)/ BA(ComputerScience)/ BA (IT) OR any Graduate with PGDCA OR any Graduate with 20-24 credits in the subjects of computer OR any graduate with minimum of 6 courses of computer studied in graduation (in case of degree not in credit system)from a recognized University or an equivalent examination".

2. Any Candidate with eligibilitycriteria"Bachelor Degree with Mathematics either at 10+2 Level or at Graduation Level with at least 50% marks" must be required to pass additional one year diploma course offered by the department. After completion of one year diploma course, candidate is eligible for admission in MCA programme of 2 year duration.

After deliberate discussion, all the members agreed to start MCA (Masters of Computer Applications) Programme of Two Years duration with eligibility criteria as per mentioned in point one. The MCA programme with eligibility criteria mentioned in point 2 may be started in the future.

AGENDA ITEM NO. - CSI-BOS-6/21-3

To deliberate and approve the minutes of the meeting of Course Development Committee (CDC) as well as the Course Scheme (course duration, eligibility conditions, criteria of selection, credit requirement and conditions for the award of Degree etc.) for the MCA Programme of Two Years duration.

Decision:

Subject experts strongly suggested following necessary changes in course scheme structure for MCA (Masters of Computer Applications) Programme of Two Years-

* Student intake, examination pattern, and evaluation have been included in the proposed course scheme.
* Eligibility conditions are included as per suggestions in AGENDA ITEM NO. - CSI-BOS-6/21-2.
* All credits of fourth semester are assigned to project work.
* Some courses of core compulsory, core open, elective specialization, and elective open have been shifted to suggested course categories.

All members agreed and approved the CDC minutes and the Course Scheme with above mentioned suggestions as per Annexure –II, III(a).

AGENDA ITEM NO. - CSI-BOS-6/21-4

To deliberate and approve the course contents developed by CDC (Course Development Committee) for the MCA Programme of Two Years duration

Decision:

Subject experts suggested that the course contents developed by CDC (Course Development Committee) for the MCA Programme of Two Years duration may be fitted according to the course structure as suggested in AGENDA ITEM NO. - CSI-BOS-6/21-3.All members agreed and approved the course contents with these changes as per Annexure-IV(a).

AGENDA ITEM NO. - CSI-BOS-6/21-5

To deliberate and approve the course contents for the MCA Programme of Three Years duration

Decision:

All members agreed and approved the course contents for the MCA Programme of Three Years duration as attached in Annexure –V.

AGENDA ITEM NO. - CSI-BOS-6/21-6

Proposal of the Faculty Member of the Department of Computer Science and Informatics to become M.Phil./Ph.D. Supervisor/Guide

Decision:

All the members of BoS unanimously approved the Dr.Keshav Singh Rawat, Assistant Professor, Department of Computer Science and Informatics, School of Mathematics, Computers and Information Sciences to Supervise thePh.D scholars of the Department (as per CUHP Ordinance No. 42, Clause 6):

AGENDA ITEM NO. - CSI-BOS-6/21-7

To approve the change of Research Supervisor for the Ph.D. Students in the Department of Computer Science and Informatics

Decision:

All members agreed and approvedDr.Keshav Singh Rawat, Assistant Professor, Department of Computer Science and Informatics as the Research Supervisor of Mr.Dheeraj Kumar (Roll No. CUHP20RDCS01), Mr.Girish Sharma (Roll No. CUHP20RDCS02), and Mr. Manoj Dhiman (Roll No. CUHP20RDCS03) in place of previous supervisor Dr.Sandeep Kumar Sood as he left the University.

AGENDA ITEM NO.-CSI-BOS-6/21-8

To approve the Co-Supervisor for the Ph.D. Students in the Department of Computer Science and Informatics

Decision:

All members agreed to allow Dr. Sandeep Kumar Sood, Associate Professor, NIT Kurukshetra to act as research Co-Supervisor of Mr. Dheeraj Kumar (Roll No. CUHP20RDCS01) and Mr. Girish Sharma (Roll No.CUHP20RDCS02) as per the recommendations from the present Supervisor and approval from the RAC.

AGENDA ITEM NO.-CSI-BOS-6/21-9

Approval of List of Experts as Examiners for the Practical and Viva Voce Examinations of M.Sc. IT and MCA.

Decision:

All members agreed and approved the list of examiners as proposed at Annexure VI. It was also suggested that the list will be updated regularly by the faculty members of the Department of Computer Science and Informatics with the consent of the respective Head of the Department and the same be reported in the next meeting of BoS. It was also suggested that preferably the subject course experts be invited for specific courses. The BoS also recommended that, if needed, HoD may invite a Subject Expert (External Examiner) not included in the list, on the recommendations of the concerned faculty member(s) and after approval of competent authority of the university.

AGENDA ITEM NO. - CSI-BOS-6/21-10

Any item with the permission of the Chair.
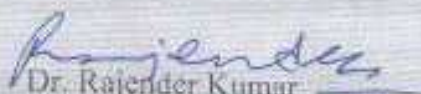
The subject experts also suggested that a different department-level committee may be constituted instead of BoS for discussion of research degree matters.
In this context, as per the CUHP ordinance, the Research Advisory Committee (RAC) of the Department is already constituted, and all research degree matters are approved by the Research Advisory Committee (RAC) followed by BoS and School Board.

The meeting ended with a vote of thanks to the chair.

Mr. Manoj Dhiman
(Special Invitee)

Dr. Keshav Singh Rawat.
(Dean's Nominee)

Dr. Rajender Kumar
(VC's Nominee)

Prof. O.S.K.S. Sastri
(VC's Nominee)

Dr. T.P. Sharma
(Subject Expert)

Dr. Arvind Kalia
(Subject Expert)

Prof. Rakesh Kumar
Chairman & Convener

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(Established under Central Universities Act 2009)
Shahpur Parishar, District Kangra, Himachal Pradesh-176206
Department of Computer Science &Informatics

MCA Programme (2-years) as per the NEP-2020 guidelines of CUHP

A student must have to earn 80 credits as per the Course Scheme for the award of MCA degree.

Course category	Credit
Disciplinary/ Interdisciplinary: Major Course	30
Disciplinary/ Interdisciplinary: Minor Course	16
Vocational/ Skill	14
IKS	4
Review of Literature, Research Proposal	8
Dissertation	8
Total	**80**

*University has issued the guidelines for the implementation of NEP 2020 which are subject to the approval from Academic Council and Executive Council, CUHP.

First Semester- Master of Computer Applications

S. No.	Course Code	Course Name	Credits
1.	MCA-501	Data Structures	4
2.	MCA-502	Data Structures Lab	2
3.	MCA-503	Operating System	4
4.	**	Minor-I	4
5.	**	*Vocational/ Skill	4
6.	**	+IKS	2

Second Semester- Master of Computer Applications

S. No.	Course Code	Course Name	Credits
1.	MCA-504	Theory of Computation	4
2.	MCA-505	Database Management System	4
3.	MCA-506	Database Management System Lab	2
4.	MCA-507	Design & Analysis of algorithms	2
5.	**	Minor-II	4
6.	**	Vocational/ Skill	2
7.	**	#IKS	2

Third Semester- Master of Computer Applications

S. No.	Course Code	Course Name	Credits
1.	**	Elective Specialization	4
2.	MCA-601	Minor-III (*Research Methodology)	4
3.	**	*Vocational/ Skill	4
4.	MCA-604	*Literature Review	4
5.	MCA-605	Research Proposal	4

Fourth Semester- Master of Computer Applications

S. No.	Course Code	Course Name	Credits
	**	Elective Specialization	4
1.	MCA-602	Minor-IV(*Academic writing)	2
2.	MCA-603	Minor-V(Paper publication)	2
3.	**	*Vocational/ Skill	4
4.	MCA-606	Dissertation	8

Note: Students can opt Minor/ vocational courses/ bridge courses from certificate courses offered by the department.

+02 Credits Course Developed by University Level Committee and uniform for all the programmes
02 Credits Course Developed by the Department concerned,
* 50% Theory and 50% Practical
** Course code belongs to Minor/ Vocational/ Skill /IKS/ Elective Specialization courses list.

Major Courses (30 credits)

S. No.	Course Code	Course Name	Credit
1.	MCA-501	Data Structures	4
2.	MCA-502	Data Structures Lab	2
3.	MCA-503	Operating System	4
4.	MCA-504	Theory of Computation	4
5.	MCA-505	Database Management System	4
6.	MCA-506	Database Management System Lab	2
7.	MCA-507	Design & Analysis of algorithms	2
Elective Specialization (08)			
S. No.	Course Code	Course Name	Credit
1.	MCA-508	Digital Image Processing	4
2.	MCA-509	Computer Graphics	4
3.	MCA-510	Data Mining	4
4.	MCA-511	Machine Learning	4
5.	MCA-512	Cloud Computing Concepts	4
6.	MCA-513	Internet of Things	4
7.	MCA-514	Mobile Computing	4
8.	MCA-515	Cryptography and Network Security	4
9.	MCA-516	Web Programming	4

Minor Courses (16 credits)

S. No.	Course Code	Course Name	Credit
1.	MCA-517	Soft Computing	4
2.	MCA-518	Bioinformatics	4
3.	MCA-519	Computer Networks	4
4.	MCA-520	Computer Organization & Architecture	4
5.	MCA-521	Software Engineering	4
6.	MCA-522	Software testing	4
7.	MCA-523	Software Project Management	4
8.	MCA-524	Compiler Design	4
9.	MCA-525	Distributed System	4
10.	MCA-526	Discrete structure	4
11.	MCA-601	Research Methodology	4
12.	MCA-602	Academic Writing	2
13.	MCA-603	Research Paper Publications	2

Review of Literature, Research Proposal (8 credits)

S. No.	Course Code	Course Name	Credit
1.	MCA-604	Review of Literature	4
2.	MCA-605	Research Proposal	4

Dissertation and Viva-Voce (8 credits)

S. No.	Course Code	Course Name	Credit
1.	MCA-606	Dissertation and Viva-Voce	4

Vocational/ Skill Courses (14 credits)

S. No.	Course Code	Course Name	Credit
1.	MCA-527	Python Programming	2
2.	MCA-528	Web Applications	4
3.	MCA-529	Business Data Processing	4
4.	MCA-530	Office Communication Tools	4
5.	MCA-531	Basics of Web Designing	2
6.	MCA-532	Network Administration	4
7.	MCA-533	Cyber Security	4
8.	MCA-534	Object Oriented Programming	4
9.	MCA-535	Introduction of Data Analytics Tools	4
10.	MCA-536	Java Programming	4
11.	MCA-537	Android Application Development	4
12.	MCA-537	NoSQL Databases	2

#Indian Knowledge System (2 credits)

S. No.	Course Code	Course Name	Credit
2.	MCA-551	IT Tools for IKS	2
3.	MCA-552	Knowledge Representation in Sanskrit and Artificial Intelligence	2

Bridge Courses (0 credits)

S. No.	Course Code	Course Name	Credit
1.	CS-401	Fundamentals of Computer	2
2.	CS -402	Programming in C	2

Note: Practical work of all the lab courses will be based on corresponding theory courses.

MCA 501
Data Structures

UNIT- I
Introduction: Basic Terminology, Data structures and its classification, Algorithm, Complexity-space & time complexity, complexity notations- big Oh, Omega, Theta. Array Definition, Representation and Analysis of Arrays, Single and Multidimensional Arrays, Address calculation, Linear Search, Binary Search of Array, Traversing, Insertion & deletion in array, Sparse Matrices, Strings. Internal and External sorting, Insertion Sort, Bubble Sort, selection sort, Quick Sort, Merge Sort, Radix sort.

UNIT- II
Linked List Introduction,   Representation of linked list in to memory, Memory allocation -Garbage Collection, Traversing & Searching in Linked List, Insertion into linked list- at beginning of list & at given location, Deletion in linked list- from starting of list & given location of node, Header Linked List, two way List, Input & output restricted liked list, Circular Header Linked List, Representation of Polynomials using linked List.

UNIT- III
Stack, Array Implementation of stack, Linked Representation of Stack, Application of stack: Conversion of Infix to Prefix and Postfix Expressions and Expression evaluation. Queue, Array and linked implementation of queues, Circular queues, D-queues and Priority Queues.

UNIT- IV
Trees: Basic terminology, Binary Trees, algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees, Binary Search Tree (BST), AVL Trees, B-trees. Graphs: Introduction, Sequential Representations of Graphs, Adjacency Matrices, Traversal, Connected Component and Spanning Trees, Minimum Cost Spanning Trees. Searching & Hashing: Sequential search, binary search, Hash Table, Hash Functions, Collision Resolution Strategies.

Text Books:
1. Lipschuitz L. Seymour, "Data Structures", Schaum Outline Series, TMH.
2. R. S. Salaria, "Data Structures & Algorithm Using C", Khanna Book Publishing.

Reference Books:
1. Horowitz and Sahani, "Fundamentals of data Structures", Galgotia Publication Pvt. Ltd., N Delhi.
2. R. S. Salaria, "Data Structures & Algorithm Using C++", Khanna Book Publishing
3. A.M. Tenenbaum, "Data Structures using C & C++", Prentice-Hall of India Pvt. Ltd., New Delhi.
4. Trembley and Sorenson, "Data Structures", TMH Publications

MCA 503
Operating System

UNIT-I
Operating System Introduction: function, characteristics, structures–simple batch, multiprogrammed, timeshared, personal computer, parallel, distributed systems, real-time systems, system components, operating system services, system calls, virtual machines.
Process and CPU Scheduling: Process concepts and scheduling, operation on processes, cooperating processes, threads and inter-process communication scheduling criteria, scheduling algorithm, multiple-processor scheduling, real time scheduling.

UNIT-II
Management and Virtual memory: logical versus physical address space, swapping, contiguous allocation, paging, segmentation, segmentation with paging. Demand paging, performance of denuding paging, page replacement, page replacement algorithm, allocation of frames, thrashing.

UNIT-III
File System Interface and Implementation: access methods, directory, structure, protection, file system structure, allocation methods, free space management, directory management, directory implementation, efficiency and performance.
I/O Management: I/O software and its types, disk scheduling.
Process Management and Synchronization: Critical section problem, synchronization, critical regions, monitors.

UNIT-IV
Deadlocks: system model, dead locks characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection and recovery from deadlock.
Shell Programming: vi editor, shell variables, I/O in shell, control structures, loops, subprograms, creating shell scripts. Basic system administration in Linux/Unix.

Text Books:
1. Silberschart, Galvin, Gagne, "Operating System Concepts", Ninth Edition, WSE Wiley.
2. Das, S., Your UNIX: The Ultimate Guide, Fourth Edition, McGraw-Hill Inc.

Reference Book:
1. D.M. Dhamdhere, "Operating Systems: A Concept Based Approach", Tata McGraw-Hill.
2. Milan Milenkovic, "Operating system-concepts and design", McGraw Hill International
3. Edition
4. A. S. Godbole, "Operating systems", Tata McGraw hill
5. Deitel H. M., "Operating System", Pearson Publications
6. William Stallings, "Operating Systems: Internals and Design Principles", Prentice-Hall of India
7. Andrew. S. Tanenbaum, "Modern operating systems", Pearson Prentice Hall.

MCA 504
Theory of Computations

UNIT-I
Introduction of Theory of Computation, Alphabet, Strings and their properties, Definition of an automation, Description of a finite Automation, Transition graph, transition function, Acceptability of a string by a Finite Automation, Deterministic and nondeterministic FSM'S, Equivalence of DFA and NDFA, Mealy & Moore machines, Minimization of finite automata.

UNIT-II
Chomsky classification of Languages, Languages and their relation, Languages and Automata, Regular sets, regular expression, Regular Grammars, Finite state machine and regular expression, Pumping lemma for regular sets, Application of pumping lemma, closure properties of regular sets.

Introduction to CFG, Context-free languages and Derivation Trees, Ambiguity in context-free Grammars, simplification of context-free Grammars, Normal forms for context-free Grammars – Chomsky normal form and Greiback normal form.

UNIT-III
Pushdown Automata: Definitions – Moves – Instantaneous descriptions – Deterministic pushdown automata – Pushdown automata and CFL, PDA corresponding to given CFG, CFG corresponding to a given PDA, Closure properties of CFL's.

UNIT-IV
Introduction, TM model Representation of Turing machines, languages acceptability of TM, Design of TM, Universal TM & Other modification, Church's hypothesis, Properties of recursive and Recursively enumerable languages.
Tractable and Untractable Problems: P, NP, NP complete and NP hard problems

Text Books:
1. John E. Hopcroft, Jeffery Ullman,"Introduction to Automata theory, Langauges& computation" , Narosa Publishers.
2. John C Martin, "Introdution to languages and theory of computation", McGraw Hill

Reference Books:
- K.L.P Mishra & N.Chandrasekaran,"Theory of Computer Science", PHI Learning
- Daniel I.A. Cohen,"Introduction to Computer Theory",Wiley India.
- Peter Linz, "An Introduction to Formal Languages and Automata", Jones & Bartlett Learning.

MCA 505
Data Base Management System

UNIT-I

Basic Concepts: Entity, Relationship and its types, Components of a database, three level architecture of a DBMS, Database models.

File Organization: Serial, Sequential, Index Sequential and Direct file organization.

UNIT-II

Entity-Relationship Model: Entity Types, Entity Sets, Attributes & keys, Relationships,Relationships Types, Roles and Structural Constraints, Design issues, E-R Diagrams,Design of an E-R Database Schema, Reduction of an E-R Schema to Tables.

Relational Data Model: Relational model concepts, Integrity constraints over Relations,Relational Algebra – Basic Operations.

SQL: DDL, DML, and DCL, views & Queries in SQL, Specifying Constraints & Indexesin SQL.

UNIT-III

Relational Database Design: Functional Dependencies, Decomposition, Normal formsbased on primary keys (1 NF, 2 NF, 3 NF, & BCNF)

Transaction Processing Concepts: Introduction to Transaction Processing, Transaction &System Concepts, Properties of Transaction, Schedules and Recoverability, SerializabilityofSchedules.

Concurrency Control Techniques: Locking Techniques, Timestamp ordering, MultiversionTechniques, Optimistic Techniques, Granularity of Data items.

UNIT-IV

Databases for Advanced Applications: Active database concepts, Temporal database concepts, Spatial databases, Deductive databases; Emerging Database Technologies: Mobile databases, Multimedia Databases, Geographic information systems (GIS); XML and Internet Databases: Structured, Semi-structured and Unstructured Data, Introduction to web databases and XML, Structure of XML data.

Text Books:
1. R. Elmasri and S. B. Navathe, "Fundamentals of Database Systems", 7E, Addison Wesley.
2. Bayross, I., "SQL, PL/SQL: The Programming Language of Oracle",4E , BPB Publications.

Reference Books:
1. R. Ramakrishnan and J. Gehrke, "Database Management Systems", 3E, McGraw Hill.
2. A. Silberschatz, H. Korth and S. Sudarshan, "Database System Concepts", 6E, McGraw Hill.

MCA 507
Design & Analysis of Algorithm

UNIT- I
Algorithms, designing algorithms, analyzing algorithms, asymptotic notations, Introduction to divide and conquer technique, analysis, design and comparison of various algorithms based on this technique, example binary search, merge sort, quick sort, strassen's matrix multiplication.

UNIT- II
Study of Greedy strategy, examples of greedy method like optimal merge patterns, Huffman coding, minimum spanning trees, knapsack problem, job sequencing with deadlines, single source shortest path algorithm.
Concept of dynamic programming, problems based on this approach such as 0/1 knapsack, multistage graph, reliability design, Floyd-Warshall algorithm.

UNIT- III
Backtracking concept and its examples like 8 queen's problem, Hamiltonian cycle, Graph coloring problem etc.Introduction to branch & bound method, examples of branch and bound method like travelling salesman problem etc.Meaning of lower bound theory and its use in solving algebraic problem.

UNIT- IV
Binary search trees, height balanced trees, 2-3 trees, B-trees, basic search and traversal techniques for trees and graphs (In order, preorder, postorder, DFS, BFS), NP-completeness.

Text Books:
1. Ellis Horowitz, SartajSahni and SanguthevarRajasekaran, "Computer Algorithms", 2E, Universities Press, 2007.
2. Cormen, T.H., Leiserson, C.E., Rivest, R.L. and Stein, C., "Introduction to Algorithms", 2E, Prentice Hall of India Pvt. Ltd, 2003.

Reference Books:
1. Aho, A.V., Hopcroft J.E. and Ullman, J.D., "The Design and Analysis of Computer Algorithms", Pearson Education, 1999.
2. Sara Baase and Allen Van Gelder, "Computer Algorithms, Introduction to Design and Analysis", 3E, Pearson Education, 2009.
3. Dasgupta; "Algorithms"; TMH
4. Michael T Goodrich, RobartoTamassia, "Algorithm Design", Wiely India

MCA 508
Digital Image Processing

UNIT-I
Introduction: The role of Computer Vision, applications, successes, research issues; its relationship to natural vision, basic image properties. Digital image representation, fundamental steps in image processing, elements of digital image processing systems digitization, Display and recording devices.

UNIT-II
Digital Image fundamentals: A simple Image model. Sampling and quantization, Relationship between pixel, imaging geometry, image transformation, introduction to fourier transformation, Discrete fourier transformation, fast fourier transformation.

UNIT-III
Image Enhancement: Histogram processing, image subtraction, image averaging, smoothing filters, sharpening filters, enhancement in frequency domain, low pass filtering, high pass filtering.

UNIT-IV
Image Encoding & Segmentation: Segmentation, detection of discontinuation by point detection, line detection, edge detection. Edge linking & Boundary Detection: Local analysis, global by Hough transform & Global by graph theoretic techniques.
Image Representation and Description: Chain codes, polygonal approximation, signatures, boundary segments, boundary descriptors, regional descriptors, introduction to image understanding.Motion Tracking , Image differencing, Feature matching, Optic flow.

Text Book:
1. Gonzalez, Rafael C., and Richard E. Woods. "Digital Image Processing", 4E, Addison-Wesley.

Reference Book:
1. Jain, Anil K. "Fundamentals of digital image processing", Prentice-Hall, Inc., 1989.

MCA 509
Computer Graphics

UNIT-I
Introduction: Survey of computer Graphics and its applications; Interactive and passive graphics; display processors; Graphic Devices: Display systems-refresh CRTs, raster scan and random scan monitors, Grey shades, Interlacing, beam penetration shadow mask monitors, lookup tables, plasma panel, LED and LCD monitors, VGA and SVGA resolutions; Hard copy Devices-printers, plotters; Interactive Input Devices

UNIT-II
Drawing Geometry: Coordinate system; resolution; use of the homogeneous coordinate system; scan conversion: symmetrical DDA, simple DDA, Bresenham's line drawing algorithm, Circle drawing using DDA and polar coordinates, Bresenham's circle drawing algorithm, generation of an ellipse. Curve Drawing

UNIT-III
2-D Transformations: Translation; rotation; scaling; mirror reflection; shearing; zooming; panning; input techniques-pointing, positioning, rubber band methods and dragging; tweening, Morphing. Graphic operations: Clipping-line clipping using Sutherland-Cohen and midpoint sub- division algorithm, Liang Barsky Line clippers algorithm, polygon clipping; window and viewport; windowing transformation; Filling algorithms.

UNIT-IV:
3-D Graphics: 3D modelling of objects; 3D display techniques; coordinate system; 3D transformation matrices for translation, scaling and rotation; parallel projection; perspective projection; Hidden-surface removal - Z-buffer, back face, scan-line, depthsorting, area subdivision; Shading - modelling light intensities, Gouraud shading, Phong shading.

Text Books:
1. Hearn, D., Baker, M.P. and Carithers, W.R., "Computer Graphics with OpenGL", 4E, Prentice Hall, 2014.

Reference Books:
1. Klinger, A., Fu, K.S. and Kunii, T.L., "Data Structures, Computer Graphics, and Pattern Recognition", Academic Press. 2014.
2. Marschner, S. and Shirley, P., "Fundamentals of Computer Graphics", CRC Press, 2015.
3. Enderle, G., Kansy, K. and Pfaff, G., "Computer Graphics Programming: GKS—The Graphics Standard", Springer Science & Business Media. 2012.
4. Foley, J.D., Van, F.D., Van Dam, A., Feiner, S.K., Hughes, J.F., Angel, E. and Hughes, J., "Computer Graphics: Principles and Practice", Addison-Wesley Professional. 2018.

MCA 510
Data Mining

UNIT I

Motivation, importance, Data type for Data Mining : relation Databases, Data Warehouses, Transactional databases, advanced database system and its applications, Data mining Functionalities: Concept/Class description, Association Analysis classification & Prediction, Cluster Analysis, Outlier Analysis, Evolution Analysis, Classification of Data Mining Systems, Major Issues in Data Mining.

UNIT II

Data Warehouse and OLAP Technology for Data Mining: Differences between Operational Database Systems and Data Warehouses, a multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Architecture, Data Warehouse Implementation, Data Cube Technology. Data Preprocessing: Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Data Mining Primitives, Languages, and System Architectures, Concept Description: Characterization and Comparison, Analytical Characterization.

UNIT III

Mining Association Rules in Large Databases: Association Rule Mining: Market Basket Analysis, Basic Concepts, Mining Single-Dimensional Boolean Association Rules from Transactional Databases: the Apriori algorithm, Generating Association rules from Frequent items, Improving the efficiency of Apriory, Mining Multilevel Association Rules, Multidimensional Association Rules, Constraint-Based Association Mining.

UNIT IV

Classification & Prediction and Cluster Analysis: Issues regarding classification & prediction, Different Classification Methods, Prediction, Cluster Analysis, Major Clustering Methods, Applications& Trends in Data Mining: Data Mining Applications, currently available tools.

Text Books:
1. J. Han and M. Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Pub.
2. Berson "Dataware housing, Data Mining & DLAP", TMH.

Reference Books:
1. W.H. Inmon "Building the Datawarehouse", Wiley India.
2. Anahory, "Data Warehousing in Real World", Pearson Education.
3. Adriaans, "Data Mining", Pearson Education.
4. S.K. Pujari, "Data Mining Techniques", University Press, Hyderabad.

MCA 510
Machine Learning

UNIT I

Overview and Introduction to Bayes Decision Theory: Machine intelligence and applications, pattern recognition concepts classification, regression, feature selection, supervised learning class conditional probability distributions,Examples of classifiers bayes optimal classifier and error, learning classification approaches.

UNIT II

Linear machines: General and linear discriminants, decision regions, single layer neural network, linear separability, general gradient descent, perceptron learning algorithm, mean square criterion and widrow-Hoff learning algorithm; multi-Layer perceptrons: two-layers universal approximators, backpropagation learning, on-line, off-line error surface, important parameters.

Learning decision trees: Inference model, general domains, symbolic decision trees, consistency, learning trees from training examples entropy, mutual information, ID3 algorithm criterion, C4.5 algorithm continuous test nodes, confidence, pruning, learning with incomplete data

UNIT III

Instance-based Learning: Nearest neighbor classification, k-nearest neighbor, nearest neighbor error probability, Machine learning concepts and limitations: Learning theory, formal model of the learnable, sample complexity, learning in zero-bayes and realizable case, VC-dimension, fundamental algorithm independent concepts, hypothesis class, target class, inductive bias, occam's razor, empirical risk, limitations of inference machines, approximation and estimation errors, Tradeoff.

UNIT IV

Machine learning assessment and Improvement: Statistical model selection, structural risk minimization, bootstrapping, bagging, boosting.

Support Vector Machines: Margin of a classifier, dual perceptron algorithm, learning nonlinear hypotheses with perceptron kernel functions, implicit non-linear feature space, theory, zero-Bayes, realizable infinite hypothesis class, finite covering, margin-based bounds on risk, maximal margin classifier.

Text Books:
1. E. Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2006.
2. C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

Reference Books:
1. T. M. Mitchell, "Machine Learning", McGraw-Hill, 1997.
2. R. O. Duda, P. E. Hart, and D.G. Stork, "Pattern Classification",John Wiley and Sons, 2001.
3. Vladimir N. Vapnik, "Statistical Learning Theory", John Wiley and Sons, 1998.
4. Shawe-Taylor J. and Cristianini N., Cambridge, "Introduction to Support Vector Machines", University Press, 2000.

MCA 512
Cloud Computing Concepts

UNIT-I
Overview of Computing Paradigms: Recent Trends in Computing: Distributed Computing, Cluster Computing, Grid Computing, Utility Computing, Cloud Computing, Evolution of Cloud Computing: Migrating into a Cloud
Cloud Computing Basics: Cloud Computing Overview; Characteristics; Applications; Benefits; Limitations; Challenges, SOA; Cloud Computing Service Models: Infrastructure as a Service; Platform as a Service; Software as a Service, Cloud Computing Deployment Models: Private Cloud; Public Cloud; Community Cloud; Hybrid Cloud, Major Cloud Service providers

UNIT-II
Virtualization Concepts: Overview of Virtualization Technologies, Types of Virtualization, Benefits of Virtualization, Hypervisors VM Provisioning & Migration: VM Lifecycle, VM Provisioning Process, VM Migration Techniques
Scheduling in Cloud: Overview of Scheduling problem, Different types of scheduling, Scheduling for independent and dependent tasks, Static vs. Dynamic scheduling, Optimization techniques for scheduling

UNIT-III
Cloud Storage: Overview; Storage as a Service, Benefits and Challenges, Storage Area Networks(SANs), Case Study of Amazon S3
Cloud Security: Infrastructure Security: Network Level Security, Host Level Security and Application Level Security; Data Security: Data Security & Privacy Issues; Identity & Access Management; Legal Issues in Cloud Computing

UNIT-IV
Mobile Cloud Computing: Overview of Mobile Cloud Computing, Advantages, Challenges, Using Smartphones with the Cloud, Offloading techniques - their pros and cons, Mobile Cloud Security.
SLA Management: Overview of SLA, Types of SLA, SLA Life Cycle, SLA Management Process

Text Books:
1. RajkumarBuyya, James Broberg, AndrzejGoscinski, " Cloud Computing: Principles and Paradigms", Wiley, 2011
2. Barrie Sosinsky: Cloud Computing Bible, Wiley, 2011.

Reference Books:
1. Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, "Cloud Computing: A Practical Approach", McGraw Hill, 2010.
2. Judith Hurwitz, Robin Bloor, Marcia Kaufman,FernHalper, "Cloud Computing for Dummies", Wiley, 2010.
3. BorkoFurht, Armando Escalante , "Handbook of Cloud Computing", Springer, 2010.

MCA 513
Internet of Things

UNIT-I
Introduction to IoT: Sensing, Actuation, Networking basics, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Communication models & APIs.

UNIT-II
M2M to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics. Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT.
M2M vsIoT An Architectural Overview–Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. Reference Architecture and Reference Model of IoT

UNIT-III
IoT Reference Architecture- Getting Familiar with IoT Architecture, Various architectural views of IoT such as Functional, Information, Operational and Deployment. Constraints affecting design in IoT world- Introduction, Technical design Constraints.
Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT application.

UNIT-IV
Developing IoT solutions: Introduction to Python, Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.

Text Books:
1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-onApproach)", 1E, VPT
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press

Reference Books:
1. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications
2. CunoPfister, Getting Started with the Internet of Things, O"Reilly

MCA 514
Mobile Computing

Unit-I:
Wireless Networks: Introduction, Applications, History of Wireless Communication. Electromagnetic Spectrum, Radio Propagation Mechanisms, Characteristics of the Wireless Channel, Modulation Techniques, Multiple Access Techniques, Voice Coding, Error Control.
Wireless LANS and PANS: Introduction, Fundamentals of WLANs, IEEE 802.11 Standards, HIPERLAN Standard, Bluetooth, HomeRF.

Unit-II:
Wireless WANS AND MANS: Introduction, Cellular Concept, Cellular Architecture, The First-Generation Cellular Systems, The Second-Generation Cellular Systems, The Third-Generation Cellular Systems, Wireless in Local Loop, Wireless ATM.

Unit-III:
Wireless Internet: Introduction, Mobile network Layer, Mobile IP, Route optimization, Handoffs, IPv6 Advancements, IP for Wireless domains, Security in Mobile IP, Mobile Transport layer, TCP in Wireless Domain, Optimizing Web over Wireless.

Unit-IV:
Ad Hoc Wireless Networks: Introduction. Issues in Ad Hoc Wireless Networks. Ad Hoc Wireless Internet. MAC Protocols for Ad Hoc Wireless Networks, Routing Protocols for Ad Hoc Wireless Networks, Security in Ad hoc wireless networks, Recent advances in Wireless Networks.

Text Book:
1. C-Siva Ram Murthy & B S Majo, "Adhoc Wireless Networks, Architectures Protocols" , Pearson.
2. Jochen Schiller "Mobile Communications", PEARSON.
3.

Reference Book:
1. William C.Y Lee, "Mobile Communication Design Fundamental", John Wiley.
2. William Stalling, "Wireless Communication and Network", Pearson Education.

MCA 515
Cryptography and Network Security

UNIT-I

Classical Encryption Techniques: Symmetric Cipher Model, substitution Techniques, tranposition techniques, rotor machines, steganography.

Block Ciphers and the Data Encryption standards: Simplified DES, block cipher principles, the data encryption standard, the strength of DES, differential and linear cryptanalysis, blockcipher design principles, block cipher modes of operation.

Advanced Encryption Standard: Evaluation Criteria for AES, the AES cipher.

Contemporary symmetric ciphers: Triple DES, blowfish.

Confidentiality using symmetric encryption: Placement of Encryption function, traffic confidentiality, key distribution, and random number generation.

UNIT-II

Public key Encryption and Hash functions: Prime numbers, Fermat's and Euler's Theorems, testing for primality, the chinese remainder theorem, discrete logarithms.

Public key cryptography and RSA: Principles of Public key cryptosystems, the RSA algorithm.

Key Management other public key cryptosystems: Key management, diffie-Hallman key exchange, elliptic curve arithmetic, and elliptic curve cryptography.

UNIT-III

Message authentication and Hash function: Authentication

Requirements, Authentication functions, message authentication codes, hash functions, security of hash function and MACs.

Hash Algorithms: MD5 message digest algorithm, secure Hash algorithm, ripemd-160, HMAC.

Digital Signature and Authentication protocols: Digital signatures, Authentication protocols, and digital signature standard.

Authentication Applications: Kerberos, X.509 Authentication service.

UNIT-IV

Electronic Mail Security: Pretty Good privacy, S/MIME.

IP Security: IP Security overview, IP security architecture,authentication header, encapsulating security payload, combining security associations, key management.

Web Security: Web security considerations, Secure sockets layer and transport layer security, secure electronic transaction.

System security: Intruders, intrusion detection, and password management. Malicious software: Viruses and related threats, virus countermeasures. Firewalls: Firewall Design Principles, Trusted systems.

Text Books:
1. William Stallings "Cryptography and Network Security", 3 ed, Pearson Education.
2. W.Stallings" Network security Essential " Applications & Standards", 6E, Pearson.

Reference Books:
1. Kanfren "Network Secirity : Private Communications in a public world 2/e
2. Eric Maiwald" NetworkSecirity : A Preginner's Guide", Tata Mcgraw Hill.
3. Roberta Bragg, Mark Rhodes, Ousley& Keith Strassberg, "Network Secirity : The Complete Reference " Tata McGraw Hill.
4. Eric Maiwald "Fundamentals of Network Security" Wiley India.

MCA516
Web Programming

UNIT-I
Introduction to PHP: how PHP script work, PHP syntax, write your first PHP program, embed PHP in html/html in PHP, PHP data type, variable in PHP, operator in PHP.
Control Structure: if statement, if......else statement, if...if else statement, nested if statement, switch statement
Looping Structure: for loop, while loop, do...while loop, for each loop function.

UNIT-II
Function: introduction, syntax, user defined function, system defined function, parameterized function, date & time function, hash function, mail function
Array: syntax, associative array, numeric array, multi-dimensional array.
String matching with regular expression: creating and accessing string, searching & replacing string, formatting string, string related library function, what is regular expression, pattern matching in PHP, replacing text, splitting a string with a Regular Expression?

UNIT-III
Objects: Creating classes and object in PHP, working with methods, overloading, inheritance, constructor and destructor.
Handling HTML form with PHP, Preserving state with query strings, cookies & sessions.
Working with file and directories: Understanding file & directory, Opening and closing a file, Reading, writing, coping, renaming and deleting a file, working with directories, Building a text editor

UNIT-IV
Generating images with PHP: Basics of computer graphics, creating images, manipulating images, using text in images.
Database access using PHP and MySQL: Connecting to MySQL from PHP, Retrieving data from MySQL with PHP, Manipulating MySQL data with PHP.

Text Book:
1. Matt Doyale ,"Beginning PHP 5.3", Wiley India Edition.

Reference Books:
1. Larry Ulman ,"PHP and MySQL5", Pearson
2. Robert Sebesta,"Programming with World Wide Web", Pearson.
3. John Duckett, "Beginning with HTML, XHTML, CSS and Javascript", Wiley- Wrox
4. Building PHP Applications WithSymfony, CakePHP, AndZend, Framework by BartoszPorebski Karol PrzystalskiLeszek Nowak, Wiley India.

MCA 517
Soft Computing

UNIT-I
Introduction, Soft Computing concept explanation, brief description of separate theories.Neural Networks and Probabilistic Reasoning; Biological and artificial neuron, neural networks and their classification.Adaline, Perceptron, Madaline and BP (Back Propagation) neural networks. Adaptive feed forward multilayer networks. Algorithms: Marchand, Upstart, Cascade correlation, Tilling. RBF and RCE neural networks. Topologic organized neural network, competitive learning, Kohonen maps.

UNIT-II
CPN , LVQ, ART, SDM and Neocognitron neural networks. Neural networks as associative memories(Hopfield, BAM). Solving optimization problems using neural networks. Stochastic neural networks, Boltzmann machine.

UNIT-III
Fundamentals of fuzzy sets and fuzzy logic theory, fuzzy inference principle.Examples of use of fuzzy logic in control of real-world systems.

UNIT-IV
Fundamentals of genetic programming, examples of its using in practice. Genetic Algorithms Applications of GA's – Class.

Text Books:
1. Cordón, O., Herrera, F., Hoffman, F., Magdalena, L," Genetic Fuzzy systems", World Scientific Publishing Co. Pte.Ltd
2.Kecman, V."Learning and Soft Computing", The MIT Press, 2001, ISBN 0-262-11255-8

Reference Books:
1. Mehrotra, K., Mohan, C., K., Ranka, S. "Elements of Artificial Neural Networks", The MIT Press, 1997, ISBN 0-262-13328-8
2. Munakata, T, "Fundamentals of the New Artificial Intelligence" ,Springer-Verlag New York, Inc., 1998.

MCA 518
Bioinformatics

UNIT-I
Introduction to Bioinformatics: What is a Database, Types of Databases, Biological Databases, Pitfalls of Biological Databases, Information Retrieval from Biological Databases.

UNIT-II
Sequences: Problem statement, Edit distance and substitution matrices, HMMs and pairwise HMMs, Global and local alignments, Spliced alignment, Space-efficient sequence alignment, Multiple alignment, Database searching tools, Sequence by hybridization, Profile HMMs.

UNIT-III
Structures: Protein structure alignment, Protein Structure Prediction: Methods for predicting the secondary and tertiary structure of proteins. Techniques: neural networks, SVMs, genetic algorithms and stochastic global optimization.

UNIT-IV
Transcriptomics: Methods for analysing gene expression and microarray data. Techniques: clustering, SVMs. Agent-based Genome Analysis: Automation of genome analysis using intelligent software agents. Drug Discovery Informatics: Approaches to drug discovery using bioinformatics techniques.

Text Books:
1. Compeau, P. and Pevzner, P.A., "Bioinformatics Algorithms: An Active Learning Approach", Active Learning Publishers, 2018.
2. Jones, N.C., Pevzner, P.A. and Pevzner, P., "An Introduction to Bioinformatics Algorithms", MIT press, 2004.

Reference Books:
1. Krawetz, S.A. and Womble, D.D., "Introduction to Bioinformatics: A Theoretical and Practical Approach", Springer Science & Business Media, 2003.
2. Lesk, A., "Introduction to bioinformatics", Oxford University Press, 2019.
3. Mandoiu, I. and Zelikovsky, A., "Bioinformatics Algorithms: Techniques and Applications", John Wiley & Sons, 2008.

MCA519
Computer Networks

UNIT-I
Introduction To Computer Networks: Definition of a Computer Network, The OSI
Reference Model, The TCP/IP Reference Model, Protocols and Hardware involved in the
OSI model, Comparison of the OSI & the TCP/IP.
Application Layer: Domain name space, DNS in internet, electronic mail, FTP, WWW,
HTTP, SNMP, multimedia, network security

UNIT-II
Physical Layer: Introduction: Network topologies; Linear Bus Topology, Ring Topology,
Star Topology, Hierarchical or Tree Topology, Topology Comparison, Considerations
when choosing a Topology: Switching; Circuit switching, Message switching, Packet
switching.
Transmission Medium: Introduction: Transmission medium; Guided & Unguided
Transmission medium, Twisted pair, Coaxial cable, Optical fiber, Comparison of fiber optics and
copper wire: Wireless transmission; Electromagnetic spectrum, Radio
transmission, Microwave transmission.

UNIT-III
Data Link Layer: Introduction; Goal of DLL: Design issues of DLL; Services provided to
the Network layer, Framing, Error control, Flow control, ARQ strategies: Stop-and-Wait,
RTT estimation, sliding window, Go-Back-N retransmission, Error Detection and
correction: Parity bits, Single bit error correction or (n, m), Error Detection or Cyclic
Redundant Code (CRC): Data Link layer protocols; Transmission control protocols,
HDLC.

Unit-IV
Network Layer: Introduction: Design issues of Network layer; Nature of the service
provided, Internetworking: Principles of Routing; Types of routing algorithms, Properties
of routing algorithms, Optimality principle: Routing algorithms; Shortest path algorithm,
Flooding, Distance vector routing, Hierarchical routing, Link state routing, Congestion:
Factors of congestion, Comparison of flow control and congestion control, General
principles of congestion control, Closed loop solution: IP protocol (IPV4).
Transport Layer: Introduction: Services of Transport layer; Service primitives:
Connection establishment: Connection Release: Transport Protocols; TCP protocol, UDP
protocol

Text Books:
1. Behrouz A. Forouzan, "Data Communications and Networking", 4E , 2017, Tata McGraw
   Hill.

Reference Books:
1. Natalia Olifer& Victor Olifer, "Computer Networks", John Wiley & Sons Ltd., 2013.
2. William Stallings, "Data & Computer Communication", Pearson Education, 2014.
3. Andrew S. Tanenbaum, "Computer Networks", Pearson Education, 2017

MCA 520
Computer Organization and Architecture

UNIT – I
Digital Logic Circuits – Digital Computers, Logic Gates, Boolean Algebra, Map Simplification, Conbinational Circuits, Flip Flops, Sequential Circuits
Digital Components & Data Representation – Decoders, Multiplexers, Registers, Shift Registers, Binary Counters, Memory Units, Data Types, Complements, Fixed Point Representation, Floating Point Representation, Other Binary Codes, Error Correction Codes

UNIT – II
Register Transfer and Micro-operations – Register Transfer Language, Register transfer, Bus and Memory Transfer – Three State Bus Buffer, Memory Transfer; Arithmetic Micro-operations – Binary Adder, Binary Adder-Subtractor, Binary Incrementer, Arithmetic Circuit; Logic Micro-operations, Shift Micro-operations, Arithmetic Logic Shift Unit.
Basic Computer Organization – Instruction codes – Stored Program Organization, Indirect Address; Computer Registers – Common Bus System; Computer Instructions – Instruction Set Completeness; Timing and Control; Instruction Cycle – Fetch and Decode, Determine the Type of Instruction, Register-Reference Instructions; Memory Reference Instructions; Input-Output and Interrupt, Complete Computer Description, Design of Basic Computer, Design of Accumulator Logic

UNIT – III
Programming the Basic Computer – Machine Language, Assembly Language, Introduction to Assembler, Program Loops, Programming Arithmetic and Logic Operations
Microprogrammed Control – Control Memory, Address Sequencing – Conditional Branching, Mapping of Instructions, Subroutines, Microprogram Example – Computer Configuration, Microinstruction Format, Symbolic Microinstructions, Fetch Routine, Symbolic Microprogram, Binary Microprogram, Design of Control Unit – Microprogram Sequencer
Central Processing Unit – Introduction, General Register Organization, Stack Organization – Register Stack, Memory Stack, Reverse Polish Notation, Evaluation of Arithmetic Expressions, Instruction Formats – Three-, Two-, One- and Zero-Address Instructions, Addressing Modes, Data Transfer and Manipulation, Program Control – Status Bit Conditions, Conditional Branch Instructions, Subroutine Call and Return, Program Interrupt, Types of Interrupt, RISC & CISC Characteristics, Overlap Register Window

UNIT – IV
Pipeline and Vector Processing – Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, RISC Pipeline, Vector Processing, Array Processors
Computer Arithmetic – Addition and Subtraction, Multiplication Algorithms, Division Algorithms, Floating Point Arithmetic Operations, Decimal Arithmetic Unit and Operations
Input-Output Organization – Peripheral Devices, Input-Output Interface, Modes of Transfer – Programmed I/O, Interrupt-Driven I/O, Priority Interrupt, Direct Memory Access (DMA), Input-Output Processor (IOP), Serial Communication
Memory Organization – Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware

TEXT BOOK:
1. M. Morris Mano, "Computer System Architecture", Revised 3E , Pearson Education

REFERENCE BOOKS:
1. John P. Hayes, "Computer Architecture and Organization", Third Edition, McGraw Hill Publication.

2. William Stallings, "Computer Organization and Architecture: Designing for Performance", Tenth Edition, Pearson Education India.

MCA 521
Software Engineering

UNIT-I
Introduction: Introduction to software Engineering, Software characteristics, Software components, Software applications, Software Engineering Principles, Software metrics and measurement, monitoring and control. Software development life-cycle, Water fall model, prototyping model, Incremental model, Iterative enhancement Model, Spiral model.

Unit-II
Software Requirement Specification: Requirements Elicitation Techniques, Requirements analysis, Models for Requirements analysis, requirements specification, requirements validation.
System Design: Design Principles: Problem partitioning, abstraction, Top down and bottom up – design, structured approach. Functional versus object-oriented approach of design, design specification, Cohesiveness and Coupling.Overview of SA/SD Methodology, structured analysis, data flow diagrams, extending DFD to structure chart.

Unit-III
Software project Management: Project planning and Project scheduling. Software Metrics: Size Metrics like LOC, Token Count, Function Count. Cost estimation using models like COCOMO. Risk management activities.
Software Reliability and Quality Assurance: Reliability issues, Reliability metrics, reliability models, Software quality, ISO 9000 certification for software industry, SEI capability maturity model.

Unit-IV
Testing: Verification and validation, code inspection, test plan, test case specification. Level of testing: Unit, Integration Testing, Top down and bottom up integration testing, Alpha and Beta testing, System testing and debugging. functional testing, structural testing, Software testing strategies.
Software Maintenance: Structured Vs unstructured maintenance, Maintenance Models, Configuration Management, Reverse Engineering, Software Re-engineering.

Text Book:
1. Software Engineering, "K. K. Aggarwal&Yogesh Singh", 2E, New Age International, 2005
2. PankajJalote's, "Software Engineering", Wiley India

Reference Book:
1. Roger S. Pressman, "Software Engineering- A Practitioner's Approach", Tata McGraw Hill
2. Rajib Mall, "Fundamentals of Software Engineering", PHI Learning Pvt. Ltd.

MCA 522
Software Testing

UNIT-I
Introduction: Software Failures, Testing Process, Program and Software, Verification and Validation, Fault, Error, Bug and Failure, Test, Test Case and Test Suite, Deliverables and Milestones, Alpha, Beta and Acceptance Testing, Quality and Reliability, Testing, Quality Assurance and Quality Control, Static and Dynamic Testing, Testing and Debugging, Limitations of Testing, The V Shaped Software Life Cycle Model, Graphical Representation, Relationship of Development and Testing Parts
Functional Testing: Boundary Value Analysis – Robustness Testing, Worst-Case Testing, Robust Worst-Case Testing, Applicability; Equivalence Class Testing – Creation of Equivalence Classes, Applicability; Decision Table Based Testing – Parts of the Decision Table, Limited Entry and Extended Entry Decision Tables, 'Do Not Care' Conditions and Rule Count, Impossible Conditions, Applicability; Cause-Effect Graphing Technique – Identification of Causes and Effects, Design of Cause-Effect Graph, Use of Constraints in Cause-Effect Graph, Design of Limited Entry Decision Table, Writing of Test Cases, Applicability

UNIT-II
Structural Testing: Control Flow Testing – Statement Coverage, Branch Coverage, Condition Coverage, Path Coverage; Data Flow Testing – Define/Reference Anomalies, Definitions, Identification of du and dc Paths, Testing Strategies Using du-Paths, Generation of Test Cases; Slice Based Testing – Guidelines for Slicing, Creation of Program Slices, Generation of Test Cases; Mutation Testing – Mutation and Mutants, Mutation Operators, Mutation Score
Software Verification: Verification Methods – Peer Reviews, Walkthroughs, Inspections, Applications; Software Requirements Specification (SRS) Document Verification – Nature of the SRS Document, Characteristics and Organization of the SRS Document, SRS Document Checklist; Software Design Description (SDD) Document Verification – Organization of the SDD Document, SDD Document Checklist; Source Code Reviews – Issues Related to Source Code Reviews, Checklist of Source Code Reviews; User Documentation Verification – Review Process Issues, User Documentation Checklist; Software Project Audit – Relevance Scale, Theory and Practice Scale, Project Audit and Review Checklist

UNIT-III
Creating Test Cases from Requirements and Use Cases: Use Case Diagram and Use Cases – Identification of Actors, Identification of Use Cases, Drawing of Use Case Diagram, Writing of Use Case Description; Generation of Test Cases from Use Cases – Generation of Scenario Diagrams, Creation of Use Case Scenario Matrix, Identification of Variables in a Use Case, Identification of Different Input States of a Variable, Design of Test Case Matrix, Assigning Actual Values to Variables; Guidelines for generating validity checks – Data Type, Data Range, Special Data Conditions, Mandatory Data Inputs, Domain Specific Checks; Strategies for Data Validity – Accept Only Known Valid Data, Reject Known Bad Data, Sanitize All Data; Database Testing
Selection, Minimization and Prioritization of Test Cases for Regression Testing: What is Regression Testing – Regression Testing Process, Selection of Test Cases; Regression Test Cases Selection – Select All Test Cases, Select Test Cases Randomly, Select Modification Traversing Test Cases; Reducing the Number of Test Cases – Minimization of Test Cases, Prioritization of Test Cases; Risk Analysis – What is Risk, Risk Matrix; Code Coverage Prioritization Technique – Test Cases Selection Criteria, Modification Algorithm, Deletion Algorithm
Software Testing Activities: Levels of Testing – Unit Testing, Integration Testing, System Testing, Acceptance Testing; Debugging – Why Debugging is so Difficult, Debugging Process, Debugging

Approaches, Debugging Tools; Software Testing Tools – Static Software Testing Tools, Dynamic Software Testing Tools, Process Management Tools; Software Test Plan

UNIT-IV

Object Oriented Testing: What is Object Orientation – Classes and Objects, Inheritance, Messages, Methods, Responsibility, Abstraction, Polymorphism, Encapsulation, What is Object Oriented Testing – What is a Unit, Levels of Testing; Path Testing, Activity Diagram, Calculation of Cyclomatic Complexity, Generation of Test Cases; State Based Testing – What is a State Machine, State Chart Diagram, State Transition Tables, Generation of Test Cases; Class Testing – How Should We Test a Class, Issues Related to Class Testing, Generating Test Cases

Metrics and Models in Software Testing: Software Metrics – Measure, Measurement and Metrics, Applications, Categories of Metrics – Product Metrics for Testing, Process Metrics for Testing; Object Oriented Metrics Used in Testing – Coupling Metrics, Cohesion Metrics, Inheritance Metrics, Size Metrics; What Should We Measure During Testing – Time, Quality of Source Code, Source Code Coverage, Test Case Defect Density, Review Efficiency; Software Quality Attributes Prediction Models – Reliability Models, An Example of Fault Prediction Model in Practice, Maintenance Effort Prediction Model

Automated Test Data Generation: What is Automated Test Data Generation – Test Adequacy Criteria, Static and Dynamic Test Data Generation; Approaches to Test Data Generation – Random Testing, Symbolic Execution, Dynamic Test Data Generation; Test Data Generation using Genetic Algorithm – Initial Population, Crossover and Mutation, Fitness Function, Selection, Algorithm for Generating Test Data; Test Data Generation Tools

Text Book:
1. YogeshSingh , "Software Testing" , Cambridge University Press.

Reference Books:
1. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", 4E, CRC Press.
2. Boris Beizer, "Software Testing Techniques", 2E, Dreamtech Press.
3. A.P. Mathur, "Fundamentals of Software Testing", Pearson.
4. S. Desikan& G. Ramesh, "Software Principals and Practices", Pearson.
5. G.J. Myers, T. Badgett, C. Sandler, "The Art of Software Testing", 3E, Wiley India.

MCA 524
Compiler Design

UNIT-I
Introduction to Compiler & Lexical Analysis: Introduction of Compiler, Major data Structure in compiler, BOOT Strapping, Compiler structure: analysis-synthesis model of compilation, various phases of a compiler, Lexical analysis: Input buffering , Specification & Recognition of Tokens, LEX.

UNIT-II
Syntax analysis: CFGs, Top down parsing, Brute force approach, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence parsing, LR parsers (SLR,LALR, LR).

UNIT-III
Syntax directed definitions: Construction of Syntax trees, Bottom up evaluation of S-attributed definition, L-attribute definition, Top down translation, Bottom Up evaluation of inherited attributes Recursive Evaluation, Analysis of Syntax directed definition.
Intermediate code generation: Declarations, Assignment statements, Boolean expressions, Case statements.

UNIT-IV
Type Checking & Run Time Environment: Type checking: type system, specification of simple type checker.
Run time Environment: storage organization, Storage allocation strategies, parameter passing, dynamic storage allocation, and Symbol table.
Introduction to Code optimization: sources of optimization of basic blocks, dead code elimination, loop optimization, Introduction to global data flow analysis, Code Improving transformations, peephole optimization.
Code Generation: Issues in the design of code generator, Basic block and flow graphs, Register allocation and assignment, DAG representation of basic blocks.

Text Books:
1. A. V. Aho, R. Sethi, and J. D. Ullman, "Compilers: Principles, Techniques and Tools", Pearson Education
2. Raghavan, "Compiler Design", TMH Pub.

Reference Books:
1. Louden, "Compiler Construction: Principles and Practice", Cengage Learning
2. A. C. Holub, "Compiler Design in C", Prentice-Hall Inc., 1993.
3. Mak, "Writing compiler & Interpreters", Willey Pub.

MCA 526
Discrete Mathematics

UNIT-I
Mathematical Logic: Proposition (Compound Propositions, Tautology, Contradiction, Satisfiable, Equivalent, and Dual), Equivalences, Well-formed Formula, Logical implication, Inference with rules, Predicate and Quantifiers, Proofs, Mathematical Induction.

UNIT-II
Sets, Relations and Functions:Sets, Types of sets, Set operations, Inclusion and Exclusion, relation, Binary Relations, Equivalence Relations and Partitions, Partial Ordering Relations, Partially ordered set (POSET), Hasse Diagram, Lattice, Functions, Types of functions. Algebraic System, Semigroups, monoids, Groups, Abelian groups, subgroups, cyclic groups.

UNIT-III
Graphs theory: Graph and its types, Special graphs (null graph, cycle graph, complete graph, Bipartite graph, regular graph, N-cube), Sub graph, Adjacency Matrix, Isomorphism, Complement of graph, directed and connected graph, walk, closed walk, paths, cycles, Eulerian and Hamiltonian graphs, cut edge, cut vertex, cut set, edge and vertex connectivity.

UNIT-IV
Counting Principles: Basic counting techniques, the rules of Sum and Product, Permutations, Combinations, Generation of Permutations and Combinations.Recurrence Relations, Linear recurrence relations with constant coefficients and their solving techniques.

Text Books:-
1. 1. J.P Trembley, "Discrete mathematical Structures with Applications to Computer Science", TMH, New York.

Reference Books:-
1. C.L. Liu, D.P Mohapatra, "Elements of Discrete Mathematics: A Computer oriented Approach", 3E, TMH.
2. Kenneth H. Rosen, "Discrete Mathematics", 7E , TMH,
3. Seymour Lopshutz, M. Lipson, "Discrete Mathematics", TMH.
4. Richard Hammack, "Book of Proofs", VCU Mathematics textbook series.
5. S. Kaushik, "Logic and Prolog Programing", New Age International.

CSI 601
Research Methodology

UNIT-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.
Effective literature studies approaches, analysis Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT-II

Statistical Methods of Analysis Descriptive Statistics: Mean, Median, Mode, Range, Standard Deviation, regression and correlation analysis. Inferential Statistics: Estimation of parameters, Hypothesis, Types of Hypothesis, Testing of Hypothesis, Test of Normality, Introduction to Parametric and Non Parametric tests. Test of significance: t-test, chi square test, ANOVA(1-way, 2-way), Repeated Measures ANOVA, ANCOVA, α-correction

UNIT-III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc.

Text Books:-
1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners",2nd Edition.
2. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Reference Books:-
1. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction" .
2. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.

MCA 527

Python Programming

UNIT-I

Introduction to Python Programming Language: History and Origin of Python Language, Installing Python, setting up Path and Environment Variables, Running Python, First Python Program. Python Data Types & Input/ Output: Keywords, Identifiers, Python Statement, Indentation, Documentation, Variables, Multiple Assignment, Understanding Data Type, Data Type Conversion, Python Input and Output Functions, Import command. Operators and Expressions: Operators in Python, Expressions, Precedence, Associativity of Operators, Non Associative Operators.

UNIT-II

Control Structures: Decision making statements, Python loops, Python control statements. Python Native. Data Types: Numbers, Lists, Tuples, Sets, Dictionary, Functions & Methods of Dictionary, Strings (in detail with their methods and operations).

UNIT-III

Python Functions: Functions, Advantages of Functions, Built-in Functions, User defined functions,Anonymous functions, Pass by value Vs. Pass by Reference, Recursion, Scope and Lifetime of Variables. Python Modules: Module definition, Need of modules, creating a module, Importing module, Path Searching of a Module, Module Reloading, Standard Modules, Python Packages.

UNIT-IV

Exception Handling: Exceptions, Built-in exceptions, Exception handling, User defined exceptions in
Python. File Management in Python: Operations on files (opening, modes, attributes, encoding, closing), read() & write() methods, tell() & seek() methods, renaming & deleting files in Python, directories in Python. Classes and Objects: The concept of OOPS in Python, Designing classes, Creating objects, Accessing attributes, Editing class attributes, Built-in class attributes, Garbage collection, Destroying objects.

Text Books:
1. R. S. Salaria, "Programming in Python", Khanna Publishing.
2. A. Martelli, A. Ravenscroft, S. Holden, "Python in a Nutshell", OREILLY.

Reference Books:
1. PoojaSharma,"Programming in Python", BPB Publications.
2. R. NageswaraRao, "Core Python Programming", 2E, Dreamtech.
3. Martin C. Brown, "Python, The complete Reference", McGraw Hill.

MCA 531
Basics of Web Designing

UNIT-I
HTML-Introduction, Basic Formatting Tags, color coding, Grouping Using Div Span, lists, images.

UNIT-II
HTML- Hyperlinks, Tables, frames, forms, headers.

UNIT-III
Introduction to Cascading Style Sheets, Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling(Background, Text Format, Controlling Fonts), Working with block elements and objects, Working with Lists and Tables, CSS Id and Class (Introduction, Border properties, Padding Properties, Margin properties),

UNIT-IV
CSS Advanced(Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector), CSS Color, Creating page Layout and Site Designs.

Text Books:
1. Kogent Learning Solutions Inc., "HTML 5 in simple steps", Dreamtech Press.
2. Steven M. Schafer, "HTML, XHTML, and CSS Bible", 5ed Wiley India

Reference Books:
1. Ian Pouncey, Richard York, "Beginning CSS: Cascading Style Sheets for Web Design", 5ed Wiley India
2. John Duckett, "Beginning HTML, XHTML, CSS, and JavaScript", Wiley India.

MCA 532
Network Administration

UNIT-I
Introduction to Computer Networks: OSI & TCP/IP Model
Physical Media: UTP, Fiber and Wireless Media
LAN Architecture: 10/100/1000/10G Ethernet

UNIT-II
Switching & Routing: Layer 2 & Layer 3 switching; Routing; VLAN; Cisco L2 and L3 Switch Configuration
IP Addressing: IPv4 Addressing and Sub-netting; DHCP Configuration; IPv6
Wireless LAN: 802.11 a/b/g/n/ac WiFi; Access Point and Wireless Router configuration
Internet Architecture: ISP Architecture; DNS Resolution; BGP Routing; Content Mirroring

UNIT-III
Internet Applications: DNS; Web; Mail; Proxy; NTP
Perimeter Security: Firewall; UTM
Network Security: LAN and WLAN Security issues; IP Spoofing; Dictionary Attack; DoS

UNIT-IV
DDoS Attack; Rogue/Misconfigured/External APs
Network Troubleshooting: ping, traceroute, nslookup, dig, tcpdump
Network Monitoring: SNMP; MRTG

Text Books:
1. CCENT/CCNA ICND1 (Official Exam Certification Guide, Second Edition)By – Wendell Odom.
2. Hunt, Craig, "TCP/IP network administration", Vol. 2. " O'Reilly Media, Inc.", 2002.

Reference Book:
1. Bergstra, Janand Mark Burgesseds,"Handbook of network and system administration", Elsevier, 2011.

MCA 533
Cyber Security

UNIT-I
Cyber security Fundamentals: Introduction to Cyberspace, Cyber security, need of cyber security. Types of Malware:Worms, Viruses, Spyware, Trojans.Cyber Security Breaches: Phishing, Identity Theft, Harassment etc.

UNIT-II
Types of Cyber Attacks: Password Attacks, Denial of Service Attacks, Passive Attack, Penetration Testing.
Prevention Tips: Craft a Strong Password, Two-Step Verification, Download with care, Question Legitimacy of Websites.

UNIT-III
Cryptography and Network Security: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography.

UNIT-IV
Cyber Forensics: Introduction to Cyber Forensics, Handling Preliminary Investigations, Controlling an Investigation, Conducting disk-based analysis, Investigating Information-hiding, Scrutinizing E-mail, Validating E-mail header information, Tracing Internet access, Tracing memory in real-time.

Text Book:
   1. Zach Webber, "Cyber Security".

MCA534

Object Oriented Programming Using C++

UNIT-I:
Data Types, Identifiers, Variables Constants and Literals, Basic input/output statements, Operators, Expressions, Type conversion, Control structures, Arrays, Strings, Structures and Pointers.
Functions: Basic, Recursive functions, Overloaded functions, inline functions, function with default arguments.

UNIT-II:
Introduction to classes and objects, Access specifiers, Constructor, Destructor, Function overloading, Operator overloading, friend functions.

UNIT-III:
Inheritance-Concept of derived and base class, accessing base class members, Single inheritance, multiple inheritance, hierarchical inheritance, multilevel inheritance, hybrid inheritance, constructor in derived classes.
Virtual Functions-Functions accessed with pointers, virtual member functions accessing with pointers, late binding, pure virtual functions, abstract classes, virtual base classes.

UNIT-IV:
Exception handling.
Working with files- classes for file stream operations, opening and closing a file, detecting end-of-file, file modes, file pointers and their manipulations, sequential input and output operations, updating a file, error handling.
Command line arguments.

Text Book:
1. Balagurusamy, E. "Object Oriented Programming with C++", 8E , Tata McGraw Hill.

Reference Book:
1. Herbert Schildt, " C++ The Complete Reference " , 4E , TMH Publication.
2. RobertLafore, "Object Oriented Programming in Turbo C++", 4E ,Galgotia Publications Pvt. Ltd.

MCA 536
Java Programming

UNIT-1
Object oriented programming, features of java, general structure of java program, sample program, lexical issues, data types, variables, type conversion and casting, arrays & strings, operators and expressions, controls statements.
String handling: String class, String class constructors, String class methods,StringBuffer class,StringBuffer class constructors, StringBuffer class methods.

UNIT-II   Class
fundamentals & objects, Methods, constructors, this keyword, garbage collection, overloading methods & constructors, using object as arguments, returning objects, recursion, nested and inner classes, inheritance, using super, method overriding, dynamic method dispatch, using abstract classes, using final with inheritance.
Interfaces: Defining interfaces, extending interfaces, implementing interfaces, accessing interface variables.

UNIT-III
Packages: Introduction, java API packages, Using system packages, naming conventions, creating packages, accessing a package, using a package, adding a class to a package.
Multithreading: Introduction, crating threads, creating multiple threads, thread priorities, synchronization, in thread communication, suspending, resuming and stopping threads.
Exception handling: Introduction, exception types, uncaught exceptions, using try, catch, throw and throws, java's built in exceptions, creating own exception subclasses.
Applets programming: introduction, applet architecture, an applet Skelton, the HTML APPLET tag, passing parameters to applet.

UNIT-IV
Collections: Array List, Linked List, collections Methods, Stack, Sets, Maps.
Java Swings: Java Foundation Classes, Hierarchy of Java Swing classes, Swing components (Container: Window, Frame ,Dialog, Panel and Applet; JComponent: JLabel, JList, JTable, JComboBox, JSlider, JMenu, Abstract Button, JButton).

Text book:
1. Herbert Schildt, "The Complete Reference", 11E ,Tata McGraw Hill.

Reference Books:
1. Cay S. Horstmann, Gary Cornell," Core Java", Pearson.
2. R. NageswaraRao, "Core Java an integrated approach", Dreamtech Press
3. James R. Levenick , "Simply JAVA :An Introduction to JAVA programming ",Firewall Media Publication New,Delhi.
4. E Balaguruswamy," Programming with Java", Tata McGraw Hill.

MCA 537
Android App Development

UNIT-I
Android: Introduction, History of Android, Android Features, OSS, OHA, Android Versions and compatibility, Android devices, Prerequisites to learn Android, Android Architecture: Android Stack, Linux Kernel, Android Runtime, Dalvik VM, Application Framework, Android emulator, Android applications.

UNIT-II
Android development: Java, Android Studio, Eclipse, Virtualization, APIs and Android tools, Debugging with DDMS, Android File system, Working with emulator and smart devices, A BasicAndroid Application, Deployment.

UNIT-III
Android Services: Simple services, Binding and Querying the service, Executing services.
Broadcast Receivers: Creating and managing receivers, Receiver intents, ordered broadcasts.
Content Providers: Creating and using content providers, Content resolver. Working with databases: SQLite, coding for SQLite using Android, Sample database applications, Data analysis.

UNIT-IV
Android User Interface: Android Layouts, Attributes, Layout styles, Linear, Relative, Table, Grid, Frame. Menus: Option menu, context menu, pop-up menu. Lists and Notifications: creation and display. Input Controls: Buttons, Text, Fields, Checkboxes, alert, dialogs, Spinners, progress bar.

Text Books:
1. Barry Burd, "Android Application Development – All-in-one for Dummies", 2nd Edition,Wiley India, 2016.
2. Lauren Darcey, Shane Conder, "Sams Teach Yourself Android Application Development in 24 hours", 2nd edition, Pearson Education, 2013.

Reference Book:
1. Paul Deitel, Harvey Deitel, Alexander Wald, " Android 6 for Programmers – An App-driven Approach", 3rd edition, Pearson education, 2016.

MCA 538
NoSQL Databases

UNIT-I
Define what a NoSQL database is, Why we need NoSQL and how is it different from traditional databases. Learn about the various tools available such as MongoDB, Cassandra, HBase etc. Explore the principles of NoSQL using elementary examples in MongoDB.

UNIT-II
Develop an understanding of the available data models: value stores, document databases, column-family stores, graph databases. Understand the basic storage architecture in a distributed environment – column oriented databases, nested maps of key/value pairs, Hbase distributed storage architecture.

UNIT-III
The set of essential operations – CRUD refers to Create, Read, Update and Delete operations in the context of a NoSQL database environment. Practical experience of CRUD operations for document databases using MongoDB.

UNIT-IV
Developing Web Application with NOSQL and NOSQL Administration: Php and MongoDB, Python and MongoDB, Creating Blog Application with PHP,NOSQL Database Administration.

Text Books:
1. ShashankTiwari, "Professional NoSQL", John Wiley and Sons.
2. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide tothe Emerging World of Polyglot Persistence", Addison-Wesley.

MCA 401
Fundamental of ICT

UNIT-I
Introduction: Computer, Data Processing, Computer System Characteristics, Evolution of Computers, Capabilities and Limitations, Generations of computers, Block diagram of computer, Basic components of a computer system- Input unit, Output unit, Storage unit, ALU, Control unit, Central Processing unit; Number Systems- Non-positional number system, Positional number system, Decimal Number system, Binary number system, Octal number system, Hexadecimal number system.

UNIT-II
Memory: Main memory organization, Main memory capacity, RAM, ROM, PROM, EPROM, Cache Memory, Secondary storage devices: Sequential access devices- Magnetic tape; Direct access devices- Magnetic disks, Floppy disks, Optical disks, Types of Optical disks: CD-ROM, CD-R, CD-RW, DVD.
Input devices: Keyboard, Pointing Devices-Mouse, Touch screens, Joystick, Electronic pen, Trackball, Scanning devices: Optical Scanners, OCR, OMR, Bar code reader, MICR, Electronic card reader, Image capturing devices, Digital cameras.
Output devices: Monitors- CRT, LCD, Printers-Dot matrix, Inkjet, Laser; Plotters, Screen image projector.

UNIT-III
Introduction: Software, Relationship between Hardware and Software, Types of Software-System Software, Application Software; System Software-Operating System, Utility Program; Programming Languages-Machine, Assembly, High Level; Assembler, Compiler, Interpreter.

UNIT-IV
Data Communication & Computer Networks, Basic elements of a communication system, Data Transmission modes-Simplex, Half duplex, Full duplex; Data Transmission speed-Narrowband, Voice band, Broadband; Data Transmission media-Twisted Pair Wire, Coaxial cable, Optical fibers; Modems, Types of Network-LAN, WAN, MAN; Internet, World Wide Web, Web Browsers.

Text Book:
1. Pradeep K. Sinha, PritiSinha, "Computer Fundamentals", 6E ,BPB Publications.

Reference Books:
1. Rajaraman, V., "Fundamental of Computers", Fifth Edition, Prentice Hall India, New Delhi.
2. E. Balagurusamy, "Introduction to Computers (Special Indian Edition)", Tata McGraw Hill.

MCA 402
C Programming

UNIT-I

Overview of C- General Structure of C Program, C compilers, Editing, Compiling & , Running of a C program Data types, Constants and Variables, Operators and expressions, Storage Classes, Different types of expressions and their Evaluation, Conditional Expression, Assignment statement, Enumerated data type, Redefining/ Creating data types, Library functions, Type casting.
Input/Output- Unformatted and formatted I/O Functions.

UNIT-II

Control Statements- Decision making using if, if-else, elseif and switch statements, Looping using for, while and do-while statements, Transferring Program controlling break and continue statements, Programming examples to illustrate the use of these control statements.
Functions- Defining a function, Local variables, return statement, invoking a Function, specifying and passing arguments to a function, Functions returning non Integer, External, static, and register variable, block structure, initialization and recursion.

UNIT-III

Array & strings- Introduction to arrays, Declaring arrays, Initializing, arrays, Processing arrays, Pointers to arrays, Passing arrays as arguments to functions, Introduction to strings, Pointers to strings, Passing strings and Arrays of strings as arguments to a function, Programming examples to illustrate the use of arrays and strings.
Pointers- Definition, Need of pointers, declaring Pointers, Accessing Values via Pointers, Pointer arithmetic, Types of pointers, Programming examples to illustrate the use of pointers.

Unit-IV

Structures- Declaring a structure type, Declaring Variables of structure type, Initializing Structures, Accessing Elements of structures, arrays of structures, nested structures, Pointers to structures Programming examples to illustrate the use of Structures. File Handling.

Text Books:
1. E. Balagurusamy, "Programming in ANSI C", 8E ,Tata McGraw Hill.

Reference Books:
1. R S Salaria, Application in C, Khanna book publishing.
2. YashwantKanetakar, "Let us C" BPB.
3. Kerninghan B.W. & Ritchie D.M. "The C Programming Language" Prentice-Hall.
4. Mullish Cooper, "The Spirit of C" Jaico Publishing House.
5. Byron Gottfried, "Programming with C", Schaum's Outlines, Tata McGraw Hill.
6. Herbert Schildt, C: The complete reference, Tata mcCgraw hill.

Proposed List of Courses for the Course work in PhD Computer Science & Informatics in the Light of NEP 2020*

S. No.	Course Code	Course Name	Credit
1.	CSI 651	Research Methodology	4
2.	CSI 652	Big Data Analytics	4
3.	CSI653	Internet of Things	4
4.	CSI 654	Data Mining & Machine Learning	4
5.	CSI 655	Cloud computing Concepts	4
6.	CSI RPE	Research And Publication Ethics	2

*University has issued the guidelines for the implementation of NEP 2020 which are subject to the approval from Academic Council and Executive Council, CUHP.

CSI 651
Research Methodology

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Effective literature studies approaches, analysis Plagiarism, and Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Statistical Methods of Analysis Descriptive Statistics: Mean, Median, Mode, Range, Standard Deviation, regression and correlation analysis. Inferential Statistics: Estimation of parameters, Hypothesis, Types of Hypothesis, Testing of Hypothesis, Test of Normality, Introduction to Parametric and Non Parametric tests. Test of significance: t-test, chi square test, ANOVA(1-way, 2-way), Repeated Measures ANOVA, ANCOVA, α-correction

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc.

Books & References:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
- Mayall, "Industrial Design", McGraw Hill, 1992.
- Niebel, "Product Design", McGraw Hill, 1974.
- Asimov, "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

CSI 652
Big Data Analytics

Introduction to Big Data: Platform – Traits of Big data -Challenges of Conventional Systems - Web Data – Evolution of Analytic Scalability - Analytic Processes and Tools - Analysis vs Reporting - Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions - ReSampling - Statistical Inference - Prediction Error.

Data Analysis: Regression Modeling - Multivariate Analysis - Bayesian Modeling - Inference and Bayesian Networks - Support Vector and Kernel Methods - Analysis of Time Series: Linear Systems Analysis - Nonlinear Dynamics - Rule Induction - Neural Networks: Learning And Generalization - Competitive Learning - Principal Component Analysis and Neural Networks - Fuzzy Logic: Extracting Fuzzy Models from Data - Fuzzy Decision Trees - Stochastic Search Methods.

Mining Data Streams: Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.
Frequent Itemsets And Clustering: Mining Frequent Item sets - Market Based Model – Apriori Algorithm – Handling Large Data Sets in Main Memory – Limited Pass Algorithm – Counting Frequent Itemsets in a Stream – Clustering Techniques – Hierarchical – K-Means – Clustering High Dimensional Data – CLIQUE and PROCLUS – Frequent Pattern based Clustering Methods – Clustering in NonEuclidean Space – Clustering for Streams and Parallelism.

Frameworks And Visualization: MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Visualizations - Visual Data Analysis Techniques - Interaction Techniques; Systems and Analytics Applications - Analytics using Statistical packages-Approaches to modeling in Analytics – correlation, regression, decision trees, classification, association Intelligence from unstructured information-Text analytics-Understanding of emerging trends and technologies-Industry challenges and application of Analytics.

Books& References:

- Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
- AnandRajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
- Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
- Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007
- Pete Warden, "Big Data Glossary", O'Reilly, 2011.

CSI 653
Internet of Things

Introduction to IoT: Sensing, Actuation, Networking basics, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Communication models & APIs.

M2M to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics. Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT.
M2M vsIoT An Architectural Overview–Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. Reference Architecture and Reference Model of IoT

IoT Reference Architecture- Getting Familiar with IoT Architecture, Various architectural views of IoT such as Functional, Information, Operational and Deployment. Constraints affecting design in IoT world- Introduction, Technical design Constraints.
Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT application.

Developing IoT solutions: Introduction to Python, Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.

Books & References:

- Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-onApproach)", 1E, VPT
- Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press
- Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications
- CunoPfister, Getting Started with the Internet of Things, O"Reilly

CSI 654
Data Mining & Machine Learning

Introduction to Data mining, types of Data, Data Quality, Data Processing, Measures of Similarity and Dissimilarity, Exploring Data: Data Set, Summary Statistics, Visualization. Classification: Basic Concepts, Decision Trees, Nearest Neighborhood classifier, Bayesian Classifier, Support vector Machines: Linear SVM, Separable and Non Separable case.

Association Analysis: Problem Definition, Frequent Item-set generation, rule generation, compact representation of frequent item sets, FP-Growth Algorithms.
Clustering: Over view, K-means, Agglomerative Hierarchical clustering, DBSCAN, Cluster evaluation: overview, Unsupervised Cluster Evaluation using cohesion and separation, using proximity matrix, Scalable Clustering algorithm.

Overview and Introduction to Bayes Decision Theory: Machine intelligence and applications, pattern recognition concepts classification, regression, feature selection, supervised learning class conditional probability distributions, Examples of classifiers bayes optimal classifier and error, learning classification approaches.
Linear machines: General and linear discriminants, decision regions, single layer neural network, linear separability, general gradient descent, perceptron learning algorithm, mean square criterion and widrow-Hoff learning algorithm; multi-Layer perceptrons: two-layers universal approximators, backpropagation learning, on-line, off-line error surface, important parameters.

Learning decision trees: Inference model, general domains, symbolic decision trees, consistency, learning trees from training examples entropy, mutual information, ID3 algorithm criterion, C4.5 algorithm continuous test nodes, confidence, pruning, learning with incomplete data.
Instance-based Learning: Nearest neighbor classification, k-nearest neighbor, nearest neighbor error probability, Machine learning assessment and Improvement: Statistical model selection, structural risk minimization, bootstrapping, bagging, boosting. Support Vector Machines

Books & References:

- Jiawei Han and MichelineKamber, "Data Mining: Concepts and Techniques", 2E, Morgan Kaufmann, 2006.
- E. Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2006.
- T. M. Mitchell, "Machine Learning", McGraw-Hill, 1997.
- ArunPujari, "Data Mining Techniques", University Press, 2001
- D. Hand, H. Mannila and P. Smyth, "Principles of Data Mining", Prentice-Hall of India, 2006
- G.K. Gupta, "Introduction to Data Mining with Case Studies", Prentice-Hall of India, 2006

CSI 655
Cloud Computing Concepts

Overview of Computing Paradigms: Recent Trends in Computing: Distributed Computing, Cluster Computing, Grid Computing, Utility Computing, Cloud Computing, Evolution of Cloud Computing: Migrating into a Cloud

Cloud Computing Basics: Cloud Computing Overview; Characteristics; Applications; Benefits; Limitations; Challenges, SOA; Cloud Computing Service Models: Infrastructure as a Service; Platform as a Service; Software as a Service, Cloud Computing Deployment Models: Private Cloud; Public Cloud; Community Cloud; Hybrid Cloud, Major Cloud Service providers

Virtualization Concepts: Overview of Virtualization Technologies, Types of Virtualization, Benefits of Virtualization, Hypervisors VM Provisioning & Migration: VM Lifecycle, VM Provisioning Process, VM Migration Techniques

Scheduling in Cloud: Overview of Scheduling problem, Different types of scheduling, Scheduling for independent and dependent tasks, Static vs. Dynamic scheduling, Optimization techniques for scheduling

Cloud Storage: Overview; Storage as a Service, Benefits and Challenges, Storage Area Networks(SANs), Case Study of Amazon S3

Cloud Security: Infrastructure Security: Network Level Security, Host Level Security and Application Level Security; Data Security: Data Security & Privacy Issues; Identity & Access Management; Legal Issues in Cloud Computing

Mobile Cloud Computing: Overview of Mobile Cloud Computing, Advantages, Challenges, Using Smartphones with the Cloud, Offloading techniques - their pros and cons, Mobile Cloud Security.

SLA Management: Overview of SLA, Types of SLA, SLA Life Cycle, SLA Management Process

Books & References:

- RajkumarBuyya, James Broberg, AndrzejGoscinski, " Cloud Computing: Principles and Paradigms", Wiley, 2011
- Barrie Sosinsky: Cloud Computing Bible, Wiley, 2011.
- Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, "Cloud Computing: A Practical Approach", McGraw Hill, 2010.
- Judith Hurwitz, Robin Bloor, Marcia Kaufman,FernHalper, "Cloud Computing for Dummies", Wiley, 2010.
- BorkoFurht, Armando Escalante , "Handbook of Cloud Computing", Springer, 2010.

Course Code: RPE
Course Name: Research & Publication Ethics

PHILOSOPHY AND ETHICS

Introduction to philosophy: definition, nature and scope, concept, branches.

Ethics: definition, moral philosophy, nature of moral judgments and reactions.

SCIENTIFIC CONDUCT

1. Ethics with respect to science and research.

2. Intellectual honesty and research integrity.

3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP).

4. Redundant publications: duplicate and overlapping publications, salami slicing.

5. Selective reporting and misrepresentation of data.

PUBLICATION ETHICS

1. Publication ethics: definition, introduction and importance

2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.

3. Conflicts of interest

4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types

5. Violation of publication ethics, authorship and contributor ship

6. Identification of publication misconduct, complaints and appeals

7. Predatory publishers and journals

PRACTICE OPEN ACCESS PUBLISHING

1. Open access publications and initiatives.

2. SHERPA/ROMEO online resource to check publisher copyright &selfarchiving policies.

3. Software tool to identify predatory publications developed by SPPU .

4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

PUBLICATION MISCONDUCT

A. Group Discussions

1. Subject specific ethical issues, FFP, authorship

2. Conflicts of interest

3. Complaints and appeals: examples and fraud from India and abroad.

B. Software tools Use of plagiarism software like Turnitin, Urkund and other open source software tools

DATABASES AND RESEARCH METRICS

A. Databases

1. Indexing databases

2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics

1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score.

2. Metrics: h-index, g index, i10 index, altmetrics.

Books & References:

- MiroTodorovich, Paul Kurtz& Sidney Hook, "The Ethics of Teaching and Scientific Research".

- Barbara H. Stanley, Joan E. Sieber& Gary B. Melton, "Research Ethics: A Psychological Approach".

- Jeffrey A. Gliner, George A. Morgan, "Research Methods in Applied Settings: An Integrated Approach to Design and Analysis", Lawrence Erlbaum Associates, 2000.

- Joel Lefkowitz, "Ethics and Values in Industrial-Organizational Psychology", Lawrence Erlbaum Associates, 2003.

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय

Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

शाहपुर परिसर, शाहपुर, ज़िला काँगड़ा (हि.प्र.) - 176206

Shahpur Parisar, Shahpur, Distt. Kangra (HP) - 176206

Website: www.cuhimachal.ac.in

File No.: CSI/1-13/RDC/CUHP/21/336

Dated: 07.11.2022

MINUTES OF THE MEETING

The **meeting** of the **1st Research Degree Committee (RDC)** of the **Department of Computer Science and Informatics**, School of Mathematics, Computers and Information Science, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur was held on **07th October, 2022** at **03:00 PM** onwards in the **Seminar Hall** of the Central University of Himachal Pradesh, Shahpur Parisar, Shahpur. **Dr. Pardeep Kumar, Dean (I/c)**, School of Mathematics, Computers and Information Sciences **chaired** the meeting.
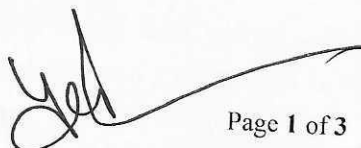
The following members attended the meeting:

1. **Dr. Pradeep Chouksey – Member**
   Head, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.
2. **Prof. Dhirendra Sharma - External Expert**
   Hony. Director- HPU, Campus Networking and Wi-Fi, Cyber Security, University Institute of Information Technology, Himachal Pradesh University, Shimla
3. **Dr. Vikram Singh - External Expert**
   Barnala Rd, Chaudhary Devi Lal University, Sirsa, Haryana

The **following members attended the meeting through online mode on Google meet** (meet.google.com/vaw-fdpe-guh):-

1. **Prof. Pardeep Kumar – Chairperson**
   Dean (I/c), School of Mathematics, Computers and Information Sciences, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.
2. **Prof. Vishal Goyal – External Expert**
   Department of Computer Science, Punjabi University, Patiala.
3. **Dr. Keshav Singh Rawat – Member (Research Supervisor)**
   Associate Professor & Head, Department of Computer Science and Information Technology, Central University of Haryana.

The **Chairperson** welcomed all the **Hon'ble members** of the RDC and **briefed** about the various **agenda items** to be **discussed** in the **meeting** which were **sent** in **advance** to all the members through e-mail including **External Experts**. After **detailed discussions** and **deliberations** on each **Agenda** item, the **following decisions** were taken:-

AGENDA ITEM NO. - CSI-RDC-1/22-1

To approve the Research Supervisors to the newly admitted Ph.D. Students of 2021 batch allotted by the Departmental Standing Committee (DSC).

Decision:

The Research Supervisor allotted to Ms. Neha Thakur, CUHP21RDCS01 admitted in Ph.D. in 2021 batch by the Departmental Standing Committee was discussed and approved (Annexure-I).

AGENDA ITEM NO. - CSI-RDC-1/22-2

To review the Research Proposal and Finalize the Topic of Research of Mr. Dheeraj Kumar, Roll No. CUHP20RDCS01 as per the recommendations of the Departmental Research Committee (DRC).

Decision:

The Research Proposal of Mr. Dheeraj Kumar under Roll No. CUHP20RDCS01 was reviewed on the basis of presentation made by Mr. Dheeraj Kumar, and "IoT and Cloud-driven Data Analytics for Airborne Diseases" was finalized as Topic of Research (Annexure-II).

AGENDA ITEM NO. - CSI-RDC-1/22-3

To approve the Research Synopsis of Mr. Dheeraj Kumar, Roll No. CUHP20RDCS01 as per the recommendations of the Departmental Research Committee (DRC

Decision:

The Research Synopsis of Mr. Dheeraj Kumar, under Roll No. CUHP20RDCS01 was approved as per the recommendations of the Departmental Research Committee as attached at Annexure-II.

AGENDA ITEM NO. - CSI-RDC-1/22-4

To review the Research Proposal and Finalize the Topic of Research of Mr. Girish Sharma, Roll. No. CUHP20RDCS02 as per the recommendations of the Departmental Research Committee (DRC).

Decision:

The Research Proposal of Mr. Girish Sharma, under Roll No. CUHP20RDCS02 was reviewed on the basis of presentation made by Mr. Girish Sharma, and "IoT and Cloud-driven Data Analytics for 3-D Printed Bioimplants" was finalized as Topic of Research (Annexure-III).

AGENDA ITEM NO. - CSI-RDC-1/22-5

To approve the Research Synopsis of Mr. Girish Sharma, Roll. No. CUHP20RDCS02 as per the recommendations of the Departmental Research Committee (DRC).

Decision:

The Research Synopsis of Mr. Girish Sharma, under Roll No. CUHP20RDCS02 was approved as per the recommendations of the Departmental Research Committee (Annexure-III).

AGENDA ITEM NO. - CSI-RDC-1/22-6

To approve the change of Research Supervisors of Mr. Manoj Dhiman, CUHP20RDCS03, and Ms. Neha Thakur, CUHP21RDCS01 as recommended by the Departmental Standing Committee (DSC).

Decision:

The requests of Mr. Manoj Dhiman, CUHP20RDCS03, and Ms. Neha Thakur, CUHP21RDCS01 to change of the Research Supervisors were discussed and approved (Annexure-IV).

AGENDA ITEM NO. - CSI-RDC-1/22-7

To review the research progress of Mr. Dheeraj Kumar, Roll No. CUHP20RDCS01 to make recommendations for upgradation of JRF to SRF.

Decision:

The Research Progress of Mr. Dheeraj Kumar, under Roll No. CUHP20RDCS01 was reviewed, and committee recommended the case of Mr. Dheeraj Kumar, Roll No. CUHP20RDCS01 for upgradation from JRF to SRF (Annexure-V).

AGENDA ITEM NO. - SRDM-RDC-1/22-8

Any other item with the permission of the Chair

Decision: No item was taken.

The meeting ended with a vote of thanks to the chair.

Approved online

Dr. Keshav Singh Rawat,
(Member & Research Supervisor)

7-11-2022
Dr. Vikram Singh
(External Expert)

Approved online

Prof. Vishal Goyal
(External Expert)

01-11-2022
Prof. Dhirendra Sharma
(External Expert)

7.11.22
Dr. Pradeep Chouksey
Head, DCSI (Member)

Prof. Pardeep Kumar
I/c Dean (Chairperson)

Respected Sir,

Please find attached herewith the Minutes of the 1st RDC meeting. You are hereby requested to approve minutes through e-mail.

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Established under Central Universities Act 2009)
शाहपुर परिसर, शाहपुर, ज़िला काँगड़ा (हि.प्र.) - 176206
Shahpur Parisar, Shahpur, Distt. Kangra (HP) - 176206
Website: www.cuhimachal.ac.in

File No.: CSI/1-13/RDC/CUHP/21/336   Dated: 07.11.2022

MINUTES OF THE MEETING

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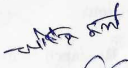
The following members attended the meeting:

1. **Dr. Pradeep Chouksey – Member**
   Head, Department of Computer Science and Informatics, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.
2. **Prof. Dhirendra Sharma - External Expert**
   Hony. Director- HPU, Campus Networking and Wi-Fi, Cyber Security, University Institute of Information Technology, Himachal Pradesh University, Shimla
3. **Dr. Vikram Singh - External Expert**
   Barnala Rd, Chaudhary Devi Lal University, Sirsa, Haryana

The following members attended the meeting through online mode on Google meet (meet.google.com/vaw-fdpc-guh):-

1. **Prof. Pardeep Kumar – Chairperson**
   Dean (I/c), School of Mathematics, Computers and Information Sciences, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur.
2. **Prof. Vishal Goyal – External Expert**
   Department of Computer Science, Punjabi University, Patiala.
3. **Dr. Keshav Singh Rawat – Member (Research Supervisor)**
   Associate Professor & Head, Department of Computer Science and Information Technology, Central University of Haryana.

The **Chairperson** welcomed all the **Hon'ble members** of the **RDC** and **briefed** about the various **agenda items** to be **discussed** in the **meeting** which were **sent** in **advance** to all the members through **e-mail** including **External Experts**. After **detailed discussions** and **deliberations** on each **Agenda** item, the **following decisions** were taken:-

Page **1** of **3**

AGENDA ITEM NO. - CSI-RDC-1/22-1

To approve the Research Supervisors to the newly admitted Ph.D. Students of 2021 batch allotted by the Departmental Standing Committee (DSC).

Decision:

The Research Supervisor allotted to Ms. Neha Thakur, CUHP21RDCS01 admitted in Ph.D. in 2021 batch by the Departmental Standing Committee was discussed and approved (Annexure-I).

AGENDA ITEM NO. - CSI-RDC-1/22-2

To review the Research Proposal and Finalize the Topic of Research of Mr. Dheeraj Kumar, Roll No. CUHP20RDCS01 as per the recommendations of the Departmental Research Committee (DRC).

Decision:

The Research Proposal of Mr. Dheeraj Kumar under Roll No. CUHP20RDCS01 was reviewed on the basis of presentation made by Mr. Dheeraj Kumar, and "IoT and Cloud-driven Data Analytics for Airborne Diseases" was finalized as Topic of Research (Annexure-II).

AGENDA ITEM NO. - CSI-RDC-1/22-3

To approve the Research Synopsis of Mr. Dheeraj Kumar, Roll No. CUHP20RDCS01 as per the recommendations of the Departmental Research Committee (DRC

Decision:

The Research Synopsis of Mr. Dheeraj Kumar, under Roll No. CUHP20RDCS01 was approved as per the recommendations of the Departmental Research Committee as attached at Annexure-II.

AGENDA ITEM NO. - CSI-RDC-1/22-4

To review the Research Proposal and Finalize the Topic of Research of Mr. Girish Sharma, Roll. No. CUHP20RDCS02 as per the recommendations of the Departmental Research Committee (DRC).

Decision:

The Research Proposal of Mr. Girish Sharma, under Roll No. CUHP20RDCS02 was reviewed on the basis of presentation made by Mr. Girish Sharma, and "IoT and Cloud-driven Data Analytics for 3-D Printed Bioimplants" was finalized as Topic of Research (Annexure-III).

AGENDA ITEM NO. - CSI-RDC-1/22-5

To approve the Research Synopsis of Mr. Girish Sharma, Roll. No. CUHP20RDCS02 as per the recommendations of the Departmental Research Committee (DRC).

Decision:

The Research Synopsis of Mr. Girish Sharma, under Roll No. CUHP20RDCS02 was approved as per the recommendations of the Departmental Research Committee (Annexure-III).

AGENDA ITEM NO. - CSI-RDC-1/22-6

To approve the change of Research Supervisors of Mr. Manoj Dhiman, CUHP20RDCS03, and Ms. Neha Thakur, CUHP21RDCS01 as recommended by the Departmental Standing Committee (DSC).

Decision:

The requests of Mr. Manoj Dhiman, CUHP20RDCS03, and Ms. Neha Thakur, CUHP21RDCS01 to change of the Research Supervisors were discussed and approved (Annexure-IV).

AGENDA ITEM NO. - CSI-RDC-1/22-7

To review the research progress of Mr. Dheeraj Kumar, Roll No. CUHP20RDCS01 to make recommendations for upgradation of JRF to SRF.

Decision:

The Research Progress of Mr. Dheeraj Kumar, under Roll No. CUHP20RDCS01 was reviewed, and committee recommended the case of Mr. Dheeraj Kumar, Roll No. CUHP20RDCS01 for upgradation from JRF to SRF (Annexure-V).

AGENDA ITEM NO. - SRDM-RDC-1/22-8

Any other item with the permission of the Chair

Decision: No item was taken.

The meeting ended with a vote of thanks to the chair.

Dr. Keshav Singh Rawat,
(Member & Research Supervisor)

Dr. Vikram Singh
(External Expert)

Prof. Vishal Goyal
(External Expert)

Prof. Dhirendra Sharma
(External Expert)

Dr. Pradeep Chouksey
Head, DCSI (Member)

Prof. Pardeep Kumar
I/c Dean (Chairperson)

Page **3** of **3**

धन्यवाद/Thanking you

सादर/regards,

गौरव चम्बयाल/GOURAV CHAMBYAL
डाटा एंट्री ऑपरेटर/Data Entry Operator
गणित, कंप्यूटर एवं सूचना विज्ञान स्कूल/School of Mathematics, Computers and Information Science
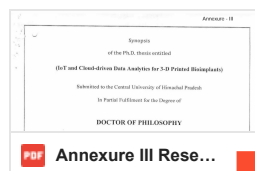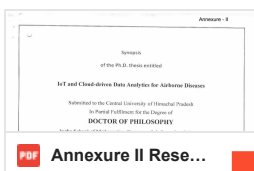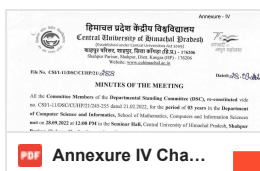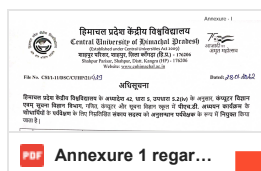**हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय/Central University of Himachal Pradesh**
शाहपुर परिसर, शाहपुर/Shahpur Parisar, Shahpur
मोबाइल/Mobile: +91- 9418555980
ई-मेल/ E-mail: gourav.cuhimachal@hpcu.ac.in

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5 Attachments • Scanned by Gmail

| PDF Annexure 1 regar… | PDF Annexure IV Cha… | PDF Annexure II Rese… | PDF Annexure III Rese… |

Gourav Chambyal <gourav.cuhimachal@hpcu.ac.in>
to Vishal
Nov 7, 2022, 4:55 PM (11 days ago)

Respected sir,
Please find attached herewith the Remuneration Form for the 1st RDC meeting held on 07.11.2022.
You are hereby requested to kindly fill the form and put your signatures (on 02 page, two places) and send the scan copy to me.

धन्यवाद/Thanking you

सादर/regards,

गौरव चम्बयाल/GOURAV CHAMBYAL
डाटा एंट्री ऑपरेटर/Data Entry Operator
गणित, कंप्यूटर एवं सूचना विज्ञान स्कूल/School of Mathematics, Computers and Information Science
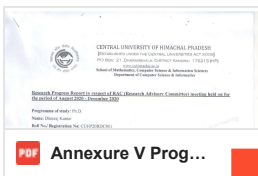हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय/Central University of Himachal Pradesh
शाहपुर परिसर, शाहपुर/Shahpur Parisar, Shahpur
मोबाइल/Mobile: +91- 9418555980
ई-मेल/ E-mail: gourav.cuhimachal@hpcu.ac.in

One attachment • Scanned by Gmail

PDF F-2 - TA claim - N…

Vishal Goyal(विशाल गोयल)
to Keshav, Keshav, dr.pchouksey, hod_csi, Vikram, vikramsingh, vikramsinghcdu, dhirendra, me
Nov 7, 2022, 5:29 PM (11 days ago)

I hereby endorse the meeting proceedings.

Dr. Keshav Rawat
to me, vishal.pup, Keshav, dr.pchouksey, hod_csi, vikramsinghkuk, vikramsingh, vikramsinghcdu, dhirendra.sharma
Nov 7, 2022, 8:28 PM (11 days ago)

The minutes of the RDC meeting are approved from my side.

--
Dr. Keshav Singh Rawat
Head & Associate Professor
Computer Science & Information Technology,
Central University of Haryana

Thanks a lot. | Approved. | I will attend the meeting.

Reply | Reply all | Forward

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
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आज़ादी का
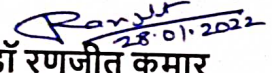अमृत महोत्सव

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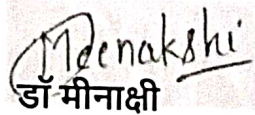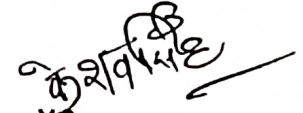
Dated: 28.01.2022

अधिसूचना

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय के अध्यादेश 42, धारा 5, उपधारा 5.2(iv) के अनुसार, कंप्यूटर विज्ञान एवम् सूचना विज्ञान विभाग, गणित, कंप्यूटर और सूचना विज्ञान स्कूल में पीएच.डी. अध्ययन कार्यक्रम के शोधार्थियों के पर्यवेक्षण के लिए निम्नलिखित संकाय सदस्य को अनुसन्धान पर्यवेक्षक के रूप में नियुक्त किया जाता है |

क्र. सं.	शोधार्थी का नाम	पिता का नाम	विश्वविद्यालय रोल नंबर	पर्यवेक्षक का नाम
1.	Neha Thakur	Mahinder Singh	CUHP21RDCS01	Dr. Keshav Singh Rawat

यह अधिसूचना अनुसंधान डिग्री समिति के अनुमोदन के अधीन है |

डॉ रणजीत कुमार
सहायक प्रोफेसर, और,
विकलांग श्रेणी प्रतिनिधि

डॉ मीनाक्षी
सहायक प्रोफेसर, और,
महिला प्रतिनिधि

डॉ केशव सिंह रावत
सहायक प्रोफेसर, और,
अन्य पिछड़ा वर्ग प्रतिनिधि

श्री मनोज धीमान
वरिष्ठतम सहायक प्रोफेसर, और
अनुसूचित जाति एवं अनुसूचित जनजाति
प्रतिनिधि

प्रो.राकेश कुमार
प्रोफेसर,और,
विभागाध्यक्ष, कंप्यूटर विज्ञान एवम् सूचना विज्ञान विभाग

Synopsis

of the Ph.D. thesis entitled

IoT and Cloud-driven Data Analytics for Airborne Diseases
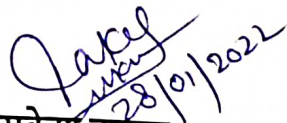
Submitted to the Central University of Himachal Pradesh

In Partial Fulfilment for the Degree of

DOCTOR OF PHILOSOPHY

In the School of Mathematics, Computer & Information Sciences

In the Department of Computer Science & Informatics

Under the Supervision(s) of

Dr. Keshav Singh Rawat (Supervisor)

Assistant Professor, Department of Computer Science & Informatics, CUHP

Dr. Sandeep Kumar Sood (Co-Supervisor)

Associate Professor, Department of Computer Applications, NIT Kurukshetra

By

Dheeraj Kumar

(CUHP20RDCS01)

February 2022

CENTRAL UNIVERSITY OF HIMACHAL PRADESH

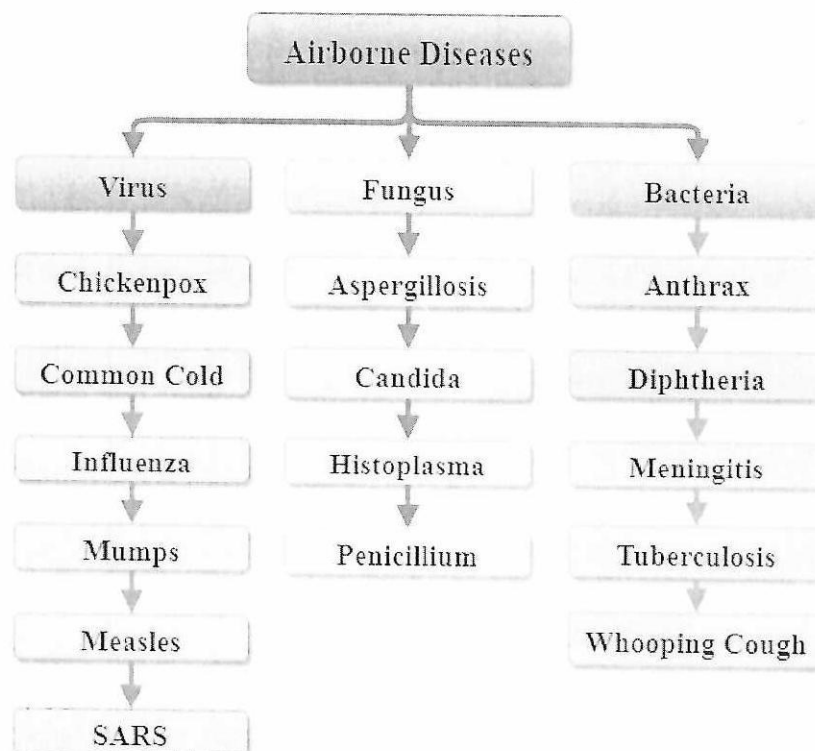**Shahpur Parisar-176206, Shahpur, Kangra, Himachal Pradesh-176206**

1

Title : IoT and Cloud-driven Data Analytics for Airborne Diseases

Introduction

The proliferation of novel viruses has accelerated significant health threats and become a global problem in a very short period. Airborne illnesses are growing every year due to globalization, urbanization, and the spread of dangerous pathogens [1]. The dissemination of infections is a severe problem causing social consequences, economic loss and significant mortality around the globe. According to the World Health Organization (WHO) [2], more than 7 million people lose their lives due to infectious diseases every year, and at least 30 new diseases have been grown in the last two decades. The influenza virus is the most prevalent disease worldwide, and a global outbreak was being declared. The World Health Organization (WHO) estimates that this virus kills approximately 65,000 people every year. Currently, COVID-19 has spread to almost every country and affects the lives of millions of people around the world. As of 11 February 2022, there has been 399.67 million confirmed COVID-19 cases, including 5.76 million deaths, are reported globally. Like COVID-19, several other airborne illnesses such as Chickenpox, Influenza, Tuberculosis, and middle east respiratory syndrome coronavirus provoked disease severity and humanitarian catastrophes in most countries, as shown in the figure.

Airborne Diseases

Virus	Fungus	Bacteria
Chickenpox	Aspergillosis	Anthrax
Common Cold	Candida	Diphtheria
Influenza	Histoplasma	Meningitis
Mumps	Penicillium	Tuberculosis
Measles		Whooping Cough
SARS		

The widespread of novel viruses has put traditional health systems under immense pressure and posed several serious issues. Henceforth, early detection, identification, rapid testing, and advanced surveillance systems are required to address public health emergencies.

The dissemination of COVID-19 and other infectious diseases have significantly emphasized the importance of modern technologies, including Artificial Intelligence (AI), Internet of Things (IoT), big data analytics, and cloud computing for the timely detection, prevention, and control of viral infections. These technologies provide numerous promising solutions such as enabling people to continue work from home, reducing the threats of infodemic and sharing of fake news [2], establishing remote education programs for students during public health crisis time [3], enabling online booking for COVID-19 vaccination [4], surveillance public places during lockdown period and predicting the next hotspot of the pandemic [5].

Artificial intelligence is one of the most powerful tools that has been extensively used to respond to this ongoing pandemic viz; analyzing the complicated health data, reducing the impact of infodemic, helping to gain insight of best treatment, analyzing the symptoms of suspects in early stages with the help of medical imaging such as computer tomography scan, and x-ray imaging for the detection of the virus.

Cloud computing provides functionality over the internet. It offers a common platform for IoT and Big Data technologies [6]. IoT enables connectivity among different medical devices in the healthcare sector. It connects all devices with the internet and acquires patient health information using sensors [7]. In the COVID-19 disaster, IoT is used for testing and monitoring real-time patients' conditions, tracing the infected patients, surveillance of crowded areas to ensure the implementation of quarantine. Big data analytics is used to store large volumes of data in an organized manner that can be easily accessed and analyzed for better decision making [8]. In the pandemic situation, big data has been significantly used to collect real-time data from online sources such as social media and predict the curve of infected cases. Moreover, big data is used to preserve the records of patients that helps the doctors to decide the best treatment for them.

Several recent research papers demonstrate the potential scope of technologies in the healthcare domain and provide significant cues for the research community to continue this research for further enhancement in this field of study. After careful examination of related prior research, the focus of most publications is to control and diagnose the COVID-19 only. Furthermore, many research publications have addressed various aspects and risks associated with this pandemic. Such as, Mohanty et al. [9] explore the potential of cloud-assisted IoT and Big data technologies in healthcare. It provides an overview of these technologies in smart healthcare. Ray et al. [10] investigate the significant security and privacy threats of big data computing technologies. It also describes

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how IoT and blockchain in mobile healthcare can protect against such threats. Nazir et al. [11] summarise the significance of IoT and Big data analytics in the medical field. Furthermore, it discusses how technologies can overcome existing challenges in healthcare. Ahmed et al. [12] proposed a framework for analyzing and forecasting the covid-19 situation using IoT and big data. Farahani et al. [13] proposed and described an IoT-based patient-centric eHealth ecosystem model. This research enlightened the various services, applications, and current challenges in IoT eHealth and reviewed various papers related to IoT eHealth. Yang et al. [14] developed an IoT-based privacy-preserving smart system with break-glass access control to secure and maintain patient health information. This method ensures specific access control in both regular and emergency conditions. Zahedi et al. [22] proposed a framework to make a robust supply chain network through IoT. This framework can assess the sensitivity of response time and selected routes. Mahajan et al. [16] conducted scientific research on the H1N1 influenza virus to extract evidence-based searching mechanisms for administrative decisions in the information science discipline. Rahimi et al. [17] explored machine learning models used to forecast the COVID-19 outbreak globally. Besides scientometric studies, some papers have developed frameworks and models to address infectious diseases using Information and Communication Technology (ICT). Calderon-Gomez et al. [18] proposed a telemonitoring system based on microservices architecture for detecting, monitoring, and assisting clinical diagnosis of infectious diseases. Lin et al. [19] have explored how information technologies control the COVID-19 pandemic. This paper also describes the role of ICT-based testing kits to detect the virus in Taiwan. Rodrıguez et al. [20] explored the applications of artificial intelligence and other emerging techniques associated with intelligent data analysis for the management of the COVID-19 pandemic. Azzaoui et al. [15] proposed a Social Network Services Big Data Analytic Model for COVID-19 prediction in smart healthy cities in order to minimize the effects of an infodemic and raise public awareness about pandemics. Ahmed et al. [6] proposed a big data analytics-based model for the prediction of the outbreak. It leverages IoT and Neural network technologies for tracking and predicting the infected cases.

Dheeraj Kumar

Motivation

The noble coronavirus has spread worldwide and has become one of the most acute and serious illnesses in the last 100 years. It has created dreadful situations and dramatically affected societies and economies throughout the world. The increasing importance of COVID-19 research has led to the inclination of various countries to invest their substantial efforts and money in the healthcare sector. The motive of most countries is to build robust and innovative hospitals that will be able to handle airborne illnesses and future pandemics like COVID-19. As a consequence, ICT has gained worthy attention from the scientific community and has significantly been employed to support healthcare facilities. ICT tools are used to access a wide range of technological solutions such as home hospitalization systems, on-site detection of infectious viruses, rapid and accurate testing of suspects, online survey for an immediate public response, participatory disease surveillance systems to curtail the spread of virus, deployment of cost-effective and more portable point of care diagnostic testing, and location-based contact tracing applications to notify its users if they were in close proximity to an infected person.

The widespread of COVID-19 and the increasing significance of ICT in this field motivate us to conduct this research for the exploration area of airborne diseases and examine the potential use of technologies in the prevention of viral infections. The aim of this research is not only to investigate critical ICT applications in healthcare but also to develop an IoT-based smart framework to improve the clinical features and treatment processes.

Dheeraj kumar

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Research Questions

After careful evaluation of prior scientific research, the following research challenges have been identified:

1) What is the current international research status of ICT in common infectious diseases?

2) What are the research hotspots, frontiers, and emerging trends of technology in the field of airborne diseases?

3) How have digital technologies been implemented to address the severe challenges posed by the COVID-19 pandemic?

4) What is the role of Industry 4.0 innovations and the medical supply chain in the healthcare sector during the COVID-19 outbreak?

5) Can IoT-assisted technologies provide an effective hospitalization system at home?

Research Objectives

This research aims to provide an IoT-based Intelligent ecosystem for controlling and managing airborne infections. This work intends to analyze the recent status of the aforementioned technologies and their potential applications in healthcare in the context of airborne infections. More specifically, the key objectives of this research are as follows:

1) To identify global research dynamics from numerous perspectives to provide research hotspots, research fronts, pivotal points, and emerging trends in this knowledge domain.

2) To study the essential role of modern technologies in common infectious diseases.

3) To perform scientometric analysis on major Industry 4.0 technologies in healthcare.

4) To assess the recent advances of enabling technologies in Airborne diseases.

5) To explore the classification of information and communication technologies and their potential applications in the COVID-19 pandemic.

6) To establish an IoT-based surveillance system for proper tracking and monitoring of suspects.

7) To design an IoT-based framework for a safe home hospitalization system.

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Significance of Research

In the contemporary situation, the development of the cloud-based architecture for continuous monitoring and identification of infected people is required to reduce the threats of COVID-19 and related infectious diseases. It is necessary to develop futuristic health frameworks that can predict and analyze the risk assessment and related preventive measures. Similarly, the development of effective IoT-based home-hospitalization systems is suitable not only during a lockdown or any health emergencies but also for those who are not able to visit hospitals due to their physical conditions.

Novelty of Research

In the establishment of smart infrastructure for controlling infectious diseases, it observed that there is a need to improve the efficacy in existing models and develop a mechanism to support health facilities at home. This study fills this research gap by proposing an innovative model using noble methods.

In addition, this research outlines various research topics, evolving trends, and research frontiers in this field to assist researchers and the academic fraternity to understand the intellectual structure of airborne diseases from the perspective of ICT.

Research Design and Methodology

- This research employs a **scientometric approach** to fulfil the first four objectives of this research. The scientometric analysis investigates the quantitative aspects of the science disciplines using various bibliometrics approaches to evaluate the development of research, impact, and social relevance in science and technology. In general, it is an essential statistical analysis to detect important topics of research and explain evolutionary pathways in a specific field of science [16].

- Similarly, this research adopts a modelling approach to fulfil the fifth, sixth, and seventh objectives.

- This research has been employed the Python programming language to fulfil the coding requirement.

- This research has been used secondary data sources such as Books, Journals, Prior research, and the Internet.

- Furthermore, the **CiteSpace** tool and **Microsoft Excel** have been used to analyze and visualize scholarly information from massive data collection.CiteSpace is the best visualization tool that offers rich features to researchers for identifying the intellectual links among the publications. It is a freely available open software tool that provides different insights to analyze the bibliometric data. It enables
  the users to analyze the data by publications metrics such as references, authors, source, country, and keywords. Likewise, Microsoft Excel has been employed to store bibliometric data and perform statistical analysis.

- In addition, this research has been used **Flowchart Maker and Online Diagram Software** (https://app.diagrams.net/#) for creating diagrams and figures for the representation of analysis and related applications in a more interactive manner.

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Turnitin report 2

by Dheeraj Kumar

Synopsis

of the Ph.D. thesis entitled

(IoT and Cloud-driven Data Analytics for 3-D Printed Bioimplants)

Submitted to the Central University of Himachal Pradesh

In Partial Fulfilment for the Degree of

DOCTOR OF PHILOSOPHY

In the School of Mathematics, Computer & Information Sciences

In the Department of Computer Science & Informatics

Under the Supervision(s) of

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Dr. Sandeep Kumar Sood (Co-Supervisor)

Associate Professor, Department of Computer Applications, NIT Kurukshetra
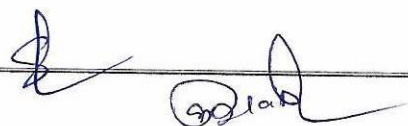
By

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February 2022

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Title : IoT and Cloud-driven Data Analytics for 3-D Printed Bioimplants

Introduction

The production of a concrete 3D part of an arbitrary figure derived straight from a mathematical representation typically a CAD model, by employing extremely flexible, rapid, absolutely automated procedure without the help of any tool is referred to as 3-D Printing (3DP) [1]. According to ASTM International Committee F42 and Wohler's Report 2014 [2], 3DP also referred to as Additive Manufacturing which uses other printer technology or print head, nozzle for production of items through the process of material deposition. The field of 3-D printing is blended with an array of new methods, technologies, and applications leading to the development of innovative research in various domains associated with it. Many industries are grossed with new ways of improving the processes by way of introducing new ideas, mass customization, innovative product development, and profitability enhancement. This technology can be employed for early verification of concepts in the creation of physical models as well as for offering a method of economic, fast, and less or zero waste production [3].

Role of 3-D printing technology has increased manifold with the introduction of materials and technologies that exist as of date. 3-D printing process offers transformative edge at all steps of production process ranging from initial construct to the production of end product to be marketed. Presently, a large variety of 3-D printing technologies are available, thus, it is vital to remain abreast of choosing the right 3-D printing technology for specific applications. Since the emergence of 3DP technology in 1980s, it is rapidly evolving and yielding long-term strategic value by leveraging the benefits of 3-D printing technologies among Software developers, Animation artist (creator), Designers, Architecture, Biomedical and technology engineers, Industrial engineers, Mechanical engineers, 3-D environmental artist, 3-D modeler, Interior designer, Bioprinter, Prosthesis and implant designer, Pharmaceutical technologist, Educator, Physicians, Researchers, Academics, and Manufacturers. 3-D printing technologies are being used to evaluate more concepts in a short time for improving the decision making and design process early in product development to achieve more productiveness, lowered logistics cost, increased adaptability, cost-benefit based optimization, enhancing quality of product, lighter products, minimal parts for assembly, even unlock entirely new business models and attaining higher efficiency for the promising growth of industry worldwide [4]. In most

cases, 3-D printing technology can prototype parts very rapidly, maximize performance, lowering manufacturing costs, and delivers the highest quality enhancing design-to-manufacturing capabilities.

Amount of ease and flexibility extended by the adoption of 3-D printing technology, and availability of functional material in recent times has broadened the magnum of utility of services both for academic and industrial use. The most popular and broadly used three-dimensional printing technology processes include Fused Filament Fabrication - FFF , Stereolithography - SLA, Selective Laser Sintering - SLS, Fused Deposition Modeling - FDM, Laminated Object Modelling - LOM, and 3D-printing – 3DP. The term "additive manufacturing" (AM) refers to the process of creating products by "adding" material. In most cases, additive manufacturing necessitates the use of both a machine and CAD software. The machine builds the required object by adding material according to the instructions from the CAD software. Broadly AM as shown in Fig.1 involves wide range of processes for the building up of 3D physical models, sample specimens, forms, and tooling components using various materials such as ceramics, metals, plastics, etc. [5]. Additive manufacturing processes include electron-beam manufacturing and selective laser melting which are being used in emerging areas of 3-D printing technology. Although neither of these creates layers of material, they both involve the addition of material to create objects. Most of the applications linked with such technologies has industrial and commercial significance. Almost all 3D printing techniques work by employing a machine called a 3-D printer and CAD software to create consecutive layers of the 3D object under construction. The 3-D printer is controlled by the CAD software in terms of material deposition quantum and location, thus, forming solid objects by making use of either powder-based, liquid, or solid materials. Basic 3-D printing process is composed of following steps [6] : i) Creation of CAD model for the design. ii) Convert image to Stereolithography format. iii) Slicing a Stereolithography format to 3D model. iv) Developing a specimen. v) Cleanse and wrap up a model. The most common applications of 3-D printing are related to consumer and recreational usage.

Additive bio-manufacturing (bio-AM) employs various additive manufacturing technologies in biotechnology/bioprocess engineering for the fabrication of bio-constructs by satisfying different levels of heterogeneity through multi-material, and desired functionality that mimimcs or conform to the human tissues. Scaffolds are fabricated in regards to cell type, morphology, and mechanical property gradients using multi-material. It employs 3-D printing for medical or non-therapeutic "human enhancement".

Biofabrication can be accomplished through technological processes in a multidisciplinary way, including catalysis, synthetic biology, biotechnology, sensing, and tissue engineering and regenerative medicine, among others. Biofabrication can be accomplished through the use of a bioprinting or bioassembly approach, followed by a tissue maturation process. 3-D printing technology is widely utilised in biofabrication to precisely arrange cells, matrix, and materials in position for tissue growth. These constructs can be utilised as testing platforms for novel drugs, to better understand cell biology, and to replace tissues and organs lost by injury or illness.

3-D printing technology is a part of digital fabrication process, and is being used worldwide in one or the other industry. The diverse fields that cover the inclusion of this technology, ranging from health to home decor, agriculture, automotive industry, aerospace industry, and the number is growing. Adoption of additive manufacturing has the capacity to revolutionize industrial sector and impacting production line by increasing the production speed, improving economy scale, providing end-user feedback based production, better quality control, reduction in the requirement of global transportation, making the whole process accessible from a single control for the dissemination of an entire set of services for the delivery of end product. Recent progress in this knowledge domain has fuelled its capabilities and resulted in increasing the speed, and lowering of prices in printers and feedstock. Most popular three-dimensional printing projects include bioprinting of tissues and organs, custom-made implants and prostheses, dentistry, embryonic stem cell culture, and anatomical models for surgical procedures that creates 3D physical objects from their CAD designs [7], making changes feasible through the edits of CAD models, and precision in size.
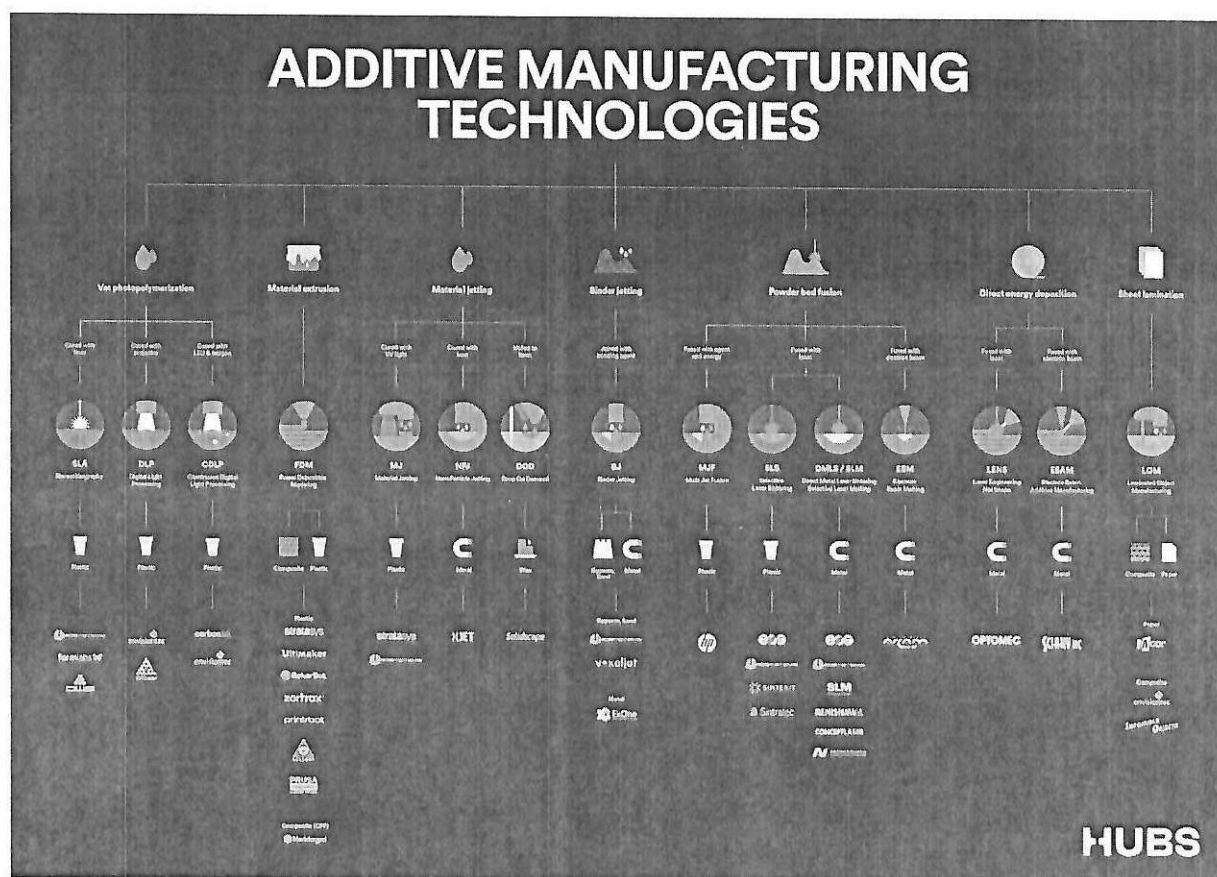
Fig.1. List of 3-D Printing Technologies (Additive Manufacturing Technologies)
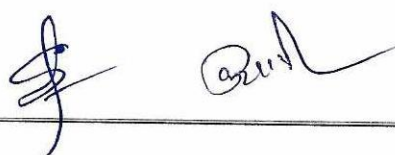
Exploration of this research domain is performed through review of literature, which is reproduced as follows:

Yan et al. [8] highlights the importance and use of three-dimensional printing technology for healthcare sector viz; potential of controlling drawbacks of traditional methods with the adoption of a rapid manufacturing process for customized formation of tissue or organ for human bionics, a roadmap for repairing tissue deformity in situ with cells, method of bioprinting of organs and tissues, and categorizing medical applications of 3-D printing technology into four major areas of concern: i) scientific contribution on production of organ models based on pathology to assist patients and make aware prior to surgical planning and analysis of surgical procedure [9]; ii) scientific contribution on customized production of fixed non-bioactive implants; iii) scientific contribution on composition of biodegradable scaffolds and bioactive locally; iv) scientific contribution on full biological functionality of directly printed tissues and organs [10]. Chimene et al. [11] presented advanced bio ink formulations

mechanisms with the least criteria for printing complex and high-resolution tissue structures. Control of direct cellular process by the development of new bioresponsive inks [12], focused on the application of stimuli-responsive and controlled release of immune modulators, and suggested that growth factors are the key player in applying extra control on the bioactivity of bio-inks. Liu et al. [13] introduced the development of personalized food in varied complicated structures and shapes is possible with a controlled supply of nutrients for the production of environment-friendly, good quality, healthy, and economical 3D-food [15]. Sachs et al. [16] introduced the role of rapid prototyping in the pharmaceutical industry with the release of 3D tablet Spiritam. Novel complex drug products in one dosage form, customized drug release, and personalized design of medical products for meeting patient needs can be designed and manufactured using a local 3D printer or even at home by the patient [17].

Hutmacher[18] discussed research on scaffolds of bone and cartilage in tissue engineering. The outcomes of this study showed that the use of biomaterials for designing and fabrication of 3D scaffolds provide better support for the research on tissue engineering. Woodruff & Hutmacher[19] reviewed the use of PCL-based biomaterial and discussed the advantages and applications in tissue engineering and medical devices. Zein et al. [20] discussed the modeling of scaffold architecture based on fused deposition in tissue engineering. The experiment analysis depicted a relationship between the porosity of scaffold and compressive attributes of power-law associations. Hutmacher[21] discussed a variety of scaffold fabrications methods that covered early and latest period techniques with the representation of scaffold architecture and fabrication capacities. Hutmacher et al. [22] developed a computer-controlled system that designs and fabricates porous and bio-resorbable scaffolds. The outcomes of this study depicted that FDM permitted reproducible bioresorbable 3-D scaffolds for designing and fabrication of pore networks. Melchels et al. [23] also discussed the fundamentals of tissue engineering and additive manufacturing concepts with a computer-aided design that is used for cells and material decomposition.

Motivation

Based on the present situation prevailing worldwide on the availability of organ donors for the grieved patient and healthcare system, a huge gap between the demand and supply of organs is observed. Employing 3-D printing technologies in the manufacturing of bioimplants has tremendous scope for bridging this gap and can be useful for the society. This factor paves the way for conducting research in this domain.
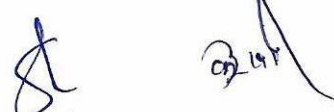
Objectives and Scope:

i) Research Questions

Based on the exploration of scientific literature and understanding of the research area, following research questions are identified:

1. What is the present state of published research, possible research areas, leading journals, prolific authors, influential papers, research hotspots, emerging areas, technological trends, future research directives, and limitations in the 3D printing technology domain?

2. What is the role of enabling technologies of Industry 4.0 in 3-D printing from the perspective of Practitioners and Business Managers?

3. What is the role of controls and their recent advances in the manufacturing of 3-D printed bioimplants?

4. What is the present state of Artificial Intelligence algorithms in the context of 3-D bioprinting of bioimplants?

5. What optimal parameters of a 3-D printer should be taken into consideration while printing a bioimplant using 3-D printing technologies?

6. What are the points of differences between a digital model and final outcome of a 3-D printed bioimplant?

ii) Research Objectives

This research is a conglomerate of IoT, Cloud computing and use of Artificial Intelligence approach for performing data analytics in the generation of 3-D printed bioimplants. Key objectives of this research are as follows:

1. To perform scientometric analysis for identification of present status of research, intellectual structures, leading journals, prolific authors, influential research papers, research hotspots, emerging trends, future research directives and limitations in the 3-D printing technology domain.

2. To perform systematic literature review for the role of enabling technologies of Industry 4.0 in soft tissue engineering from the perspective of Practitioners and Business Managers, and adoption of Artificial Intelligence approach in 3-D printing of bioimplants

3. To perform a survey of implementation of controls in 3-D printed bioimplants

4. To propose a framework for incorporating IoT, Cloud computing, Artificial Intelligence approaches in 3-D printing of bioimplants

5. To introduce a model for Feature engineering of 3-D printer parameters using machine learning algorithms (ML) and anomalies detection for 3-D printed bioimplants using deep learning.

Description of the research work

a. The research problems

Selection of optimal parameters of a 3-D printer for detection of anomalies in the manufacturing of a bioimplant to minimize the difference between a digital model and it's final outcome.

b. Solution Methodologies, and

This research proposes to employ following research methodologies :

- Scientometric approach for the fulfillment of first objective
- Systematic literature review approach for the fulfillment of second, third, and fourth objective.
- Feature engineering with the help of ML models, CNN and Transfer learning approach for the detection of anomalies.

This research uses various softwares viz; CiteSpace for performing quantitative and qualitative analysis, and visualization of the research domain; Microsoft Excel for the data cleaning; Flowchart Maker; and Online Diagram software for the representation of analysis and related applications in a more user friendly way.

Java, and Python are useful for the implementation of research for obtaining the desired results.

c. Interpretation of the results / output

Introducing a model for Feature engineering of 3-D printer parameters using machine learning algorithms (ML) and anomalies detection for 3-D printed bioimplants using deep learning.

Significance of the Research

Development of artificial intelligence based method for the detection and recognition of type of anomaly during the layer by layer creation using bioprinted materials. Applying of appropriate model shall try to achieve overall accuracy based on data sets for testing and validation. Balancing of various anomalies within the dataset and fixing of appropriate environmental parameters shall be done during data collection. Automatic labeling process shall be applied to enhance the capability for its application.

Novelty of Research

In an established system for 3-D printing of bioimplants, it is observed that there is a difference between the digital design and final outcome of bioimplants, thus, containing certain deformities and result in the non-giving of desired functionality or get wasted. This lack of functionality in the design or wastage of finished bioimplants can be overcome by using the suggested methods.

Conclusion / Limitations/ Future Scope

a. Conclusion:
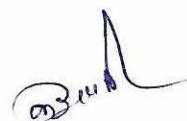
A systematic literature review shall be conducted on the list of artificial intelligence algorithms existing at present, and to gain an idea about the AI-based algorithms being adopted for practice in the manufacturing of bioimplants. Based on the identification of an appropriate AI-based algorithm for the proposed research, an appropriate model shall be developed which makes use of the identified AI-based algorithm for the detection of anomalies during the layer by layer formation of bioimplants by the selection of optimal parameters of a 3-D printer.

b. Limitations:

- Obtaining the required dataset is a big challenge.
- Selection of considerable tunable parameters from a complete list of parameters of a 3-D printer.

c. Future Scope:

Research efforts are required for anomaly correction to take this research to the next level.

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13. Z. Liu, M. Zhang, B. Bhandari, and Y. Wang, "3d printing: Printing precision and application in food sector," Trends in Food Science & Technology, vol. 69, pp. 83–94, 2017.

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CENTRAL UNIVERSITY OF HIMACHAL PRADESH

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School of Mathematics, Computers & Information Sciences
Department of Computer Science & Informatics

16. M. Palo, J. Holl¨ander, J. Suominen, J. Y liruusi, and N. Sandler, "3d printed drug delivery devices: perspectives and technical challenges," Expert review of medical devices, vol. 14, no. 9, pp. 685–696, 2017.

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18. M. A. Woodruff and D. W. Hutmacher, "The return of a forgotten polymer—polycaprolactone in the 21st century," Progress in Polymer Science, vol. 35, no. 10,pp. 1217–1256, 2010.

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20. D. W. Hutmacher, "Scaffold design and fabrication technologies for engineering tissues – state of the art and future perspectives," Journal of Biomaterials Science, Polymer Edition, vol. 12, no. 1, pp. 107–124, 2001, pMID: 11334185. [Online]. Available: https://doi.org/10.1163/156856201744489

21. D. W. Hutmacher, T. Schantz, I. Zein, K. W. Ng, S. H.Teoh, and K. C. Tan, "Mechanical properties and cell cultural response of polycaprolactone scaffolds designed and fabricated via fused deposition modeling," Journal of Biomedical Materials Research, vol. 55, no. 2, pp.203–216, 2001.

22. F. P. Melchels, M. A. Domingos, T. J. Klein, J. Malda,P. J. Bartolo, and D. W. Hutmacher, "Additive manufacturing of tissues and organs," Progress in Polymer Science, vol. 37, no. 8, pp. 1079–1104, 2012, topical Issue on Biorelated polymers.

23. Y. Jin, X. Li, R. I. Campbell, and S. Ji, "Visualizing the hotspots and emerging trends of 3d printing through scientometrics," Rapid Prototyping Journal, 2018.

Turnitin Report

by Girish Sir

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Established under Central Universities Act 2009)
शाहपुर परिसर, शाहपुर, ज़िला काँगड़ा (हि.प्र.) - 176206
Shahpur Parisar, Shahpur, Distt. Kangra (HP) - 176206
Website: www.cuhimachal.ac.in

File No. CSI/1-11/DSC/CUHP/21/288   Dated: 28.09.2022

MINUTES OF THE MEETING

All the **Committee Members** of the **Departmental Standing Committee (DSC), re-constituted** vide no. CSI/1-11/DSC/CUHP/21/245-255 dated 21.02.2022, for the **period of 03 years** in the **Department of Computer Science and Informatics,** School of Mathematics, Computers and Information Sciences **met on 28.09.2022** at **12:00 PM** in the **Seminar Hall,** Central University of Himachal Pradesh, **Shahpur Parisar,** Shahpur. The faculty members **discussed** the following **agenda items** and **decided** as under:-

<u>Item No.1</u>: To place the request of Mr. Manoj Dhiman, Ph.D. Scholar under Roll No. CUHP20RDCS03 in the Department of Computer Science and Informatics regarding Change of the Research Supervisor

<u>Item No. 2</u>: To place the request of Ms. Neha Thakur, Ph.D. Scholar under Roll No. CUHP21RDCS01 in the Department of Computer Science and Informatics regarding Change of the Research Supervisor.

Decision:
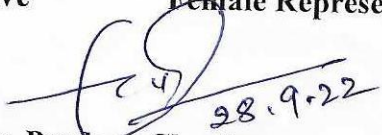
As per written request(s) of the Mr. Manoj Dhiman, Ph.D. Scholar under Roll No. CUHP20RDCS03, and Ms. Neha Thakur, Ph.D. Scholar under Roll No. CUHP21RDCS01, and consent of Dr. Keshav Singh Rawat, Assistant Professor (presently on lien at Central University of Haryana on the post of Associate Professor), the Departmental Standing Committee (DSC) agreed to change the Research Supervisor of both the Ph.D. Scholars, as per Ordinance 42, Clause 12(12.1 & 12.3) of the University.

Further, the Departmental Standing Committee (DSC) unanimously recommends that Dr. Pradeep Chouksey, Associate Professor & Head, Department of Computer Science and Informatics, School of Mathematics, Computers and Information Sciences, Central University of Himachal Pradesh, Shahpur Parisar, Shahpur will act as Research Supervisor/Guide to both the Ph.D. Scholars i.e. Mr. Manoj Dhiman, CUHP20RDCS03, Ms. Neha Thakur, CUHP21RDCS01, as per Ordinance 42, Clause 7(7.1 & 7.2) of the University.

Dr. Jitender Kumar
Assistant Professor, and,
SC & ST Cat. Representative

Dr. Ranjit Kumar
Assistant Professor, and,
PwD Cat. Representative

Dr. Meenakshi
Assistant Professor, and,
Female Representative

28.9.22

Dr. Pradeep Chouksey
Senior Most Associate Professor, and,
HoD, Computer Science and Informatics

To
Head of Department
Department of Computer Science & Informatics
Central University of Himachal Pradesh

Subject : Regarding change of my research
Supervisor

Respected Sir,

With all due respect, I want to state
that I am a Ph.D student in the Department
of Computer Science & Informatics. I am doing
my course work under Registeration No. CUHP21RDCS01

As you know that my current research sup-
ervisor Dr Keshav Rawat has joined the
Central University of Haryana as Associate
Professor. Due to long distance it is not
possible for me to visit the Central University
of Haryana fuquently.

Presently Dr. Pradeep Chouksey has joined
the Department of Computer Science &
Informatics. CUHP as Associate Professor. and
my research interest is the same as
the research area of Dr. Pradeep Chouksey.

Also as per telephonic discussion. my
current research supervisor has shown no

objection if I change my research supervisor.
Moreover, Dr. Pradeep Chouksey has vacant
Ph.D seat with him, and has agreed
to supervise me in the research.

Thus you are requested to allow me to
change my research supervisor so that I
may complete my research work within
stipulated time.

Thanks and Regards,
Neha Thakur
Neha Thakur
Roll No. CUHP 21 RDCS 01
Department of Computer Science & Informatics
Central University of Himachal Pradesh

mail this
Application to the
Respective Supervisor
for Consent
Pro. Croomar. D.O.

M Gmail

Gourav Chambyal <gourav.cuhimachal@hpcu.ac.in>

Regarding letter
2 messages

HOD Computer Science & Informatics <hod_csi@hpcu.ac.in>
Wed, May 18, 2022 at 11:45 AM
To: Keshav@cuh.ac.in, keshav79899@gmail.com
Cc: gourav.cuhimachal@hpcu.ac.in, dr.pradeep.chouksey2@gmail.com, dr.pchouksey@hpcu.ac.in

Dear Sir,
Please find **attached** herewith a **letter** received from **Ms. Neha Thakur, Ph.D. Scholar** under Roll No. **CUHP21RDCS01** in the **Department of Computer Science and Informatics** regarding Change of Research Supervisor.
As per records, you are the **Research Supervisor** of Ms. **Neha Thakur** for Ph.D. Degree. Therefore, you are hereby **requested** to kindly give your **consent/NoC** or give your **necessary comments** to Change of Research Supervisor of Ms. Neha Thakur,

To
Head of Department
Department of Computer Science & Informatics
Central University of Himachal Pradesh

Subject : Regarding change of my research
Supervisor

Respected Sir,

With all due respect, I want to state
that I am a Ph.D student in the Department
of Computer Science & Informatics. I am doing
my Course work under Registeration No. CUHP21RDCS01
. As you know that my current research sup-
ervisor Dr. Keshav Rawat has joined the
Central University of Haryana as Associate
Professor. Due to long distance it is not
possible for me to visit the Central University
of Haryana fuquently.

Presently Dr. Pradeep Chouksey has joined
the Department of Computer Science &
Informatics, CUHP as Associate Professor, and
as my research interest is the same as
the research area of Dr. Pradeep Chouksey.

Also as per telephonic discussion. my
current research supervisor has shown no

objection if I change my research supervisor.
Moreover, Dr. Pradeep Chouksey has vacant
Ph.D seat with him, and has agreed
to supervise me in the research.

Thus you are requested to allow me to
change my research supervisor so that I
may complete my research work within
stipulated time.

Thanks and Regards,
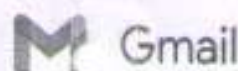Neha Thakur
Neha Thakur
Roll No. CUHP21RDCS01
Department of Computer Science & Informatics
Central University of Himachal Pradesh

Mail this
Application to the
Respective Supervisor
for Consent.

Ms. Gaorav DEO

सादर/regards,

कंप्यूटर विज्ञान एवम् सूचना विज्ञान विभाग/Department of Computer Science and Informatics

गणित, कंप्यूटर एवं सूचना विज्ञान स्कूल/School of Mathematics, Computers and Information Science

हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय/Central University of Himachal Pradesh

शाहपुर परिसर, शाहपुर/Shahpur Purisar, Shahpur

Application of Ms Neha Thakur, PhD scholar regarding change of research supervisor.pdf
717K

Dr. Keshav Rawat <keshav79699@gmail.com>   Wed, May 18, 2022 at 8:19 PM
To: HOD Computer Science & Informatics <hod_csi@hpcu.ac.in>

Cc: gourav.cuhimachal@hpcu.ac.in, dr.pradeep.chouksey2@gmail.com, dr.pchouksey@hpcu.ac.in

I have no objection.
[Quoted text hidden]

Call the meeting of Departmental Standing Committee (DSC) on Dated 24.5.22 at 11.00 am.

Mr. Gourav Chabryal (DEO)

23.5.22

Dated: 09-05- 2022

To
Head of Department
Department Of Computer Science & Informatics
Central University of Himachal Pradesh

Subject: Regarding change of my research supervisor.

Respected Sir,

With due respect, I want to state that I am a Ph. D. student in the Department of Computer Science & Informatics under Registration No. CUHP20RDCS03. I had successfully completed my Ph. D. course work.

As you know that my current research supervisor Dr. Keshav Rawat has joined the Central University of Haryana as Associate Professor. Due to the long distance it is not possible for me to visit the Central University of Haryana frequently.

Presently Dr. Pradeep Chouksey has joined the Department of Computer Science & Informatics, CUHP as Associate Professor, and my research area is the same as the research area of Dr. Pradeep Chouksey.

Also as per telephonic discussion, my current research supervisor has shown no objection if I change my research supervisor. Moreover, Dr. Pradeep Chouksey has vacant Ph. D. seats with him, and has agreed to supervise me in the research.

Thus you are requested to allow me to change my research supervisor so that I may complete my research work within stipulated time.

With Regards,

Manoj Dhiman
Roll No: CUHP20RDCS03.
Department of Computer Science & Informatics
Central University of Himachal Pradesh

HOD, CSI
Prepare greenshut for
Approval Hon'ble VC Sir

Regarding letter
2 messages

HOD Computer Science & Informatics <hod_csi@hpcu.ac.in>   Tue, May 10, 2022 at 10:20 AM
To: Keshav@cuh.ac.in, keshav79699@gmail.com
Cc: gourav.cuhimachal@hpcu.ac.in, dr.pradeep.chouksey2@gmail.com, dr.pchouksey@hpcu.ac.in

Dear Sir,
Please find **attached** herewith a letter received from **Mr. Manoj Dhiman, Ph.D. Scholar** under Roll No. **CUHP20RDCS03** in the **Department of Computer Science and Informatics** regarding **Change** of **Research Supervisor**.
With **reference** to **Notification** no. **CSI/1-2/RD/CUHP/20/167-176** dated 02.09.2021, you are the **Research Supervisor** of **Mr. Manoj Dhiman** for Ph.D. Degree.
Therefore, you are hereby **requested** to kindly give your **consent/NoC** or give your **necessary comments** to **Change** of **Research Supervisor** of Mr. Manoj Dhiman.

Dated: 09-05- 2022

To
Head of Department
Department Of Computer Science & Informatics
Central University of Himachal Pradesh

Subject: Regarding change of my research supervisor.

Respected Sir,

With due respect, I want to state that I am a Ph. D. student in the Department of Computer Science & Informatics under Registration No. CUHP20RDCS03. I had successfully completed my Ph. D. course work.

As you know that my current research supervisor Dr. Keshav Rawat has joined the Central University of Haryana as Associate Professor. Due to the long distance it is not possible for me to visit the Central University of Haryana frequently.

Presently Dr. Pradeep Chouksey has joined the Department of Computer Science & Informatics, CUHP as Associate Professor, and my research area is the same as the research area of Dr. Pradeep Chouksey.

Also as per telephonic discussion, my current research supervisor has shown no objection if I change my research supervisor. Moreover, Dr. Pradeep Chouksey has vacant Ph. D. seats with him, and has agreed to supervise me in the research.

Thus you are requested to allow me to change my research supervisor so that I may complete my research work within stipulated time.
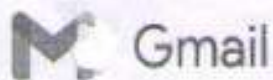
With Regards,

Manoj Dhiman
Roll No: CUHP20RDCS03.
Department of Computer Science & Informatics
Central University of Himachal Pradesh

Taken Consent from Dr. Keshav Singh Rawat. Through mail

Mr. Gaurav Chouksey- 9. 5. 22

Thanking you,

With regards,

Department of Computer Science and Informatics,
School of Mathematics, Computers and Information Sciences,

📄 plication of Mr Manoj Dhiman regarding change of Research Supervisor.pdf
335K

Dr. Keshav Singh Rawat <keshav@cuh.ac.in>   Tue, May 10, 2022 at 11:24 AM
To: hod_csi@hpcu.ac.in, gourav.cuhimachal@hpcu.ac.in, dr.pradeep.chouksey2@gmail.com, dr.pchouksey@hpcu.ac.in

पीएचडी छात्र के अनुरोध के अनुसार, मुझे कोई आपत्ति नहीं है। उनके उज्जवल भविष्य की कामना करता हूँ।

--

डॉ. केशव सिंह रावत,

विभागाध्यक्ष

कंप्यूटर विज्ञान और सूचना प्रौद्योगिकी विभाग,

हरियाणा केंद्रीय विश्वविद्यालय, जांत-पाली, महेंद्रगढ़ (हरियाणा), 123031

-- --------------------------------

Dr. Keshav Singh Rawat

Head of Department

Department of Computer Science & Information Technology,

Jant-Pali, Mahendragarh (Haryana), 123031

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📄 plication of Mr Manoj Dhiman regarding change of Research Supervisor.pdf

CENTRAL UNIVERSITY OF HIMACHAL PRADESH

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PO BOX: 21, DHARAMSHALA, DISTRICT KANGRA- 176215 (HP)

www.cuhimachal.ac.in

School of Mathematics, Computer Science & Information Sciences
Department of Computer Science & Informatics

Research Progress Report in respect of RAC (Research Advisory Committee) meeting held on for the period of August 2020 - December 2020

Programme of study: Ph.D.

Name: Dheeraj Kumar

Roll No./ Registration No: CUHP20RDCS01

Department: Department of Computer Science and Informatics

E-Mail: sharmadheeraj2899@gmail.com

Date of Enrolment: 06 August 2020

1. Conferences/Workshops/Webinars/ Schools:

- Participated in the the " Advanced Series of the web of Science Training & Certification Program" from October 2020 organized by Clarivate.
- Participated in the " Basic Series of the web of Science Training & Certification Program" from September 2020 organized by Clarivate.
- Participated in the special public webinar on "Machine Learning Methods in Computational Cancer Biology" on 28 August 2020, conducted by MHRD-Institution Innovation Council (IIC) Chapter, Deen Dayal Upadhyaya College.
- Participated in the special public webinar on "Granular Mining, Uncertainty Modelling and Data Science: Concepts, Models and Challenges" on 26 September 2020, conducted by MHRD-Institution Innovation Council (IIC) Chapter, Deen Dayal Upadhyaya College.
- Participated in the Nutrition Education Programme on "Non-Communicable Diseases" on September 2020 organized by Ministry of Women and Child Development, ICMR-National Institute of Nutrition, Government of India, Hyderabad, Telangana.
- Participated in the Nutrition Education Programme on "Basic Nutrition" on September 2020 organized by Ministry of Women and Child Development, ICMR-National Institute of Nutrition, Government of India, Hyderabad, Telangana.

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School of Mathematics, Computer Science & Information Sciences

Department of Computer Science & Informatics

3. Academic Progress

Course work: Completed.

S.No.	Courses	Course code	Credits Claimed
1.	Research and Publication Ethics	CPE-RPE	2 credits
2.	Research Methodology	CSI 604	4 credits
3.	Big data analytics	CSI 602	4 credits
4.	Internet of things	CSI 601	4 credits
	Total Credits Claimed		14 credits

Declaration:

I hereby declare that the information furnished above is true to the best of my knowledge.

Dheeraj Kumar

Signature of Student

(RAC Coordinator)

Members of Research Advisory Committee (RAC)

Dr.Keshav Singh Rawat	Dr. Mahesh Kulharia	Dr. Shivarama Rao K.	Prof. Rakesh Kumar
(Supervisor)	(Subject Expert)	(Subject Expert)	(Head of Department)

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School of Mathematics, Computers & Information Sciences
Department of Computer Science & Informatics

Research Progress Report in respect of RAC (Research Advisory Committee) meeting held on for the period of Jan 2021-June 2021

Programme of study: Ph.D.

Name: Dheeraj Kumar

Roll No./ Registration No: CUHP20RDCS01

Department: Department of Computer Science and Informatics

E-Mail: sharmadheeraj2899@gmail.com

Date of Enrolment: 06 August 2020

1. ## Conferences/Workshops/Webinars/ Schools:

   1. Participated in the "**Online Workshop on Latex for Scientific Writing**" held from 01st – 7th March, 2021 organized by **Director of Distance Education Guru Jambheshwar University of Science & Technology, Hisar-125001 (Haryana).**

   2. Participated in **International Conference on Innovations in Smart Technology, Advanced Materials and Communication Engineering (ISTAMCE 2021)** held on 09th June 2021 at Amity School of Engineering and Technology, Amity University Madhya Pradesh, Gwalior.

2. ## Papers Published in SCI Journals:

   • Dheeraj Kumar, Sandeep K. Sood, Keshav S. Rawat, "**A Scientometric Review on the Role of Technologies in Detection and Prevention of Pandemics**." *Artificial Intelligence review journal*, Springer, (Communicated), Indexed in SCI, Impact Factor - **5.747.**

   • Dheeraj Kumar, Sandeep K. Sood, Keshav S. Rawat, "**A Scientometric Analysis on ICT-Assisted solutions to control Common Airborne diseases**." *computer science review*, Elsevier, (Communicated), Indexed in SCI, Impact Factor - **7.707.**

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www.cuhimachal.ac.in
School of Mathematics, Computers & Information Sciences
Department of Computer Science & Informatics

3. Teaching Assistantship:

S.No.	Course	Course code	Credits Claimed
1.	E-Governance, E-Business & E-learning	CSI 506	2 credits

Declaration:

I hereby declare that the information furnished above is true to the best of my knowledge.

Dheeraj Kumar

Signature of Student

(RAC Coordinator)

Members of Research Advisory Committee (RAC)

Dr.Keshav Singh Rawat
(Supervisor)

Dr. Mahesh Kulharia
(Subject Expert)

Dr. Shivarama Rao K.
(Subject Expert)

Prof. Rakesh Kumar
(Head of Department)

CENTRAL UNIVERSITY OF HIMACHAL PRADESH

[ESTABLISHED UNDER THE CENTRAL UNIVERSITIES ACT 2009]

SHAHPUR PARISAR, SHAHPUR. DISTT. KANGRA (HP) -176206

www.cuhimachal.ac.in

School of Mathematics, Computers & Information Sciences
Department of Computer Science & Informatics

Research Progress Report in respect of DRC (Departmental Research Committee) meeting held on for the period of July 2021 - December 2021

Programme of study: Ph.D.

Name: Dheeraj Kumar

Roll No./ Registration No: CUHP20RDCS01

Department: Department of Computer Science and Informatics

E-Mail: sharmadheeraj2899@gmail.com

Date of Enrolment: 06 August 2020

1. Conferences/Workshops/Webinars/ Schools:

1. Participated in the " **One Week Online Short Term Training Program**" on "**Design of Soft Computing Based Machine Learning Models**" organized by "**Department of Electronics & Communication Engineering Panipat Institute of Engineering & Technology**" from 12 July 2021.
2. Participated in the "**Two Day National Online Workshop**" on "**AI & ML Toolkit in Research Application**" organized by "**Department of Electronics and Communication Engineering, Chandigarh Engineering College**" from 23 July 2021.
3. Participated in the "**Two Days Faculty Training Certification Program**" on "**Python Programming**" organized by "**Department of MCA at Chaitanya Bharathi Institute of Technology (A), Hyderabad.**" from 16 July 2021.
4. Participated in the AICTE-ISTE approved Orientation Program on "**Artificial Intelligence and Machine Learning using Python**" organized by "**Govt. Engineering College, Bikaner, Rajasthan**" from 06 Dec 2021.
5. Completed a short course on "**TAPAS-PRM a Purposeful Research Methodology**" Organized by "**Electronic and ICT Academy IIT Guwahati**" From 16 Dec 2021.
6. Submitted a paper in **3rd International conference on Recent Trends in Machine Learning, IOT, Smart Cities & Applications (ICMISC 2022)**" Organized by "**CMR Institute of Technology, Hyderabad, India**".

2. Papers Submitted in SCI Journals:

- Sandeep K. Sood, Keshav S. Rawat, Dheeraj Kumar " **Analytical Mapping of Information and Communication Technology in Emerging Infectious Diseases Using CiteSpace.**" *Telematics and Informatics.* Elsevier. (Submitted with Minor Revision), Indexed in SCI, Impact Factor – **6.182**.

- Sandeep K. Sood, Keshav S. Rawat, Dheeraj Kumar " **Emerging Trend of Airborne Diseases Using Internet Communication Technology to Control Proliferation**" *ACM Transaction on Internet Technology.* ACM, (Communicated), Indexed in SCI, Impact Factor – **3.135**.

- Sandeep K. Sood. Keshav S. Rawat, Dheeraj Kumar " **Artificial Intelligence and Industry 4.0 in Healthcare: A Scientometric Analysis**" *Computers & Electrical Engineering*, Elsevier, (Submitted with Minor revision), Indexed in SCI, Impact Factor – **3.818**.

3. Teaching Assistantship:

S.No.	Course	Course code	Credits Claimed
1.	Programming in C (MCA First Semester, Monsoon-2021)	MCA 402	2 credits

4. Research Ongoing:

During this period, I have explored scientific literature of Airborne diseases published in Science and Technology discipline. Currently, I am working on following problems:
- To identify global research dynamics from numerous perspectives to provide research hotspots, research fronts, pivotal points, and emerging trends in this knowledge domain.
- To assess the recent advances of enabling technologies in Airborne diseases.
- To design an IoT-based framework for a safe home hospitalization system.

5. Synopsis Submission:

- The synopsis entitled "IoT and Cloud-driven Data Analytics for Airborne Diseases" is presented and successfully defended by the candidate. The synopsis is approved by the DRC committee members.

Declaration:
I hereby declare that the information furnished above is true to the best of my knowledge.

Dheeraj Kumar
Signature of Student

17.02.22

(DRC Coordinator)

Departmental Research Committee (DRC)

17.02.22

Dr. Keshav Singh Rawat   **Prof. Hum Chand**   **Dr. Shivarama Rao K.**   **Prof. Rakesh Kumar**

(Member)   **(Member)**   **(Member)**   **(Chairman)**

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Established under Central Universities Act 2009)
शाहपुर परिसर, शाहपुर, ज़िला काँगड़ा (हि.प्र.) - 176206
Shahpur Parisar, Shahpur, Distt. Kangra (HP) - 176206

Website: www.cuhimachal.ac.in

Research Progress Report in respect of DRC (Departmental Research Committee) meeting held on 18.10.2022 for the period of January to June, 2022

Programme of study: Ph.D.

Name: Dheeraj Kumar

Roll No./ Registration No: CUHP20RDCS01

Department: Computer Science and Informatics

School: Mathematics, Computers and Information Sciences

E-Mail: sharmadheeraj2899@gmail.com

Date of Enrolment: 06 August 2020

1. ## Conferences/Workshops/Webinars/ Schools:

   - Participated in the workshop on **"Artificial Intelligence, robotics and automation"** organized by **"Centre for school of automation, Banasthali Vidyapith, Rajasthan"** from 09March 2022 to 14 March 2022.
   - Participated in the Faculty Development Programme on **"Intelligent Computing and Communications"**organized by **"Centre for artificial intelligence, Banasthali Vidyapith"** from March 21-26, 2022.

2. ## Papers Submitted in SCI Journals:

   - Sandeep K. Sood, Keshav S. Rawat, Dheeraj Kumar **"Analytical Mapping of Information and Communication Technology in Emerging Infectious Diseases Using CiteSpace."** *Telematics and Informatics"*, Elsevier, (Published), Indexed in SCI, Impact Factor – **9.140** DOI: https://doi.org/10.1016/j.tele.2022.101796.

   - Sandeep K. Sood, Keshav S. Rawat, Dheeraj Kumar **"Artificial Intelligence and Industry 4.0 in Healthcare: A Scientometric Analysis"** *Computers & Electrical Engineering*, Elsevier, (Published) Indexed in SCI, Impact Factor – **4.152**, DOI: https://doi.org/10.1016/j.compeleceng.2022.107948.

   - Sandeep K. Sood, Keshav S. Rawat, Dheeraj Kumar **"Scientometric Analysis of ICT-assisted Intelligent Control Systems Response to COVID-19 Pandemic**, "Neural Computing and Applications", Springer, (Communicated), Indexed in SCI, Impact Factor – **5.102**.

3. ## Participated in Academic/ Examination-related/ Co-academic/ Administrative task:

S.No.	Courses (Spring Semester-2022)	Course code/ Duty hours	Credits Claimed
1.	Design & Analysis of Algorithms (MCA II Semester)	MCA-507	10 credits
2.	Online meeting & web conferencing (MCA IV Semester)	MCA-HM1	10 credits

4. Research Ongoing:

Currently, I am working on following problems:
- Exploring the literature to address the better utilization of advanced machine learning algorithms and integrated technologies in healthcare services.
- Developing technical infrastructure to build a robust home-based hospitalization system to control the spread of viral airborne disease.

5. Synopsis Submission:

- The synopsis entitled "IoT and Cloud-driven Data Analytics for Airborne Diseases" is presented and successfully defended by the candidate. The synopsis is approved by the DRC committee members on 17-02-2022 at CR-06, Shahpur Parishar, CUHP.

Declaration:

I hereby declare that the information furnished above is true to the best of my knowledge.

Signature of Student

Remarks and Comments:

Research progress is satisfactory.

Members of Departmental Research Committee (DRC)

Dr. Keshav Singh Rawat,
Assistant Professor (on lien)
(Supervisor)

Dr. Shivarama Rao K.,
Associate Professor, DLIS
(Dean's Nominee)

Dr. Hum Chand
Professor, DPAS
(Director Research Nominee)

Dr. Pradeep Chouksey,
Associate Professor & Head,
(Chairman, DRC)

Workshop on

Artificial Intelligence, Robotics and Automation

March 9-14, 2022

Organized By
School of Automation, Banasthali Vidyapith, Rajasthan-304022

Under the Scheme of
CURIE-Artificial Intelligence
Department of Science and Technology, Government of India

Government of India
Department of Science & Technology
Ministry of Science & Technology

Certificate of Participation

This is to certify that Prof./Dr./Mr./Ms. __Dheeraj Kumar__

from __Central University of Himachal Pradesh__

has participated in the Workshop on *Artificial Intelligence, Robotics and Automation* organized

by Centre for School of Automation, Banasthali Vidyapith.

Secretary
Banasthali Vidyapith

A Faculty Development Programme on

Intelligent Computing and Communications

March 21-26, 2022

Organized by
Centre for Artificial Intelligence, Banasthali Vidyapith

Under the Scheme of
Consolidation of University Research for Innovation and Excellence-Artificial Intelligence
Department of Science and Technology, Government of India

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Secretary
Banasthali Vidyapith

Neural Computing & Applications

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Role: Author   Username: Sharma Dheeraj

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Page: 1 of 1 (1 total submissions)

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Action ▬ ▽×	Manuscript Number ▲	Title ▲	Initial Date Submitted ▽	Status Date ▲	Current Status ▲	
View Submission Author Status View Reference Checking Results Correspondence	NCAA-D-22-00852	Scientometric Analysis of ICT-assisted Intelligent Control Systems Response to COVID-19 Pandemic	03 Mar 2022	08 Aug 2022	Under Review	

Page: 1 of 1 (1 total submissions)

Results per page 10 ⌄
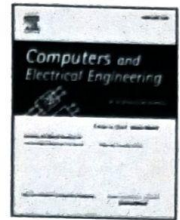
A visual review of artificial intelligence and Industry 4.0 in healthcare ☆

Sandeep Kumar Sood [a], Keshav Singh Rawat [b,*], Dheeraj Kumar [c]

[a] *Department of Computer Applications, National Institute of Technology, Kurukshetra, Haryana, India*
[b] *Department of Computer Science & Information Technology, Central University of Haryana, Mahendergarh, India*
[c] *Department of Computer Science and Informatics, Central University of Himachal Pradesh, Dharamshala, India*

ARTICLE INFO

ABSTRACT

The COVID-19 outbreak has led to a substantial loss of human life throughout the world and has a tremendous impact on healthcare services. Industry 4.0 technologies have established effective supply chain management towards the fulfillment of customized demands in the healthcare field. In addition, the internet of things, artificial intelligence, big data analytics, and 3D printing have been extensively used to combat the COVID-19 pandemic and assist in providing value-added services in the healthcare sector. Henceforth, this paper presents a scientometric analysis on the literature of aforementioned Industry 4.0 technologies in the context of COVID-19. It provides extensive insights into co-citation and co-occurrence analysis of high cited publications, participating countries, influential authors, prolific journals, and keywords using the CiteSpace tool. The analyses reveal that China has produced the highest research outputs, although India is the most collaborative country in this field. The current research hotspots include supply chain, 4D printing, and social distancing technologies. Furthermore, it explores emerging trends, intellectual structure of publications, research frontiers, and potential research directions for further work in the Industry 4.0 assisted healthcare domain.

1. Introduction

The fourth industrial revolution has completely revamped the traditional structure of healthcare field [1]. Industry 4.0 and its advanced Information and Communications Technologies (ICT) have been extensively used to control the spread of COVID-19 outbreak. ICT has addressed several challenges and produced promising solutions during this pandemic such as the establishment of effective supply chain management towards the fulfillment of unprecedented demands of health resources, identification of infection in early stages, and smart manufacturing. Industry 4.0 is based on the concept of Cyber–Physical Systems (CPS). In the healthcare field, it is also known as Medical Cyber–Physical Systems (MCPS). It enables to control and monitor the physical processes through the integration of advanced technologies. It has created huge potential for many industrial domains to improve operational efficiency. MCPS are futuristic systems that provide effective functionalities to handle emergency situations and externally control and monitor medical treatment [2]. It provides the paradigm of automated processes, flexibility in product design, rapid and high-quality manufacturing through the advancement of ICT. Industry 4.0 technologies have potential to improve information exploitation, develop futuristic health frameworks. It heavily relies on disruptive technologies such as Artificial Intelligence, Internet of Things
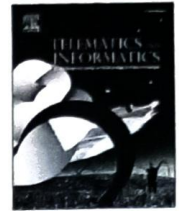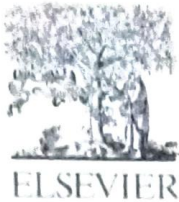
Analytical mapping of information and communication technology in emerging infectious diseases using CiteSpace

Sandeep Kumar Sood [a], Keshav Singh Rawat [b], Dheeraj Kumar [b,*]

[a] Department of Computer Aplications, National Institute of Technology, Kurukshetra, Haryana 136119, India
[b] Department of Computer Science and Informatics, Central University of Himachal Pradesh, Dharmashala, Himachal Pradesh 176215, India

ABSTRACT

The prevalence of severe infectious diseases has become a major global health concern. Currently, the COVID-19 outbreak has spread across the world and has created an unprecedented humanitarian crisis. The proliferation of novel viruses has put traditional health systems under immense pressure and posed several serious issues. Henceforth, early detection, identification, rapid testing, and advanced surveillance systems are required to address public health emergencies. However, Information and Communication Technology (ICT) tackles several issues raised by this pandemic and significantly improves the quality of services in the health care sector. This paper presents an ICT-assisted scientometric analysis of infectious diseases, namely, airborne, food & waterborne, fomite-borne, sexually transmitted illnesses, and vector-borne illnesses. It assesses the international research status of this field in terms of citation structure, prolific journals, and country contributions. It has used the CiteSpace tool to address the visualization needs and in-depth insights of scientific literature to pinpoint core hotspots, research frontiers, emerging research areas, and ICT trends. The research finding reveals that mobile apps, telemedicine, and artificial intelligence technologies have greater scope to reduce the threats of infectious diseases. COVID-19, influenza, HIV, and malaria viruses have been identified as research hotspots whereas COVID-19, contact tracing applications, security and privacy concerns about users' data are the recent challenges in this field that need to address. The United States has produced higher research output in all domains of infectious diseases. Furthermore, it explores the co-occurrence network analysis and intellectual landscape of each domain of infectious diseases. It provides potential research directions and insightful clues to researchers and the academic fraternity for further research.

1. Introduction

The proliferation of novel viruses has accelerated significant health threats and become a global problem in a very short period. Infectious illnesses are growing every year due to globalization, urbanization, and the spread of dangerous pathogens (Bloom et al., 2017). The dissemination of infections is a severe problem causing social consequences, economic loss and significant mortality around the globe. According to the World Health Organization (WHO) (Organization et al., 2015), more than 7 million people lose their lives due to infectious diseases every year, and at least 30 new diseases have been grown in last two decades. Moreover, several deadly

CSI-ITKP

Indian Traditional Knowledge System

Unit-I: Bhāratīya Civilization and Education System
Discovery of Saraswatī River, Saraswatī-Sindhu Civilization, Takṣaśilā University, Nālandā University, Traditional Knowledge System, Ancient India's Contribution to Science & Technology, Structure of Learning Centers and Education System, Overview of Traditional Knowledge Digital Library (TKDL).

Unit-II: ITKP with IT Tools
Indigenous IT, Astrology and Climatology with IT tools, Horoscope, Artificial Intelligence, AI in Indian Agriculture system, Indian Traditional Music with AI. The Future of Yoga with AI, Scope of Deep Learning in Medical Science, Kundli Software, Horoscope, MS- office.

Unit-III: ITKP and Number Systems
The idea of Zero, Number Systems: Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System, Decimal to Other Base System, Other Base System to Decimal, Other Base System to Non-Decimal, Shortcut method - Binary to Octal Shortcut method - Octal to Binary, Shortcut method - Binary to Hexadecimal, Shortcut method - Hexadecimal to Binary.

Unit-IV: Computer Applications and ITKP
Computer Generation: Machine language, Assembly language, low-level programming, Vacuum tube, Transistor, Integrated circuit, Microprocessor, CPU, Memory.
Challenges and Advantages of ITKP, Importance of Protection of Indian Traditional Knowledge, Role of WIPO's International Patent Classification (IPC) in India's Innovation in ITKP.

Text Books:
1. Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan, Under Publication by the CUHP Publication Bureau (2022).
2. A Sourcebook in Indian Philosophy, edited by S. Radhakrishnan and C. A. Moore; Princeton University Press (1957); ISBN 0-691-01958-4.

Reference Books:
1. History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and the Ramakrishnan Mission Institute of Culture, Kolkata (2014).
2. The Upanishads and Modern Thought by V. V. Rao; Mittal Publications, Delhi (1986).

MCA-521
Software Engineering

Course Objective: The objective of this course is to provide a solid fundamental knowledge of software engineering. On completion of the course, the student is expected to work as an individual and/or in team to develop and deliver quality software.

Course Outcomes

After completing the course, the student should be able to:

- Demonstrate knowledge of software engineering's layered technology and software process models, which serve as the foundation for the software development lifecycle
- Define the procedures involved in the discovery and documentation of software/system requirements and grasp the underlying mechanisms in the discovery and production of these requirements

Course Contents:

Unit-I

Introduction: Introduction to software Engineering, Software characteristics, Software components, Software applications, Software Engineering Principles, Software metrics and measurement, monitoring and control

Unit -II

Software development life-cycle, Water fall model, prototyping model, Incremental model, Iterative enhancement Model, Spiral model.

Unit-III

Software Requirement Specification: Requirements Elicitation Techniques, Requirements analysis, Models for Requirements analysis, requirements specification, requirements validation

Unit-IV

System Design: Design Principles: Problem partitioning, abstraction, Top down and bottom up design, structured approach. Functional versus object-oriented approach of design, design specification, Cohesiveness and Coupling, Overview of SA/SD Methodology, structured analysis, data flow diagrams, extending DFD to structure chart, Basics of testing

Text Books:
- K. K. Aggarwal & Second Edition, New Age International Publishers.
- Pankaj Jalote "software engineering " Wiley India

Reference Books:
- Roger S. Pressman, " Software engineering- A Practitioner Approach", TMH
- Rajib Mall, "Fundamental of Software Engineering", PHI Learning Pvt. Ltd.

MCA-522
Software Testing

Unit-I

Testing: Verification and validation, code inspection, test plan, test case specification. Level of testing: Unit, Integration Testing, Top down and bottom up integration testing, Alpha and Beta testing, System testing and debugging. Functional testing, structural testing, Software testing strategies.

Unit –II

Software Maintenance: Structured Vs unstructured maintenance, Maintenance Models, Configuration Management, Reverse Engineering, Software Re-engineering.

Unit-III

Software project Management: Project planning and Project scheduling. Software Metrics: Size Metrics like LOC, Token Count, function Count. Cost estimation using models like COCOMO. Risk management activities.

Unit-IV

Software Reliability and Quality Assurance: Reliability issues, Reliability metrics, reliability models, Software quality, ISO 9000 certification for software industry, SEI capability maturity model.

Text Books:
- Software Engineering, "K. K. Aggarwal &Yogesh Singh", 2E, New Age International, 2005
- Pankaj Jalote "software engineering " Wiley India

Reference Books:
- Roger S. Pressman, " Software engineering- A Practitioner Approach", TMH
- Rajib Mall, "Fundamental of Software Engineering", PHI Learning Pvt. Ltd.

MCA 538
Fundamentals of ICT

UNIT-I

Introduction: Computer, Data Processing, Computer System Characteristics, Evolution of Computers, Capabilities and Limitations, Generations of computers, Block diagram of computer, Basic components of a computer system- Input unit, Output unit, Storage unit, ALU, Control unit, Central Processing unit; Number Systems- Non-positional number system, Positional number system, Decimal Number system, Binary number system, Octal number system, Hexadecimal number system.

UNIT-II

Memory: Main memory organization, Main memory capacity, RAM, ROM, PROM, EPROM, Cache Memory, Secondary storage devices: Sequential access devices- Magnetic tape; Direct access devices- Magnetic disks, Floppy disks, Optical disks, Types of Optical disks: CD-ROM, CDR, CD-RW, DVD.
Input devices: Keyboard, Pointing Devices-Mouse, Touch screens, Joystick, Electronic pen, Trackball, Scanning devices: Optical Scanners, OCR, OMR, Bar code reader, MICR, Electronic card reader, Image capturing devices, Digital cameras.
Output devices: Monitors- CRT, LCD, Printers-Dot matrix, Inkjet, Laser; Plotters, Screen image projector.

UNIT-III

Introduction: Software, Relationship between Hardware and Software, Types of Software-System Software, Application Software; System Software-Operating System, Utility Program; Programming Languages-Machine, Assembly, High Level; Assembler, Compiler, Interpreter.

UNIT-IV

Data Communication & Computer Networks, Basic elements of a communication system, Data Transmission modes-Simplex, Half duplex, Full duplex; Data Transmission speed-Narrowband, Voice band, Broadband; Data Transmission media-Twisted Pair Wire, Coaxial cable, Optical fibers; Modems, Types of Network-LAN, WAN, MAN; Internet, World Wide Web, Web Browsers.

Text Book:
1. Pradeep K. Sinha, PritiSinha, "Computer Fundamentals", 6E ,BPB Publications.

Reference Books:
1. Rajaraman, V., "Fundamental of Computers", Fifth Edition, Prentice Hall India, New Delhi.
2. E. Balagurusamy, "Introduction to Computers (Special Indian Edition)", Tata McGraw Hill.

MCA 539
Problem Solving using C

UNIT-I
Overview of C- General Structure of C Program, C compilers, Editing, Compiling & , Running of a C program Data types, Constants and Variables, Operators and expressions, Storage Classes, Different types of expressions and their Evaluation, Conditional Expression, Assignment statement, Enumerated data type, Redefining/ Creating data types, Library functions, Type casting. Input/Output- Unformatted and formatted I/O Functions.

UNIT-II
Control Statements- Decision making using if, if-else, elseif and switch statements, Looping using for, while and do-while statements, Transferring Program controlling break and continue statements, Programming examples to illustrate the use of these control statements.
Functions- Defining a function, Local variables, return statement, invoking a Function, specifying and passing arguments to a function, Functions returning non Integer, External, static, and register variable, block structure, initialization and recursion.

UNIT-III
Array & strings- Introduction to arrays, Declaring arrays, Initializing, arrays, Processing arrays, Pointers to arrays, Passing arrays as arguments to functions, Introduction to strings, Pointers to strings, Passing strings and Arrays of strings as arguments to a function, Programming examples to illustrate the use of arrays and strings.
Pointers- Definition, Need of pointers, declaring Pointers, Accessing Values via Pointers, Pointer arithmetic, Types of pointers, Programming examples to illustrate the use of pointers.

Unit-IV
Structures- Declaring a structure type, Declaring Variables of structure type, Initializing Structures, Accessing Elements of structures, arrays of structures, nested structures, Pointers to structures Programming examples to illustrate the use of Structures. File Handling.

Text Books:
1.   E. Balagurusamy, "Programming in ANSI C", 8E ,Tata McGraw Hill.

Reference Books:
1. R S Salaria, Application in C, Khanna book publishing.
2. YashwantKanetakar, "Let us C" BPB.
3. Kerninghan B.W. & Ritchie D.M. "The C Programming Language" Prentice-Hall.
4. Mullish Cooper, "The Spirit of C" Jaico Publishing House.
5. Byron Gottfried, "Programming with C", Schaum's Outlines, Tata McGraw Hill.
6. Herbert Schildt, C: The complete reference, Tata mcCgraw hill.

MCA 540
NoSQL Databases

UNIT-I
Define what a NoSQL database is, Why we need NoSQL and how is it different from traditional databases. Learn about the various tools available such as MongoDB, Cassandra, HBase etc. Explore the principles of NoSQL using elementary examples in MongoDB.

UNIT-II
Develop an understanding of the available data models: value stores, document databases, columnfamily stores, graph databases. Understand the basic storage architecture in a distributed environment – column oriented databases, nested maps of key/value pairs, Hbase distributed storage architecture.

UNIT-III
The set of essential operations – CRUD refers to Create, Read, Update and Delete operations in the context of a NoSQL database environment. Practical experience of CRUD operations for document databases using MongoDB.

UNIT-IV
Developing Web Application with NOSQL and NOSQL Administration: Php and MongoDB, Python and MongoDB, Creating Blog Application with PHP,NOSQL Database Administration.

Text Books:
1. ShashankTiwari, "Professional NoSQL", John Wiley and Sons.
2. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide tothe Emerging World of Polyglot Persistence", Addison-Wesley.

MCA 401

Fundamentals of Computer

UNIT-I

Introduction: Computer, Data Processing, Computer System Characteristics, Evolution of Computers, Capabilities and Limitations, Generations of computers, Block diagram of computer, Basic components of a computer system- Input unit, Output unit, Storage unit, ALU, Control unit, Central Processing unit; Number Systems- Non-positional number system, Positional number system, Decimal Number system, Binary number system, Octal number system, Hexadecimal number system.

UNIT-II

Memory: Main memory organization, Main memory capacity, RAM, ROM, PROM, EPROM, Cache Memory, Secondary storage devices: Sequential access devices- Magnetic tape; Direct access devices- Magnetic disks, Floppy disks, Optical disks, Types of Optical disks: CD-ROM, CDR, CD-RW, DVD.
Input devices: Keyboard, Pointing Devices-Mouse, Touch screens, Joystick, Electronic pen, Trackball, Scanning devices: Optical Scanners, OCR, OMR, Bar code reader, MICR, Electronic card reader, Image capturing devices, Digital cameras.
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UNIT-III

Introduction: Software, Relationship between Hardware and Software, Types of Software-System Software, Application Software; System Software-Operating System, Utility Program; Programming Languages-Machine, Assembly, High Level; Assembler, Compiler, Interpreter.

UNIT-IV

Data Communication & Computer Networks, Basic elements of a communication system, Data Transmission modes-Simplex, Half duplex, Full duplex; Data Transmission speed-Narrowband, Voice band, Broadband; Data Transmission media-Twisted Pair Wire, Coaxial cable, Optical fibers; Modems, Types of Network-LAN, WAN, MAN; Internet, World Wide Web, Web Browsers.

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Reference Books:
1.   Rajaraman, V., "Fundamental of Computers", Fifth Edition, Prentice Hall India, New Delhi.
2.   E. Balagurusamy, "Introduction to Computers (Special Indian Edition)", Tata McGraw Hill.

MCA 402
C Programming

UNIT-I

Overview of C- General Structure of C Program, C compilers, Editing, Compiling & , Running of a C program Data types, Constants and Variables, Operators and expressions, Storage Classes, Different types of expressions and their Evaluation, Conditional Expression, Assignment statement, Enumerated data type, Redefining/ Creating data types, Library functions, Type casting. Input/Output- Unformatted and formatted I/O Functions.

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Pointers- Definition, Need of pointers, declaring Pointers, Accessing Values via Pointers, Pointer arithmetic, Types of pointers, Programming examples to illustrate the use of pointers.

Unit-IV

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3. Kerninghan B.W. & Ritchie D.M. "The C Programming Language" Prentice-Hall.
4. Mullish Cooper, "The Spirit of C" Jaico Publishing House.
5. Byron Gottfried, "Programming with C", Schaum's Outlines, Tata McGraw Hill.
6. Herbert Schildt, C: The complete reference, Tata mcCgraw hill.

MCA-602

Academic Writing

Course Objective: The objective of this course is to create an understanding of LaTeX.

UNIT-I

A brief History of Latex, what is Latex, Merits of LATEX over Word Processors, Demerits of LATEX, Installation of the software LATEX, Understanding LATEX compilation, LATEX input File structure, Preamble, Basic Syntax: Creating a Title Page, Page Numbering and Headings, Modifying Text etc. Use packages.

UNIT-II

Page Layout – Titles, Abstract Chapters, Sections, List making environments Table of contents, Figure handling numbering, List of figures, List of tables, Generating index, Matrix, Tables, List environment

UNIT-III

Math in Latex, Writing equations, references, citation. Packages: Geometry, Hyperref, amsmath, amssymb, algorithms, algorithmic graphic, color, tiles listing. Generating new commands, Generating bibliography and index.

UNIT-IV

Classes: article, book, report, beamer, IEEEtran. Applications to: Writing Resume, writing question paper, Writing articles/ research papers.

Text Book:

1. Leslie Lamport, ―LaTeX: A Document Preparation System, Second Edition‖, Addison Wesley.

Reference Book:

1. Frank Mittelbach, Michel Goossens, Johannes Braams, David Carlisle, Chris Rowley, ―LaTeX Companion‖, Addison Wesley.

MCA 507
Design & Analysis of Algorithm

Unit I

Divide and Conquer: General method, Binary Search, Merge Sort, Quick Sort, Matrix Multiplication algorithms and analysis of algorithm.

Unit II

Study of Greedy strategy, examples of greedy method like optimal merge patterns, Huffman coding, minimum spanning trees, knapsack problem, job sequencing with deadlines, single source shortest path algorithm

Unit III

Concept of dynamic programming, problems based on this approach such as 0/1 knapsack, multistage graph, reliability design, Floyd-Warshall's algorithm.

Unit IV

Backtracking concept and its examples like 8 queen's problem, Hamiltonian cycle etc. Introduction to Complexity Classes: P, NP, NP-Hard, NP-Complete.

Text Books:

1. Ellis Horowitz, SartajSahni and Sanguthevar Rajasekaran, "Computer Algorithms", 2E, Universities Press, 2007.
2. Cormen, T.H., Leiserson, C.E., Rivest, R.L. and Stein, C., "Introduction to Algorithms", 2E, Prentice Hall of India Pvt. Ltd, 2003.

Reference Books:

1. Aho, A.V., Hopcroft J.E. and Ullman, J.D., "The Design and Analysis of Computer Algorithms", Pearson Education, 1999.
2. Sara Baase and Allen Van Gelder, "Computer Algorithms, Introduction to Design and Analysis", 3E, Pearson Education, 2009.

MCA 536
Java Programming

UNIT-I
Object oriented programming: features of java, general structure of java program, sample program, data types, operators, controls statements, type conversion, functions, arrays, strings, Scanner class and its methods.

UNIT-II
Introducing Classes: class fundamentals, objects, methods, constructors, this keyword, method and constructor overloading, object as arguments, returning objects.
Inheritance: introduction, super keyword, method overriding, dynamic method dispatch, abstract classes, final keyword.

UNIT-III
Interfaces: Defining interfaces, extending interfaces, implementing interfaces, accessing interface variables.
Packages: Introduction, java API packages, using system packages, creating packages, accessing a package, using a package, adding a class to a package.
Multithreading: Introduction, creating threads, creating multiple threads, thread priorities, suspending, resuming and stopping threads.

UNIT-IV
Exception handling: Introduction, exception types, uncaught exceptions, using try, catch, throw and throws, java's built in exceptions, creating own exception subclasses.
GUI Programming with Swing: Hierarchy for Swing components, Overview of some Swing components –JLabel, JList, JTable, JComboBox, JSlider, JMenu, Abstract Button, JButton.

Text book:
1. Herbert Schildt, "The Complete Reference", 11E ,Tata McGraw Hill.
Reference Books:
1. Cay S. Horstmann, Gary Cornell," Core Java", Pearson.
2. R. NageswaraRao, "Core Java an integrated approach", Dreamtech Press.
3. James R. Levenick , "Simply JAVA :An Introduction to JAVA programming ",Firewall Media Publication New,Delhi.
4. E Balaguruswamy," Programming with Java", Tata McGraw Hill.

MCA 505
Data Base Management System

UNIT-I
Basic Concepts: Entity, Relationship and its types, Components of a database, three level architecture of a DBMS, Database models.
File Organization: Serial, Sequential, Index Sequential and Direct file organization.

UNIT-II
Entity-Relationship Model: Entity Types, Entity Sets, Attributes & keys, Relationships, Relationships Types, Roles and Structural Constraints, Design issues, E-R Diagrams, Design of an E-R Database Schema, Reduction of an E-R Schema to Tables.
Relational Data Model: Relational model concepts, Integrity constraints over Relations, Relational Algebra and Relational Calculus.
SQL: DDL, DML, and DCL, views & Queries in SQL, Specifying Constraints & Indexes in SQL.

UNIT-III
Relational Data Base Design: Functional Dependencies, Decomposition, Normal forms based on primary keys (1 NF, 2 NF, 3 NF, & BCNF), Multi-valued Dependencies, 4 NF, Join dependencies, 5 NF.
Transaction Processing Concepts: Introduction to Transaction Processing, Transaction & System Concepts, Properties of Transaction, Schedules and Recoverability, Serializability of Schedules.
Concurrency Control Techniques: Locking Techniques, Time stamp ordering, Multi- version Techniques, Optimistic Techniques, Granularity of Data items.

UNIT-IV
Recovery Techniques: Recovery concepts, Recovery Techniques in centralized DBMS. **Enhanced Data Models:** Temporal Database Concepts, Multimedia Databases, Deductive Databases, XML and Internet Databases; Mobile Databases, Geographic Information Systems, Genome Data Management, Distributed Databases and Client- Server Architectures.

Text Books:
1. R. Elmasri and S. B. Navathe, "Fundamentals of Database Systems", 7E, Addison Wesley.
2. Bayross, I., "SQL, PL/SQL: The Programming Language of Oracle",4E , BPB Publications.

Reference Books:
1. R. Ramakrishnan and J. Gehrke, "Database Management Systems", 3E, McGraw Hill.
2. A. Silberschatz, H. Korth and S. Sudarshan, "Database System Concepts", 6E, McGraw Hill.

हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Established under Central Universities Act 2009)
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MINIMUM ELIGIBILITY REQUIREMENTS, CRITERIA FOR SELECTION OF STUDENTS FOR ADMISSION, CREDIT REQUIREMENTS FOR COMPLETION AND CONDITIONS FOR AWARD OF VALUE ADDED COURSE "CERTIFICATE IN ARTIFICIAL INTELLIGENCE WITH QUANTITATIVE APTITUDE"

1. **Name of Programme: Certificate in Artificial Intelligence with Quantitative Aptitude**

2. **Programme Duration:**
   a. **Minimum:**   Six Months (01 Semester)
   b. **Maximum:**   Two Years (04 Semesters)
   c. **Intake:**   30+3 = **33**

3. **Minimum Eligibility Conditions:**

   A minimum of 50% Marks or an equivalent grade in Graduation from a recognized University/Institute.

4. **Relaxation in Minimum Qualifying Marks:**

   Relaxation in minimum qualifying marks up to a maximum of 5% shall be made in case of candidates belonging to the SC, ST and Persons with Disabilities categories.

5. **Selection Criteria for Admission:**

   All candidates seeking admission to Value Added Course "**Artificial Intelligence with Quantitative Aptitude"** shall be admitted on the basis of merit in Graduation or as decided by the University time to time.

6. **Credit Requirement for Value Added Course "**Artificial Intelligence with Quantitative Aptitude" **(01 Semester):**

   a. For the successful completion of the Programme, a student shall be required to accumulate a total of **20** credits as per course structure.
   b. The maximum number of credits that a student may earn in a Semester shall not exceed 20, and he/she shall be required to register for such number of courses accordingly.

7. **Conditions for the award of Certificate in Artificial Intelligence with Quantitative Aptitude:**

   The students will have the option to complete this Value Added Course within the duration of 02 years from the date of enrollment in the course. After successful completion of the said Value Added Course, the student will be awarded a Certificate by the University. This Certificate may be of 10 Credits (for 03 months) or 20 Credits (for 06 months), which the student has to earn during the stipulated time period.

CSI 651
Artificial Intelligence

UNIT-I
Introduction to AI- Definitions, Goals of AI, AI Approaches, AI Techniques, Branches of AI, Applications of AI.
Problem Solving, Search and Control Strategies: General problem solving, production systems, control strategies forward and backward chaining, exhaustive searches depth first breadth first search.
Heuristic Search Techniques: Hill climbing, Branch and bound technique, Best first search & A* algorithm, Problem reduction & AO* algorithm.

UNIT-II
Game Playing - Overview, Mini-Max search procedure, Game playing with Mini-Max, Alpha-Beta pruning.
Learning Systems-Rote learning, learning from example: Induction, Explanation Based Learning (EBL), Discovery, Clustering, Analogy, Neural net and genetic Learning, Reinforcement learning.
Knowledge Representations: First order predicate calculus, skolemization, resolution principle & unification, interface mechanisms, horn's clauses, semantic networks, frame systems and value inheritance, scripts, conceptual dependency.

UNIT-III
Natural Language Processing - Introduction, Syntactic processing, Semantic and Pragmatic analysis. **Pattern Recognition** - Introduction, Recognition and Classification Process, Learning Classification Pattern, Recognizing and Understanding Speech.

UNIT-IV
Expert Systems - Knowledge acquisition, Knowledge base, Working memory, Inference engine, Expert system shells, Explanation, Application of expert systems.
Fundamentals of Neural Networks -Research history, Model of artificial neuron, Neural networks architectures, Learning methods in neural networks, Single-layer neural network system, Applications of neural networks.
Fundamentals of Genetic Algorithms - Search optimization algorithm, Evolutionary algorithm, Encoding, Operators of genetic algorithm, Basic genetic algorithm.

Text Books:
1. Norvig, P. Russel, and S. ‖ Artificial Intelligence. A modern approach‖, Fourth Edition, Prentice Hall of India.

Reference Books:
1. Dan W. Patterson, —Introduction to Artificial Intelligence and Expert Systems‖, Prentice Hall of India.

2. Elaine Rich and Kevin Knight, —Artificial Intelligence‖,Tata McGraw Hill.

3. E Charniak and D McDermott, —Introduction to Artificial Intelligence‖, Pearson.

MCA 452

Python Programming

UNIT-I

Introduction to Python Programming Language: PythonData Types &Installing Python, Input/ Output: Keywords, Identifiers, Python Statement, Indentation, Documentation, Variables, Multiple Assignment, Understanding Data Type, Data Type Conversion, Python Input and Output Functions, Import command. Operators and Expressions: Operators in Python, Expressions.

UNIT-II

Control Structures: Decision making statements, Python loops, Python control statements. Data Types: Numbers, Lists, Tuples, Sets, Dictionary, Strings.

UNIT-III

Python Functions: Functions, Advantages of Functions, Built-in Functions, and User defined functions, pass by value Vs. Pass by Reference, Recursion, Python Modules, Packages.

UNIT-IV

Exception Handling: Exceptions, Built-in exceptions, Exception handling, User-defined exceptions in Python.File handling Modes, Reading Files, Writing& Appending to Files, Handling File Exceptions, The with statement, New Style Classes, Creating Classes, Instance Methods, Inheritance, Polymorphism

Text Books:

1. R. S. Salaria, "Programming in Python", Khanna Publishing.

Reference Books:

1. Pooja Sharma,"Programming in Python", BPB Publications.
2. A. Martelli, A. Ravenscroft, S. Holden, "Python in a Nutshell", OREILLY.
3. R. Nageswara Rao, "Core Python Programming", 2E, Dreamtech.
4. Martin C. Brown, "Python, The complete Reference", McGraw Hill.

CSI 453
Data Mining

Course Contents:

UNIT – I
Motivation, origin and definitions of Data Mining, opportunity, Data mining tasks, classification and its applications, clustering and its applications, Major Issues in Data Mining. Data, and attributes types. Type of data sets. Data Quality, Outliers. Similarity and Dissimilarity measures.

UNIT- II
Data Preprocessing: Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Classification: Definition, classification techniques, Decision trees and its example, Hunt's algorithm, measures of node impurity: Gini index and entropy. Nearest neighbor classifier and its example.

UNIT – III
Frequent item set: Support (S) and Confidence (C). Mining Association Rules in Large Databases: Association Rule Mining: Market Basket Analysis, The apriori algorithm, Generating Association rules from frequent items, improving the efficiency of apriori, Factors Affecting Complexity of apriori.

UNIT – IV
Cluster Analysis, Types of clusters, Types of Clustering, Clustering algorithms: K-means and its limitations, and Applications.

Reference Books:

1. Introduction to Data Mining, 2nd Edition   Tan, Steinbach, Karpatne, Kumar
2. J. Han and M. Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Pub.
3. S.K. Pujari, "Data Mining Techniques", University Press, Hyderabad.

MCA-551

IT Tools for IKS

Unit-I

IKS with computer: Indigenous IT**,** Scope of Information Technology in Ayurveda, Astrology and Climatology with IT tools, Horoscope, Importance of AI in Indian Agriculture system, Indian Traditional Music application with AI. The Future of Yoga with AI, scope of Deep Learning in Medical science

Unit-II

Computer Generation: Machine language, Assembly language, low-level programming, Vacuum tube, Transistor, Integrated circuit, Microprocessor, CPU (central processing unit), Memory, Artificial Intelligence, Computer Generations.

Unit-III

Number System: Decimal Number System**,** Binary Number System, Octal Number System, Hexadecimal Number System, Decimal to Other Base System, Other Base System to Decimal, Other Base System to Non-Decimal, Shortcut method - Binary to Octal Shortcut method - Octal to Binary, Shortcut method - Binary to Hexadecimal, Shortcut method - Hexadecimal to Binary.

Unit-IV

Kundli Software, Horoscope, MS- office.